



TENDER COVER PAGE



MBD 1

YOU ARE HEREBY INVITED TO BID FOR REQUIREMENTS OF JOHANNESBURG WATER

BID NUMBER: JW14060RR

CLOSING DATE: 28 JANUARY 2025

CLOSING TIME: 10:30 AM

DESCRIPTION: NORTHERN WASTEWATER TREATMENT WORKS DEWATERING BUILDING BELT PRESS REPLACEMENT AND ASSOCIATED ANCILLARIES

CIDB REQUIREMENTS: TENDERERS SHOULD HAVE A CONTRACTOR CIDB GRADING OF 8ME OR HIGHER

BRIEFING SESSION	COMPLUSORY: YES
BRIEFING DETAILS	DATE AND TIME: 03 DECEMBER 2024 AT 10:00 AM ADDRESS : PLOT JR/388, OFF SCHOOL ROAD, FROM WILLIAM NICOLE, DIEPSLOOT <i>For offsite briefing attendees to ensure that transport used is capable to access the gravel road for site viewing.</i>
TENDER SUBMISSION DETAILS	BID DOCUMENTS MUST BE DEPOSITED IN THE TENDER BOX SITUATED AT GROUND FLOOR IN JOHANNESBURG WATER ADDRESS: TURBINE HALL, 65 NTEMI PILISO STREET, NEWTOWN, JOHANNESBURG, 2001 PLEASE ALLOW SUFFICIENT TIME TO ACCESS JOHANNESBURG WATER OFFICES IN TURBINE HALL AND DEPOSIT YOUR TENDER DOCUMENT IN THE JOHANNESBURG WATER TENDER BOX SITUATED AT RECEPTION BEFORE TENDER CLOSING TIME. TIMES: THE BUILDING WILL OPEN 7 DAYS A WEEK FROM 06:00 UNTIL 18:00

BIDDER INFORMATION

NAME OF BIDDER				
NO. OF DOCUMENTS SUBMITTED				
PHYSICAL ADDRESS				
TELEPHONE NUMBER				
CELLPHONE NUMBER				
E-MAIL ADDRESS				
VAT REGISTRATION NUMBER				
TAX COMPLIANCE STATUS	TCS PIN		MAAA No	
OTHER STATUS	COIDA Registration No		CIDB (CRS) No	

EMPLOYER INFORMATION

DEPARTMENT	CAPEX	DEPARTMENT	SCM
CONTACT PERSON	THAPELO TEANE	CONTACT PERSON	GCINA NDELA
TELEPHONE NUMBER	011 688 6615	TELEPHONE NUMBER	011 688 1796
E-MAIL ADDRESS	thapelo.teane@jwater.co.za	E-MAIL ADDRESS	gcina.ndela@jwater.co.za



**TENDER COVER PAGE
PART B
TERMS AND CONDITIONS FOR BIDDING**

1. BID SUBMISSION:

- 1.1. BIDS MUST BE DELIVERED BY THE STIPULATED TIME TO THE CORRECT ADDRESS. LATE BIDS WILL NOT BE ACCEPTED FOR CONSIDERATION.
- 1.2. **ALL BIDS MUST BE SUBMITTED ON THE OFFICIAL FORMS PROVIDED—(NOT TO BE RE-TYPED) OR ONLINE**
- 1.3. THIS BID IS SUBJECT TO THE PREFERENTIAL PROCUREMENT POLICY FRAMEWORK ACT AND THE PREFERENTIAL PROCUREMENT REGULATIONS, 2022, THE GENERAL CONDITIONS OF CONTRACT (GCC) AND, IF APPLICABLE, ANY OTHER SPECIAL CONDITIONS OF CONTRACT.

2. TAX COMPLIANCE REQUIREMENTS

- 2.1 BIDDERS MUST ENSURE COMPLIANCE WITH THEIR TAX OBLIGATIONS.
- 2.2 BIDDERS ARE REQUIRED TO SUBMIT THEIR UNIQUE PERSONAL IDENTIFICATION NUMBER (PIN) ISSUED BY SARS TO ENABLE THE ORGAN OF STATE TO VIEW THE TAXPAYER'S PROFILE AND TAX STATUS.
- 2.3 APPLICATION FOR THE TAX COMPLIANCE STATUS (TCS) CERTIFICATE OR PIN MAY ALSO BE MADE VIA E-FILING. IN ORDER TO USE THIS PROVISION, TAXPAYERS WILL NEED TO REGISTER WITH SARS AS E-FILERS THROUGH THE WEBSITE WWW.SARS.GOV.ZA.
- 2.4 FOREIGN SUPPLIERS MUST COMPLETE THE PRE-AWARD QUESTIONNAIRE IN PART B:3.
- 2.5 BIDDERS MAY ALSO SUBMIT A PRINTED TCS CERTIFICATE TOGETHER WITH THE BID.
- 2.6 IN BIDS WHERE CONSORTIA / JOINT VENTURES / SUB-CONTRACTORS ARE INVOLVED, EACH PARTY MUST SUBMIT A SEPARATE TCS CERTIFICATE / PIN / CSD NUMBER.
- 2.7 WHERE NO TCS IS AVAILABLE BUT THE BIDDER IS REGISTERED ON THE CENTRAL SUPPLIER DATABASE (CSD), A CSD NUMBER MUST BE PROVIDED.

3. QUESTIONNAIRE TO BIDDING FOREIGN SUPPLIERS

- 3.1. IS THE ENTITY A RESIDENT OF THE REPUBLIC OF SOUTH AFRICA (RSA)? ☐ YES ☐ NO
- 3.2. DOES THE ENTITY HAVE A BRANCH IN THE RSA? ☐ YES ☐ NO
- 3.3. DOES THE ENTITY HAVE A PERMANENT ESTABLISHMENT IN THE RSA? ☐ YES ☐ NO
- 3.4. DOES THE ENTITY HAVE ANY SOURCE OF INCOME IN THE RSA? ☐ YES ☐ NO
- 3.5. IS THE ENTITY LIABLE IN THE RSA FOR ANY FORM OF TAXATION? ☐ YES ☐ NO

IF THE ANSWER IS "NO" TO ALL OF THE ABOVE, THEN IT IS NOT A REQUIREMENT TO REGISTER FOR A TAX COMPLIANCE STATUS SYSTEM PIN CODE FROM THE SOUTH AFRICAN REVENUE SERVICE (SARS) AND IF NOT REGISTER AS PER 2.3 ABOVE.

NB: FAILURE TO PROVIDE ANY OF THE ABOVE PARTICULARS MAY RENDER THE BID INVALID



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WITHOUT LIMITATION, JOHANNESBURG WATER TAKES NO RESPONSIBILITY FOR ANY DELAYS IN ANY COURIER OR POSTAL SYSTEM OR ANY LOGISTICAL DELAYS WITHIN THE PREMISES OF JOHANNESBURG WATER. JOHANNESBURG WATER LIKEWISE TAKES NO RESPONSIBILITY FOR OFFERS DELIVERED TO A LOCATION OTHER THAN THE TENDER BOX AS PER THE TENDER SUBMISSION DETAILS STATED IN THE TENDER DOCUMENT. PROOF OF POSTING OR OF COURIER DELIVERY WILL NOT BE TAKEN BY JOHANNESBURG WATER AS PROOF OF DELIVERY. TENDER SUBMISSION DOCUMENTS MUST BE IN THE BOX BEFORE TENDER CLOSURE.

The Johannesburg Water Supply Chain Management policy at time of tender advert is applicable to this tender and is available on the JW website www.johannesburgwater.co.za

THE TENDERER IS ENCOURAGED TO SIGN THE TENDER SUBMISSION REGISTER WHEN SUBMITTING THEIR TENDERS.

PLEASE ENSURE YOU SUBMIT 1 x ORIGINAL TENDER HARD DOCUMENT
(ALSO PROVIDE AN ELECTRONIC COPY IN A MEMORY STICK/USB).

Any documents required that are not submitted in the tender box at the deadline will be considered late.

The tenderer accepts that Johannesburg Water will not take responsibility for the misplacement or premature opening of the tender if the outer package is not sealed and marked as stated.

NB: NO BIDS WILL BE CONSIDERED FROM PERSONS IN THE SERVICE OF THE STATE.

NAME OF CONTACT PERSON:

SIGNATURE OF BIDDER:

CAPACITY UNDER WHICH THIS BID IS SIGNED:

DATE:



TENDER NOTICE AND INVITATION TO TENDER



1. TENDER NOTICE AND INVITATION TO TENDER

Johannesburg Water (SOC) Ltd invites the tenderer for the following:

CONTRACT NO: JW14060RR NORTHERN WASTEWATER TREATMENT WORKS DEWATERING BUILDING BELT PRESS REPLACEMENT AND ASSOCIATED ANCILLARIES

The tender document will be available in the form of a download from the Johannesburg Water website (www.johannesburgwater.co.za /supply chain/tenders) starting from 20 November 2024.

The Employer is **Johannesburg Water (SOC) Ltd**

All tenders and supporting documents must be sealed and be placed in the Tender box on the ground floor of Johannesburg Water by no later than 10:30 am on 28 January 2025.

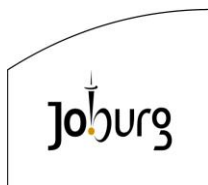
Address is as follows:

**TURBINE HALL,
65 NTEMI PILISO STREET,
NEWTOWN,
JOHANNESBURG,
2001**

The Employer is not obliged to accept the lowest or any tender and reserve the right to appoint:

- a) in whole or in part.
- b) to more than one tenderer.
- c) to the highest points scoring bidder.
- d) to the lowest acceptable tender or highest acceptable tender in terms of the point scoring system.
- e) to a bidder not scoring the highest points (based on objective grounds in terms of section 2 (1) (f) of the PPPFA) (where applicable).
- f) not to consider any bid with justifiable reasons.

A valid and binding contract with the successful tender/s will be concluded once the Employer has awarded the contract. The Employer will issue an appointment letter to the successful tenderer.



Contract: JW14060RR
Northern Wastewater Treatment Works
Dewatering Building Belt Press
Replacement and Associated Ancillaries



Volume 1 Tender and Contract
Section T1 Tender and Contract

Johannesburg Water SOC Ltd



CONTRACT NO: JW14060RR

NORTHERN WASTEWATER TREATMENT WORKS

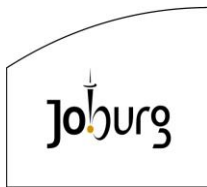
DEWATERING BUILDING BELT PRESS REPLACEMENT AND ASSOCIATED ANCILLARIES

VOLUME 1 TENDER AND CONTRACT

Prepared by
PMU
PO Box 61542
Marshalltown
2107

V1.0
August 2023

Employer:		Contractor:	
Witness:		Witness:	



Contract No JW14060RR
Northern Wastewater Treatment Works
Dewatering Building Belt Press
Replacement and Associated Ancillaries



Volume 1 Tender and Contract
Section T1 Tender and Contract

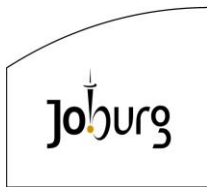
The Tenderer is to indicate in the “Submitted (Yes/No)” column in the below table that they have completed the required section of the tender document. Completion of this checklist will assist the Tenderer in ensuring that they have attended to all the required items for submission with this tender. Additionally, it is an absolute requirement that tenderers comply with National Treasury’s CSD registration as well as SARS tax compliance requirements for contract award – refer T2.2.2. The below will form part of the tender document, the tenderers are therefore encouraged to submit the returnable and or documentation with their tender offer to avoid elimination especially with regards to what is stated in the Required for Tender Evaluation column or not obtaining points for Specific Goals. Tenderers are encouraged to ensure that their Tax status remains Tax Compliant on CSD throughout the process to avoid delaying the process or being eliminated at award stage. For infrastructure related projects. Tenderer must have a CIDB Active Status at the requested CIDB requirement at evaluation stage to avoid disqualification.

All documentation listed in the Checklist below shall form part of the Contract.

Table 1

Ref	Description of Returnable/s or Documentation that will form Part of Contract and must therefore to be Completed and / or Submitted by the Tenderer	Required for Tender Evaluation	Required for Tender Award	Required After Tender Award	Submitted (Yes/No)
	Tender Cover:				
	Name of Tender	•			
	Contact Person	•			
	Telephone Number	•			
	Central Supplier Database Registration	•	•		
	CIDB Registration Number	•			
	COIDA Registration Number			•	
	Tax SARS PIN No.	•	•		
	MAAA No. for Tax Compliant Status		•		
	Mandatory Documents at Particular Stage:				
	CIDB grading of 8ME or higher	•			
	Attendance Mandatory Tender Briefing Meeting	•			
	Form of Offer Completed and Signed	•			
	Acknowledgement of Project Tender Drawings	•			
	Acknowledgement of SHE Specification & Annexures	•			
	Administrative Documentation:				
	MBD 1 - Invitation to Bid - Completed and signed	•	•		
T2.2.4	MBD 4 - Declaration of interest - Completed and signed	•	•		
	MBD 5 - Declaration for procurement above R10 Million (all applicable taxes	•	•		

Employer:		Contractor:	
Witness:		Witness:	



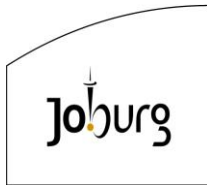
**Contract No JW14060RR
Northern Wastewater Treatment Works
Dewatering Building Belt Press
Replacement and Associated Ancillaries**



**Volume 1 Tender and Contract
Section T1 Tender and Contract**

Ref	Description of Returnable/s or Documentation that will form Part of Contract and must therefore to be Completed and / or Submitted by the Tenderer	Required for Tender Evaluation	Required for Tender Award	Required After Tender Award	Submitted (Yes/No)
	included) Completed and signed.				
	MBD 6.1 - Preference Points Schedule – Specific Goals and Price Points - Completed and signed.	•			
T2.1	Signed Certificate of Authority to Sign	•			
	Acknowledgement of Project Tender Drawings	•	•		
	Acknowledgement of SHE Specification & Annexures	•	•		
T2.2.4	MBD 8 - Bidder's past supply chain management practices – Completed and signed.	•	•		
T2.2.4	MBD 9 - Certificate of Independent Bid Determination – Completed and signed.	•	•		
	Municipal Rates and Taxes for the Company - Current municipal rates for the company not older than 90 days (if leasing/renting, submitted proof such as lease agreement where premises are rented), OR Confirmation that suitable arrangements are in place for arrear municipal obligations with your local municipality OR Current municipal rates which is not older than 90 days or valid lease agreement with affidavit from owner of property in cases stated in Proof of Good Standing with Regards to Municipal Accounts document in the Tender.	•	•		
	Municipal Rates and Taxes - Current municipal rates for the directors of the entity not older than 90 days (if leasing/renting, submitted proof such of lease agreement where premises are rented), OR Confirmation that suitable arrangements are in place for arrear municipal obligations with your local municipality OR Current municipal rates which is not older than 90 days or valid lease agreement with affidavit from owner of property in cases stated in Proof of Good Standing with Regards to Municipal	•	•		

Employer:		Contractor:	
Witness:		Witness:	



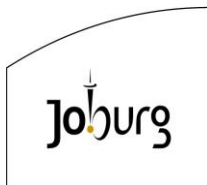
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Replacement and Associated Ancillaries



Volume 1 Tender and Contract
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Ref	Description of Returnable/s or Documentation that will form Part of Contract and must therefore to be Completed and / or Submitted by the Tenderer	Required for Tender Evaluation	Required for Tender Award	Required After Tender Award	Submitted (Yes/No)
	Accounts document in the Tender.				
	3-year financial statements (audited where applicable)	•	•		
	Any qualifications. If "Yes", reference to such qualification/s must be indicated on a cover letter. Please be aware that qualification on the tender document may result in your tender being eliminated as the qualification may impede on the ability to evaluate like with like.	•			
4.	Functionality Documentation:				
	Documentary Evidence Criteria 1 – (Contactable Reference Letters)	•			
	Documentary Evidence Criteria 2 – (Contactable Reference Letters)	•			
	Documentary Evidence Criteria 3 – (Contactable Reference Letters)	•			
	Documentary Evidence Criteria 4 – (CV)	•			
	Documentary Evidence Criteria 5 – (CV)	•			
	Documentary Evidence Criteria 6 – (CV)	•			
	Documentary Evidence Criteria 7 – (Page/pages of specific Method)	•			
5.	Specific Goals:				
	Business owned by 51% or more- Women	•			
	Business owned by 51% or more- by Black people	•			
7.	Pricing Schedule:				
	Bill of Quantities/ Schedule of Quantities. completed in accordance with the award strategy	•			
	Alterations authenticated – Refer to Conditions of Tender	•			
8.	Terms and Conditions:				
	General Conditions of Contract	•			
	Special Conditions	•			
	Tender Data	•			
9.	Other Documents				
	Form of Acceptance (do not complete will only be completed after award)			•	
	Third Liability Insurance			•	
	Insurance of Works			•	
	Common Law Liability Insurance			•	

Employer:		Contractor:	
Witness:		Witness:	



Contract No JW14060RR
Northern Wastewater Treatment Works
Dewatering Building Belt Press
Replacement and Associated Ancillaries



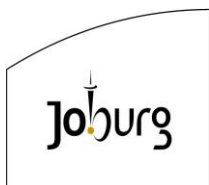
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Ref	Description of Returnable/s or Documentation that will form Part of Contract and must therefore to be Completed and / or Submitted by the Tenderer	Required for Tender Evaluation	Required for Tender Award	Required After Tender Award	Submitted (Yes/No)
	Insurance of Construction Plant and Equipment			•	
	Valid Registration with Compensation for Occupation Injuries and Diseases Act			•	
	Performance Guarantee – where applicable for industrial related services			•	
	Bank Details Form			•	

Tenderers will be notified of such or any missing and incomplete documents and will be offered a period of 3 days to complete or submit those pages i.e., Municipal Bidding Documents (MBD) and other documents that require completion and signatures that do not have a bearing on functionality, price and preference points for specific goals. Tenders that are received contrary to the above requirements will be disqualified after three (3) days period has lapsed. If locality is a specific goal in MBD6.1 – the requested documentation may not be used to allocate points for specific goals.

Signature: _____ Date _____

Employer:		Contractor:	
Witness:		Witness:	



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Johannesburg Water (SOC) Ltd



CONTRACT NO. JW14060RR

NORTHERN WASTEWATER TREATMENT WORKS

**DEWATERING BUILDING BELT PRESS
REPLACEMENT AND ASSOCIATED ANCILLARIES**

VOLUME 1

TENDERING PROCEDURES

Employer:		Contractor:	
Witness:		Witness:	

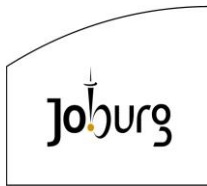
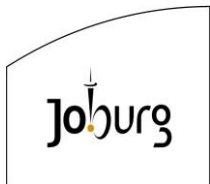


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Employer:		Contractor:	
Witness:		Witness:	



T1.1 TENDER DATA

T1.1.1 Conditions of Tender

The conditions of tender are the Standard Conditions of Tender as contained in Annex C of the CIDB Standard for Uniformity in Construction Procurement (August 2019). (See www.cidb.org.za).

The Standard Conditions of Tender make several references to the Tender Data for details that apply specifically to this tender. The Tender Data shall have precedence in the interpretation of any ambiguity or inconsistency between it and the Standard Conditions of Tender.

Each item of data given below is cross-referenced to the clause in the Standard Conditions of Tender to which it mainly applies.

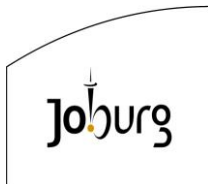
T1.1.2 Tender Data

The clause numbers in the Tender Data refer to the corresponding clause numbers in the Conditions of Tender.

The additional Conditions of Tender are:

Clause number	Tender Data
C.1.1	The Employer is, Johannesburg Water (SOC) Limited
C.1.2	The tender documents issued by the Employer comprise: Volume 1 Tender Part 1: Tendering Procedures T1.1 Tender Notice and Invitation to Tender T1.2 Tender Data Tender Part 2: Returnable Documents T2.1 List of Returnable Documents T2.2 Returnable Schedules, including the Enterprise Declaration Affidavit which may be bound in a separate volume. Contract Part 1: Agreement and Contract Data C1.1 Form of Offer and Acceptance C1.2 Contract Data C1.3 Forms of Securities Contract Part 2: Pricing Data C2.1 Pricing Instructions C2.2 Bill of Quantities/Schedule of Rates Volume 2A Contract Part 3: Scope of Work C3.1 Scope of Work C3.2 Particular Specifications

Employer:		Contractor:	
Witness:		Witness:	



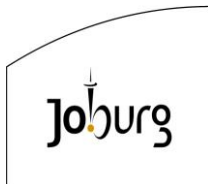
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Clause number	Tender Data
	Contract Part 4: Site Information C4 Site Information Volume 2B Generic Specifications Volume 3 Occupational Health, Safety and Environmental Specification and Environmental Management Plan Volume 4 Tender Drawings
C.1.4	The Employer's representative is: Contact Person: Mr Thapelo Teane Telephone: 011 688 6615 E-mail address: thapelo.teane@jwater.co.za The SCM representative is: Contact Person: Tshilidzi Takalani Telephone: 011 688 1772 E-mail address: tshilidzi.takalani@jwater.co.za
C.2.1	Eligibility criteria and requirements CIDB registration and grading: 1) Only tenderers who are registered with the CIDB and were capable of being so prior to the evaluation of submissions, in a contractor grading designation equal to or higher than a contractor grading designation determined in accordance with the sum tendered for an 8ME class of construction work, are eligible to submit tenders. Tenders must have an Active status at the required CIDB grading at time of tender evaluation for the bidder to meet the eligibility criteria and requirement. 2) Joint ventures are eligible to submit tenders provided that: i) Every member of the joint venture is registered with the CIDB; and ii) The combined contractor grading designation calculated in accordance with the CIDB Regulations is equal to or higher than a contractor grading designation determined in accordance with the sum tendered for an 8ME class of construction work. Failure to meet to Eligibility criteria and requirements will result in disqualification.

Employer:		Contractor:	
Witness:		Witness:	

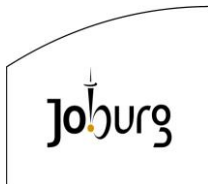


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Clause number	Tender Data
C.2.7	Tenderers should forward their contact details to the contact persons as stated on the Tender Cover Page and Invitation to Tender so that they will be sent any communication pertaining to this tender.
C.2.8	Replace the contents of the clause with the following: "Request clarification of the tender documents, if necessary, by notifying the Employer's Officials indicated on the Tender Notice and Invitation to Tender in writing at least seven (7) working days before the closing time stated in the foregoing notice.
C.2.9	Add the following to the clause: "Accept that the submission of a Tender shall be construed as an acknowledgement by the Tenderer that they are satisfied with the insurance cover, the Employer will affect under the contract."
C.2.10.5	Add the following to the clause: "If no offer is made for an item, a line must be drawn through the space in pen. All prices and details must be legible / readable to ensure the tender will be considered for adjudication."

Employer:		Contractor:	
Witness:		Witness:	



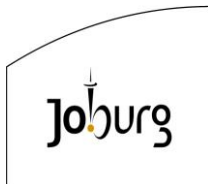
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Clause number	Tender Data
C.2.11	The evaluation on price alteration will be conducted as follows: Where the tender award strategy is to evaluate and award per item or category, the following must apply: • If there is an alteration in the rate but no alteration on the total for the item or category, the bidder will not be disqualified. • If there is an alteration on the total for the item/s without authentication, bidders will only be disqualified for alteration per item or category. Where the tender award strategy is to evaluate and award total bid offer, the following must apply: • If there is an alteration on the rate, total for the line item, sub-total/ sum brought/carried forward for the section but no alteration on the total bid offer, the bidder will not be disqualified. • If there is an alteration on the total bid offer on "Form of Offer" then the amount in words must be considered or vice-versa. • If there is an unauthenticated alteration on the total bid offer and the amount in words is not authenticated, the bidders will be disqualified for the entire tender. Where the tender pricing schedule or bill of quantities is requesting rates/price from bidder/s without providing a total, the following will apply: • (i) If there is an unauthenticated alteration on the unit rate/price the bidder must be disqualified. Please note: Corrections may not be made using correction fluid, correction tape or the like.
C.2.12.1	Replace Contents Alternative offers will not be permitted.
C.2.12.2	Failure to complete and sign the Form of Offer in full will result in the elimination of the tender.
C.2.13.3	Each tender offer shall be submitted as an original. Tenderers are also requested to submit a soft copy in a USB (Tenderers who do not submit a soft copy will not be disqualified)
C.3.9	Replace Existing Clause Arithmetic Errors Construction related tenders JW undertakes to check the highest scoring bid for arithmetical errors and correcting them as follows: JW shall check for arithmetic errors using the following sequence: - Check the amount in words against the amount in figures on the <i>Form of Offer</i>, - Check the Form of Offer against the Summary Schedule Total,

Employer:		Contractor:	
Witness:		Witness:	

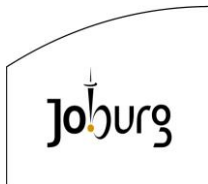


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Clause number	Tender Data
	(iii) Check the Section Sub-Totals per section against the Summary Total for summation errors, (iv) Check the Section Sub-Totals in the Summary Schedule against Section Sub-Totals in the Bill of Quantities. (v) Check the Section Sub-Totals against the Item Totals for summation errors. (vi) Check the Item Totals against the product of the Item Rate and the Quantity Provided. If a bill of quantities or price schedule applies JW will request the bidder to correct the arithmetic errors as follows: (i) In respect of the Form of Offer, where there is a discrepancy between the amounts in figures and the amount in words, the amount in words shall govern. The Tenderer must be requested to adjust the amount in figures to correspond with the amount in words. JW will notify the Tenderer of all errors or omissions that are identified in the tender offer and either request the Tenderer to confirm the offer as tendered or JW will accept the corrected total of prices. Where the Tenderer elects to confirm the tender offer as tendered, correct the errors as follows: (i) If bills of quantities or pricing schedules apply and there is an error in the line-item total resulting from the product of the unit rate and the quantity, the line-item total shall govern, and the rate shall be corrected. Where there is an obviously gross misplacement of the decimal point in the unit rate, the line-item total as quoted shall govern, and the unit rate shall be corrected. (ii) Where there is an error in the total of the prices either as a result of other corrections required by this checking process or in the tenderer's addition of prices, the total of the prices shall govern, and the tenderer will be requested to revise selected item prices (and their rates if bills of quantities apply) to achieve the tendered total of the prices. Clarification session(s) shall be held with Tenderer where there are pricing discrepancies, errors are highlighted and identified corrections are explained. Tenderer is afforded an opportunity to provide clarification, accept or reject identified corrections in writing. (i) In the event that the Tenderer accepts identified corrections, JW will proceed with evaluation. (ii) In the event that the Tenderer rejects the identified correction(s), JW must review the Tenderer's motivation and risks associated with the proposed change. This is not an opportunity for Tenderers to change the bid offer. A bidder that does not agree to the above will be disqualified.

Employer:		Contractor:	
Witness:		Witness:	

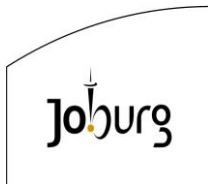


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Clause number	Tender Data
	Risk related to the Arithmetic Corrections shall be assessed. Where risks are identified, Tenderers shall provide JW with any other material or information that has a bearing on the tender offer, the Tenderer's commercial position (including joint venture agreements), quotations preferencing arrangements or samples of materials considered necessary by JW for the purpose of a full and fair risk assessment. Should the Tenderer not provide the material, or a satisfactory reason as to why it cannot be provided, by the time for submission stated in the JW request or fails to attend any meeting in which it has been formally invited to clarify any issue, the tender offer will be regarded as non-responsive.
C.2.13.5	The Employer's address for delivery of tender offers and identification details to be shown on the Tenderer's offer package are: Location of Tender Box: Ground Floor Entrance Physical address: Johannesburg Water (SOC) Ltd Turbine Hall 65 Ntemi Piliso Street Newtown Johannesburg 2001 Identification details: Tender reference number, Title of Tender and the closing date and time of the tender, <i>as well as the Tenderer's name, their Authorised Representative's name, postal address and telephonic contact numbers.</i>
C.2.13.6 & C.3.5	A two-envelope procedure will not be followed.
C.2.15.1	The closing time for submission of tender offers is as stated in the Tender Notice and Invitation to Tender.
C.2.16	The tender offer validity period is 90 days.
C.2.16.1	Add the following to the clause: "If the tender validity expires on a Saturday, Sunday or public holiday, the Tender Offer shall remain valid and open for acceptance until the closure of business on the following working day."
C.2.19	The Tenderer must provide access during working hours to his premises for inspections on request.

Employer:		Contractor:	
Witness:		Witness:	

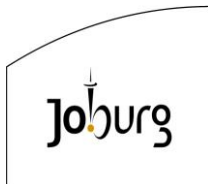


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Clause number	Tender Data
C.2.23	The Tenderer is required to submit with his tender: 1) Valid SARS Compliance status Pin for Tenders issued by the South African Revenue Services. 2) Proof of CSD registration i.e. MA xxxxxxxx number 3) A Certificate of Contractor Registration issued by the CIDB. 4) Where the tendered amount inclusive of VAT exceeds R 10 million: i. Audited annual financial statement for 3 years, or for the period since establishment if established during the last 3 years, if required by law to prepare annual financial statements for auditing. ii. If the bidder is not required by law to prepare financial statements, then the bidder is required to submit their unaudited financial statements prepared by an independent accounting professional. 5) Proof that the Tenderer and directors of the Tenderer are not in arrears for more than 90 days with municipal rates and taxes and municipal service charges, The latest municipal account is to be attached, or a signed copy of the valid lease agreement if the Tenderer or director of the Tenderer is currently leasing premises and not responsible for paying municipal accounts. i. Should the municipal statement that was submitted with the tender document before tender closing date and time be in arrears for more than 90 days at time of award, the tenderer will be requested to submit the latest municipal statement which shows that the Tenderer is not in arrears for more than 90 days. If the statement at that time is in arrears for more than 90 days, the Tenderer must submit before the stipulated deadline, the written proof of an approved arrangement with the municipality. ii. The proof may be a copy of the agreement or an updated municipal statement which reflects the arrangement. iii. Should this tender be considered for award of the contract, based on proof of submission and should proof of such submission be found to be invalid, erroneous or inaccurate, the tenderer will no longer be considered for the award of the contract. iv. Statement must not be older than 90 days from the closing date of this tender. Attach latest municipal account statement behind this page. v. In cases where the director of the tenderer resides with their spouse, parent, partner or sibling the owner of the property that confirm where the director of the tenderer resides must submit an affidavit stating such and explaining the relationship. This would happen in the case where the submitted municipal statement or lease agreement is not in the name of the director of the tenderer. Point (i) will be applicable. vi. In cases where the business address of the tenderer is also the official residence of the director of the tenderer, the director of the tenderer must submit an affidavit stating such. Proof that the municipal statement is not in arrears for more than 90 days or a valid lease agreement must be submitted. Point (i) will be applicable.

Employer:		Contractor:	
Witness:		Witness:	



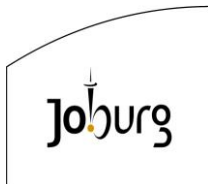
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Clause number	Tender Data
	6) Particulars of any contracts awarded to the tenderer by an organ of state during the past five years, including particulars of any material non-compliance or dispute concerning the execution of such contract. 7) A statement indicating whether any portion of the goods or services are expected to be sourced from outside the Republic, and, if so, what portion and whether any portion of payment from the municipality or municipal entity is expected to be transferred out of the Republic. 8) Where a Tenderer satisfies CIDB contractor grading designation requirements through joint venture formation, such Tenderers must submit the Certificates of Contractor Registration in respect of each partner.
C.2.24	Add the following new clause: Canvassing and obtaining of additional information by Tenderers Accept that: 1. No Tenderer shall make any attempt either directly or indirectly to canvass any of the Employers officials or the Employer's agent in respect of his tender, after the opening of the tenders but prior to the Employer arriving at a decision thereon. 2. No Tenderer shall make any attempt to obtain particulars of any relevant information, other than that disclosed at the opening of tenders.
C.2.25	Add the following new clause: Prohibitions on awards to persons in service of the state Accept that the Employer is prohibited to award a tender to a person - a) Who is in the service of the state; or b) If that person is not a natural person, of which any director, manager, principal shareholder or stakeholder is a person in the service of the state; or c) A person who is an advisor or consultant contracted with the municipality or municipal entity. "In the service of the state" means to be - i) a member of:- • any municipal council; • any provincial legislature; or • the National Assembly or the National Council of Provinces; • the board of directors of any municipal entity; ii) an official of any municipality or municipal entity; iii) an employee of any national or provincial department; iv) provincial public entity or constitutional institution within the meaning of the Public Finance Management Act, 1999 (Act No.1 of 1999); v) a member of the accounting authority of any national or provincial public entity; or vi) an employee of Parliament or a provincial legislature." To give effect to the above, the questionnaire for the declaration of interests in the tender of persons in service of state in Section T2.1 must be completed.

Employer:		Contractor:	
Witness:		Witness:	



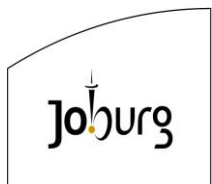
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Clause number	Tender Data
C.2.26	Add the following new clause: Awards to close family members of persons in the service of the state “Accept that the notes to the Employer’s annual financial statements must disclose particulars of any award of more than R 2 000 to a person who is a spouse, child or parent of a person in the service of the state (defined in clause C.2.25), or has been in the service of the state in the previous twelve months, including: a) The name of that person; b) The capacity in which that person is in the service of the state; and c) The amount of the award. To give effect to the above, the questionnaire for the declaration of interests in the tender of persons in service of state in part T2 – Returnable Documents must be completed in full and signed.
C.2.27	Add the following new clause: Tax Compliance In the case of a Joint Venture/Consortium the tax Compliance status Pin must be submitted for each member of the Joint Venture/Consortium.”
C.2.28	Add the following new clause: • Tenderers will be notified of such missing and incomplete documents and will be offered a period of three (3) days to complete or submit those pages i.e., Municipal Bidding Documents (MBD), Authority to sign and other documents that require completion and signatures that do not have a bearing on functionality, specific goals and price. • Tenders that are received contrary to the above requirements will be disqualified after three (3) days period has lapsed. • In cases where locality is a specific goal and the Tenderer did not submit the required documentation, the Tenderer upon submitting the municipal statement, lease agreement or letter from ward councilor confirming business address as per above, may not be eligible for points under specific goals if such documentation was not submitted with the tender document.
C.3.2	Replace the contents of the clause with the following: If necessary, issue addenda that may amend or amplify the tender documents to each tenderer during the period from the date that tender documents are available until seven (7) Working days before the tender closing time stated in the Tender Data. If, as a result a tenderer applies for an extension to the closing time stated in the Tender Data, the Employer may grant such extension and, shall then notify all tenderers who collected tender documents.
C.3.4.2	Tenders will be opened in public soon after closing time and recording of received documents but not later than 11:00 at the tender office located at Turbine Hall, 65 Ntemi Piliso, Newtown, 2001, Ground Floor. Tenderers’ names and total prices, where practical will be, read out.
C.3.11	Replace Contents with Returnable Schedule MBD 6.1 for evaluation criteria

Employer:		Contractor:	
Witness:		Witness:	



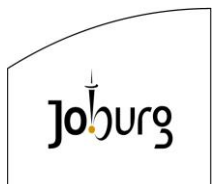
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Clause number	Tender Data			
C.1.1	<u>Mandatory Requirements</u>			
	Description		Complied	
			Yes	No
	1	CIBD grading 8ME or higher or Proof of registration with CIDB		
	2	Mandatory Tender Briefing Meeting		
	3	Completed and signed Form of Offer		
	4	Acknowledgement of Project Tender Drawings		
5	Acknowledgement of SHE Specification & Annexures			
Tenderers who FAIL to meet the mandatory criteria or requirements of tender will result in disqualification.				

Employer:		Contractor:	
Witness:		Witness:	



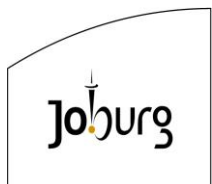
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Clause number	Tender Data				
	<u>Administrative Requirements</u>				
	Description			Complied	
	Reference	Description	Requirement	Yes	No
	Certificate of Authority	Certificate of Authority or Board Resolution granting authority to sign.	Completed and signed certificate of authority to sign or signed board resolution		
	MBD 1	Invitation to Bid Form	Complete and submit complete and signed MBD 1 Form.		
	CSD	Central Supplier Database Registration	Provide proof of CSD registration.		
	MBD 4	Declaration of Interest	Complete and submit complete and signed MBD 4 Form.		
	MBD 5	Declaration of Procurement Above R10m (All Applicable Taxes Included)	Complete and submit signed MBD 5 Form.		
	T2.3.2	Acknowledgement of Project Tender Drawings	Complete and submit signed T2.3.2 Form.		
	T2.3.1	Acknowledgement of SHE Specification & Annexures	Complete and submit signed T2.3.1 Form.		

Employer:		Contractor:	
Witness:		Witness:	



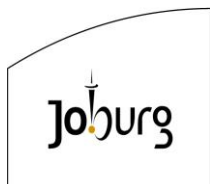
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Clause number	Tender Data				
	MBD 6.1	Preference Points Claim in Terms of The Preferential Procurement Regulations 2022	Complete and submit complete and signed MBD 6.1 Form.		
	MBD 8	Declaration of Bidder's Past Supply Chain Management Practices	Complete and submit complete and signed MBD 8 Form.		
	MBD 9.	Certificate of Independent Bid Determination	Complete and submit complete and signed MBD 9 Form.		
	Annexure – Proof of Specific Goals - Ref: 4.4	Valid BBBEE Certificate or certified copy thereof or a valid sworn affidavit	Submit applicable documentation with the tender submission		
	Annexure T2.2.4	Municipal statement of account for Director/s (not older than three (03) months from the closing date of tender or a valid lease agreement at time of tender closure).	Submit applicable documentation with the tender submission		
	Annexure T2.2.4	Municipal statement of account for Company (not older than three (03) months from the closing date of tender or a valid lease agreement at time of tender closure).	Submit applicable documentation with the tender submission		
	Annexure	Joint Venture Consortium or equivalent Agreement signed by all parties.	Submit applicable documentation with the tender submission		

Employer:		Contractor:	
Witness:		Witness:	



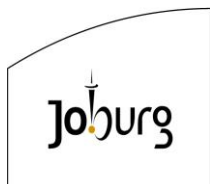
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Clause number	Tender Data					
	<u>Functionality Requirements</u>					
	NO #	CRITERIA	EVIDENCE	SUB-CRITERIA/CLAUSE		MAX SCORE
	1	Tenderers experience with respect to specific aspects of the project / comparable projects	Supporting Documents Required include Reference Letters as per T2.1.6 and T2.1.7 (Or on Client Letter Head with all required Information) and Completion / Approval Certificates per project completed. Note: <i>The reference letter must be completed by the referee/previous client of the tenderer and included in the tender submission. Alternatively, the Clients letterhead may be used provided it complies with the functional requirements. A separate form must be completed for each reference as a requirement in the evaluation criteria. The information provided will be verified and if found to be false or misrepresented, punitive measures will be instituted against the respective party including blacklisting in participating in any future government tenders. The letter must show evidence of experience on Mechanical wastewater or potable water treatment projects with a minimum value of R50mil each.</i>	Experience on Mechanical wastewater or potable water treatment projects with a minimum value of R50mil each.	Tenderer Completed Project Has 0-1 Tenderer Completed at Least 2 Projects Has Tenderer has completed 3 or more Projects.	0 35 40

Employer:		Contractor:	
Witness:		Witness:	



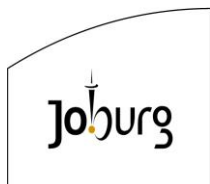
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Clause number	Tender Data						
1	OR						
	Tenderers experience with respect to specific aspects of the project / comparable projects	Supporting Documents Required include Reference Letters as per T2.1.6 and T2.1.7 (Or on Client Letter Head with all required Information) and Completion / Approval Certificates per project completed. Note: <i>The reference letter must be completed by the referee/previous client of the tenderer and included in the tender submission. Alternatively, the Clients letterhead may be used provided it complies with the functional requirements. A separate form must be completed for each reference as a requirement in the evaluation criteria. The information provided will be verified and if found to be false or misrepresented, punitive measures will be instituted against the respective party including blacklisting in participating in any future government tenders. The letter must show evidence of experience on Mechanical or Electrical wastewater or potable water treatment projects with a minimum value of R50mil each.</i>	Experience on 1 Mechanical wastewater or potable water treatment projects with a minimum value of R50mil plus 1 Electrical Project wastewater or potable water treatment with a minimum value of R50mil.	Tenderer Completed Project	Has 0-1	40	0
				Tenderer Completed at Least 2 Projects	Has		35
				Tenderer has completed 3 or more Projects.			40

Employer:		Contractor:	
Witness:		Witness:	



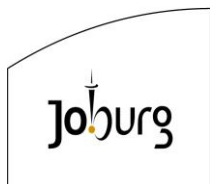
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	CRITERIA NO	CRITERIA	EVIDENCE	SUB-CRITERIA/CLAUSE		MAX SCORE	SCORE
	2	Post Qualification Experience of Contract Manager Only Contract Managers with minimum Qualifications of: - Bachelor's degree (Civil, or Mechanical or Electrical Engineering) OR - Quantity Surveying/ Construction Management) equivalent or higher. AND - Valid Professional Registration (Pr. Eng. / Pr. Tech.Eng) OR PrCPM / PrCM/ PrQS will obtain a score for experience of a Contract Manager. However, the time of registration of Contract Manager will not	Tenderer must provide CV of Contract Manager in the format given in T2.1.9 Note: Tenderers may provide their own CVs but information provided should contain information required for functionality must be there Note: Copies of qualifications and valid registrations are to accompany the CVs. Note: The information provided will be verified by requesting certified copies from successful bidder and if found to be false punitive measures will be effected.	Number of completed Mechanical or Electrical or Civil wastewater or potable water treatment projects with a minimum value of R50mil.	0 Completed Projects	15	0
1 Completed Projects		7					
2 Completed Projects		12					
>2 Completed Projects		15					

Employer:		Contractor:	
Witness:		Witness:	



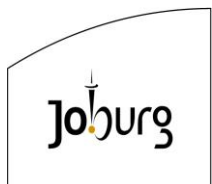
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Clause number	Tender Data					
		impact post qualification number of projects				
	NO #	CRITERIA	EVIDENCE	SUB-CRITERIA/CLAUSE		MAX SCORE
	3	Post Qualification Experience of Site Agent Only Site Agents with minimum qualifications of: National Diploma (Mech/Elec) Engineering or more; AND Registered as a Candidate Professional or more will be considered.	Tender must Provide CV of Site Agent in the format given on T2.1.9 Note: Tenderers may provide their own CVs but information provided should contain all information as provided in T2.1.9. Note: Copies of qualifications and valid registrations are to accompany the CVs. Note: The information provided will be verified by requesting certified copies from successful bidder and if found to be false punitive measures will be effected.	Number of completed Mechanical or Electrical wastewater or potable water treatment projects with a minimum value of R30mil.	0 Completed Projects 1 Completed Project 2 Completed Projects	0 7 12

Employer:		Contractor:	
Witness:		Witness:	



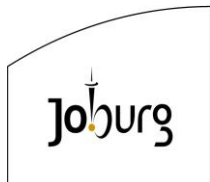
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Clause number	Tender Data					
					> Completed Projects	15
NO #	CRITERIA	EVIDENCE	SUB-CRITERIA/CLAUSE		MAX SCORE	SCORE
4	Post Qualification Experience of Safety Officer Only Safety Officers with minimum qualifications of: National Diploma (Safety Management)/National Diploma (Environmental Health/Environmental Science/ Environmental Management) /SAMTRAC / SHEOMTRAC/ SHEMTRAC / MESHTRAC /NEBOSH /	Tender must Provide CV of Safety Officer in the format given on T2.1.9 Note: All Civil Engineering related projects will be considered. Note: Copies of qualifications and valid registrations are to accompany the CVs. Note: The information provided will be verified by requesting certified copies from successful bidder and if found to be false punitive measures will be effected.	Number of completed Mechanical or Electrical or Civil Projects Completed as Safety Officer	0 Completed Projects	10	0
				1 - 2 Completed Projects		4
				3 - 4 Completed Projects		8

Employer:		Contractor:	
Witness:		Witness:	



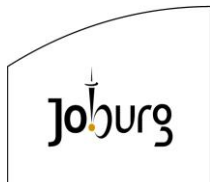
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Clause number	Tender Data					
		Safety Officers Course (NQF 5) or more, AND Valid Professional Registered with SACPCMP in the Construction Health and Safety Sector will be considered			More than 4 Completed Projects	10
CRITERIA NO #	CRITERIA	EVIDENCE		SUB-CRITERIA/CLAUSE	MAX SCORE	SCORE
5	Site Specific Method Statement	Tenderer must provide Site Specific Method Statement Which Addresses the following sections: Quality Control Plan (Minimum 1 Page -Maximum 4 pages) including all necessary standards to be used, resources available and procedures to ensure quality. This is inclusive of the following major components, - Phase 1 Belt Press removal, installation and commissioning. - Phase 2 Belt Press removal, installation and commissioning. - installation of all associated ancillary equipment. Project Programme/Schedule (On MS Projects or any other Gantt chart as Annexure) outlining critical path, aligned to the scope of		Method Statement not submitted	20	0
				The required sections are covered by the Method Statement in line with the guidelines and but are generic		8
				At least one of the required sections are covered by the Method Statement in line with the guidelines and are specific to Dewatering Belt Presses		15

Employer:		Contractor:	
Witness:		Witness:	



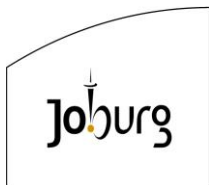
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			works, aligned to the contractual timelines, and including all contractual dates. This is inclusive of the following major components, - Phase 1 Belt Press removal, installation and commissioning; - Phase 2 Belt Press removal, installation and commissioning; - installation of all associated ancillary equipment.	All two of the required sections are covered by the Method Statement in line with the guidelines and are specific to Dewatering Belt Presses	20
				MINIMUM QUALIFYING SCORE	75
				TOTAL	100
NOTE 1: Where applicable, foreign qualifications MUST be accompanied by a SAQA verification certificate. Failure to submit SAQA verification certificate will lead to that qualification not being considered for allocation of points for that criterion. NOTE 2: When an uncertified copy of professional registration is submitted and the requirement was to submit a certified copy, JW will verify the validity of the registration on the issuing bodies or institution's website. If the verification is confirmed on the website, the bidder meets the criteria. This will only be applicable for the recommended bidders. NOTE 3: The time of registration of Contract Manager, Site Agent and Safety Officer will not impact post qualification number of projects. NOTE 4: The information provided by bidders will be verified and if found to be false, punitive measures will be affected. ECSA: Engineering Council of South Africa SACPCMP: South African Council for the Project and Construction Management Professions SAMTRAC: Safety Management Training Course NEBOSH: National Examination Board in Occupational Safety and Health SHEOMTRAC: Safety Health Environmental Occupational Management Training Course SHEMTRAC: Safety Health Environmental Management Training Course MESHTRAC: Management Environmental Safety Health Training Course					

Employer:		Contractor:	
Witness:		Witness:	



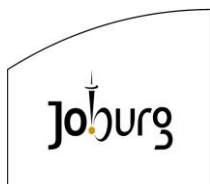
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Clause Number	Tender Data												
	4. STAGE FOR PRICE AND PREFERENCE POINTS EVALUATION: 4.1. Pricing The following aspects will be considered in the financial offer: - Costing for all items as described in the Pricing Schedule and applicable Strategies Review of financial offer and discrepancies between total and calculations. - Identify any parameters that may have a bearing on the financial offer, e.g., contract period, price escalations or adjustments required and life cycle costs. - The 90/10 preference point system will be applicable in this tender. Whereby 90 points will be allocated to price and 10 points will be allocated to the set specific goals per category as outlined on the pricing schedule. The bidder scoring the highest in terms of price and specific goal will be recommended for that specific category. 4.2. Award and Allocation Strategy: <table><tr><td>AWARD STRATEGY</td><td>The tender will be awarded to the highest scoring bidder in terms of price and Specific Goals</td></tr><tr><td>ALLOCATION STRATEGY</td><td>The tender will be allocated to the highest scoring bidder in terms of price and Specific Goals</td></tr></table> 4.3. The maximum preference points for this bid are allocated as follows: <table><tr><th></th><th>POINTS</th></tr><tr><td>PRICE</td><td>90</td></tr><tr><td>SPECIFIC GOALS</td><td>10</td></tr><tr><td>Total points for Price and SPECIFIC GOALS</td><td>100</td></tr></table>	AWARD STRATEGY	The tender will be awarded to the highest scoring bidder in terms of price and Specific Goals	ALLOCATION STRATEGY	The tender will be allocated to the highest scoring bidder in terms of price and Specific Goals		POINTS	PRICE	90	SPECIFIC GOALS	10	Total points for Price and SPECIFIC GOALS	100
AWARD STRATEGY	The tender will be awarded to the highest scoring bidder in terms of price and Specific Goals												
ALLOCATION STRATEGY	The tender will be allocated to the highest scoring bidder in terms of price and Specific Goals												
	POINTS												
PRICE	90												
SPECIFIC GOALS	10												
Total points for Price and SPECIFIC GOALS	100												

Employer:		Contractor:	
Witness:		Witness:	



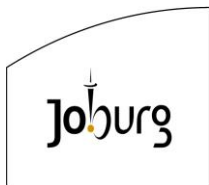
Contract: JW14060RR
Northern Wastewater Treatment Works
Dewatering Building Belt Press
Replacement and Associated Ancillaries



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Section T1 Tendering Procedures

Clause Number	Tender Data
	SPECIFIC GOALS In terms of Regulation 4(2); 5(2); 6(2) and 7(2) of the Preferential Procurement Regulations 2022, preference points must be awarded for specific goals stated in the tender. For the purposes of this tender the tenderer will be allocated points based on the goals stated in table 1 below as may be supported by proof/ documentation stated in the conditions of this tender. Specific goals may include contracting with persons, or categories of persons, historically disadvantaged by unfair discrimination on the basis of race, gender or disability. Race: I. Ownership by black people II. Black Designated Group: - Ownership by black people that are unemployed - Ownership by black people who are youth - Ownership by black people living in rural or underdeveloped areas or townships - Ownership by black people with disabilities - Ownership by black people who are military veterans - Cooperative owned by black people Gender: III. Persons, or categories of persons, historically disadvantaged by unfair discrimination on the basis of gender are women. Ownership by persons that are classified as female or women according to the Department of Home Affairs of South African. Disability: IV. Persons, or categories of persons, historically disadvantaged by unfair discrimination on the basis of disability are disabled persons. Reconstruction and Development Programme (RDP) objectives as published in Government Gazette No. 16085 dated 23 November 1994 i.e., Local Manufacture: I. Promotion of procurement of locally manufactured goods in South Africa to promote job creation in light of the high unemployment rate in South Africa which has a greater impact previously disadvantaged individuals and black youth.

Employer:		Contractor:	
Witness:		Witness:	

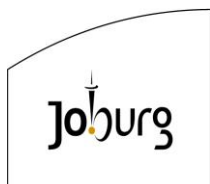


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Dewatering Building Belt Press
Replacement and Associated Ancillaries
Volume 1 Tender and Contract
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Clause Number	Tender Data
	Locality: I. Promotion of procurement from local business in the geographical areas that JW operate in. This is also directed at creating employment in the areas JW operate in. The BSC may allocate points as follows: • Promotion of enterprises located in the Gauteng Province • Promotion of enterprises located in a specific region within COJ (the 7 regions. A to G) • Promotion of enterprises located in the City of Johannesburg municipality • Promotion of enterprises located rural or underdeveloped areas or townships. QSE I. Promotion of procurement from QSE's that are black owned. EME: I. Promotion of procurement from EME's that are black own. SUB-CONTRACTING: Promotion of a company previously owned by a Historically Disadvantaged Individuals (HDI). Consider sub-contract only in cases where there are no company which can meet any of the specific goals. Check if the portion of the work cannot be subcontracted in terms of specific goals. One goal may be chosen, or a combination of goals may be decided upon including a sub-goal i.e., owned by black people that are disabled etc., JOINT VENTURE, CONSORTIUM OR EQUIVALENT: For Joint Venture Agreements, Consortiums or equivalent, the agreement must show percentages of ownership and work to be completed by each party. This agreement must form part of the tender submission. To determine the Joint Venture, Consortium or equivalent score for specific goals, JW will look at the consolidated BBBEE certificate to determine the points for specific goals that will be awarded to the tenderer. If a consolidated BBBEE certificate is not submitted, the parties to the joint venture, consortium or equivalent must submit their individual BBBEE certificates issued by a SANAS accredited verification agency or the documents listed below on 4.6 and the joint venture, consortium or equivalent agreement in order for JW to determine the proportional points for specific goals. Documentation to be provided: • JV, Consortium, or equivalent agreement

Employer:		Contractor:	
Witness:		Witness:	

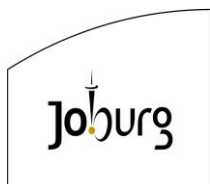


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Clause Number	Tender Data														
	- Consolidated BBBEE certificate issued by an SANAS accredited verification agency. Certificate must be valid Table 1: <table> <tr> <th>The specific goals allocated points in terms of this tender</th><th>Number of points allocated (90/10 system)</th></tr> <tr> <td>Business owned by 51% or more- by Black people</td><td>5</td></tr> <tr> <td>Business owned by 51% or more-Women</td><td>5</td></tr> <tr> <td>Total</td><td>10</td></tr> </table> 4.4. The following verification documents must be submitted with the tender document: <table> <tr> <th>SPECIFIC GOALS – ANY ONE OR A COMBINATION OF ANY</th><th>MEANS OF VERIFICATION THAT MAY BE SELECTED OR A COMBINATION THEREOF</th></tr> <tr> <td>Business owned by 51% or more -Black People</td><td>Valid BBBEE Certificate issued by SANAS accredited verification agency or DTI/CIPC BBBEE Certificate for Exempted Micro Enterprises or Affidavit sworn under oath.</td></tr> <tr> <td>Business owned by 51% or more-Women-</td><td> Valid BBBEE Certificate issued by SANAS accredited verification agency or DTI/CIPC BBBEE Certificate for Exempted Micro Enterprises or Affidavit sworn under oath, OR - CIPC registration document showing percentage of ownership and share certificate where applicable </td></tr> </table> Note: The joint venture, consortium, or equivalent agreement in order for JW to determine the proportional points for specific goals Example, If there are two parties in a Joint Venture with a 50:50 ownership of the Joint Venture and one party is located within the boundaries of COJ and one is located in Tshwane, if one of the goals is locality and has total points of 4, the JV will only be entitled the proportional points of 2.	The specific goals allocated points in terms of this tender	Number of points allocated (90/10 system)	Business owned by 51% or more- by Black people	5	Business owned by 51% or more-Women	5	Total	10	SPECIFIC GOALS – ANY ONE OR A COMBINATION OF ANY	MEANS OF VERIFICATION THAT MAY BE SELECTED OR A COMBINATION THEREOF	Business owned by 51% or more -Black People	Valid BBBEE Certificate issued by SANAS accredited verification agency or DTI/CIPC BBBEE Certificate for Exempted Micro Enterprises or Affidavit sworn under oath.	Business owned by 51% or more-Women-	Valid BBBEE Certificate issued by SANAS accredited verification agency or DTI/CIPC BBBEE Certificate for Exempted Micro Enterprises or Affidavit sworn under oath, OR CIPC registration document showing percentage of ownership and share certificate where applicable
The specific goals allocated points in terms of this tender	Number of points allocated (90/10 system)														
Business owned by 51% or more- by Black people	5														
Business owned by 51% or more-Women	5														
Total	10														
SPECIFIC GOALS – ANY ONE OR A COMBINATION OF ANY	MEANS OF VERIFICATION THAT MAY BE SELECTED OR A COMBINATION THEREOF														
Business owned by 51% or more -Black People	Valid BBBEE Certificate issued by SANAS accredited verification agency or DTI/CIPC BBBEE Certificate for Exempted Micro Enterprises or Affidavit sworn under oath.														
Business owned by 51% or more-Women-	Valid BBBEE Certificate issued by SANAS accredited verification agency or DTI/CIPC BBBEE Certificate for Exempted Micro Enterprises or Affidavit sworn under oath, OR CIPC registration document showing percentage of ownership and share certificate where applicable														

Employer:		Contractor:	
Witness:		Witness:	

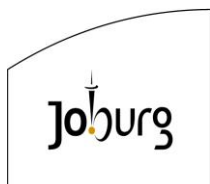


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Clause Number	Tender Data		
	4.5. The following are the requirements for the Sworn Affidavit in terms of the BBBEE Sector Codes of Good Practice:		
	Affidavit Prescribed Formats	Category	Financial Threshold
	Generic Enterprises		
		BO QSE	Between R10m and R50m
		BO EME	Less than R10m
	Sector Specific Enterprises		
		BO QSE	Between R10m and R50m
		BO EME	Less than R10m
	Construction Sector Code		
		EME Contractor	Less than R3m
		BO EME BEP	Less than R1.8m
	Financial Sector Code		
		BO QSE	Between R10m and R50m
		BO EME	Less than R10m
	Information Communication Technology Sector Code (ICT)		
		BO QSE	Between R10m and R50m
		BO EME	Less than R10m
	Marketing, Advertising & Communication Sector Code (MAC)		
	> Public Relations	BO QSE	Between R5m and R10m
	> Marketing, Advertising & Communications	BO EME	Less than R5m
	Property Sector Code		
	> Service-based	BO QSE	Between R5m and R10m
		EME	Less than R5m
	> Agency-based	BO QSE	Between R2.5m and R35m
	> Asset-based	EME	Less than R2.5m

Employer:		Contractor:	
Witness:		Witness:	

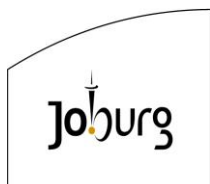


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Clause Number	Tender Data		
		BO QSE	Between R80m and R400m
	Tourism Sector Code		
		BO QSE	Between R5m and R45m
		BO EME	Less than R5m
	Specialised Enterprises		
		BO QSE	Between R10m and R50m
		BO EME	Less than R10m
	4.6. Requirements for a valid BBBEE Certificate a) Copy of a certified valid BBBEE certificate (Only Valid BBBEE certificate must be accredited by SANAS) or valid Sworn Affidavit issued by the DTIC or the CIPC or in a similar format complying with commissioner of oath Act. b) Bidders who do NOT qualify as EME's and QSE's as outlined in 4.5, must submit B-BBEE verification certificates that are issued by an Agency accredited by SANAS. c) Bidders who fail to submit a certified copy of their valid B-BBEE certificate or valid sworn affidavit or valid DTI / CIPC B-BBEE certificate will score zero points for specific goals. Valid Sworn Affidavits or certified copies of B-BBEE Certificate must comply with the requirements outlined in the Justices of the Peace and Commissioners of Oaths Act, no 16 of 1963 and its Regulations promulgated in Government Notice GNR 1258 of 21 July 1972 Justices of the Peace and Commissioners of Oaths Act, No. 16 of 1963. i.e. (i) The deponent shall sign the declaration in the presence of the commissioner of oaths (COA). (ii) Below the deponent's signature the COA shall certify that the deponent has acknowledged that he knows and understands the contents of the declaration and the COA shall state the manner, place, and date of taking the declaration. (iii) The COA shall sign the declaration and print his full name and business address below his signature; and state his designation and the area for which he holds his appointment, or the office held by him if he holds his appointment ex officio. (iv) Copy of certified copies will not be accepted. N.B. A tenderer failing to submit proof of specific goals claimed as per 4.4 will not be disqualified but will be allocated zero points for specific goals and will be allocated points for pricing. ADJUDICATION USING A POINT SYSTEM (a) The bidder obtaining the highest number of total points will be awarded the contract.		

Employer:		Contractor:	
Witness:		Witness:	



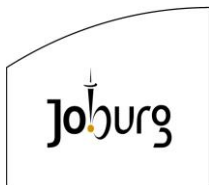
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	(b) Preference points shall be calculated after prices have been brought to a comparative basis taking into account all factors of non-firm prices and all unconditional discounts. (c) Points scored must be rounded off to the nearest 2 decimal places. (d) In the event that two or more bids have scored equal total points, the successful bid must be the one scoring the highest number of points for specific goals. (e) However, when functionality is part of the evaluation process and two or more bids have scored equal points including equal preference points for specific goals, the successful bid must be the one scoring the highest score for functionality. (f) Should two or more bids be equal in all respects, the award shall be decided by the drawing of lots. POINTS AWARDED FOR PRICE THE 90/10 PREFERENCE POINT SYSTEMS A maximum of 90 points is allocated for price on the following basis: 90/10 $P_s = 90 \left(1 - \frac{P_t - P_{\min}}{P_{\min}} \right)$ Where: P_s = Points scored for comparative price of bid under consideration P_t = Comparative price of bid under consideration P_{min} = Comparative price of lowest acceptable bid
	Add to the existing clause: Tender offers will only be accepted if: a) the tenderer submits a valid SARS tax Compliance status Pin for tenders issued by the South African Revenue Services or has made arrangements to meet outstanding tax obligations. b) Proof of CSD registration i.e., MA xxxxx number. c) the tenderer submits a letter of intent from an approved insurer undertaking to provide the Performance Guarantee to the format included in Part T2.2.22 of this procurement document. d) the tenderer is registered with the Construction Industry Development Board in an appropriate contractor grading designation. e) the tenderer or any of its directors/shareholders is not listed on the Register of Tender Defaulters in terms of the Prevention and Combating of Corrupt Activities Act of 2004 as a person prohibited from doing business with the public sector. f) the tenderer has not: i) abused the Employer's Supply Chain Management System; or ii) failed to perform on any previous contract and has been given a written notice to this effect.

Employer:		Contractor:	
Witness:		Witness:	



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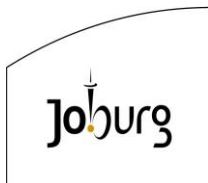


Volume 1 Tender and Contract
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Clause Number	Tender Data
	g) the tenderer has completed the Compulsory Enterprise Questionnaire and there are no conflicts of interest which may impact on the tenderer's ability to perform the contract in the best interests of the Employer or potentially compromise the tender process and persons in the employ of the state are permitted to submit tenders or participate in the contract. h) the tenderer is registered and in good standing with the compensation fund or with a licensed compensation insurer. i) the Employer is reasonably satisfied that the tenderer has in terms of the Construction Regulations, 2014, issued in terms of the Occupational Health and Safety Act, 1993, the necessary competencies and resources to carry out the work safely; and j) the tenderer: i) has sufficiently substantiated his experience in this type of work. ii) has the required and experienced key personnel; and iii) Owns the primary equipment to execute the work effectively and efficiently.
C.3.17	The number of paper copies of the signed contract to be provided by the Employer is one.
	There are no additional Conditions of Tender.

--- END OF PART ---

Employer:		Contractor:	
Witness:		Witness:	



Contract: JW14060RR
Northern Wastewater Treatment Works
Dewatering Building Belt Press
Replacement and Associated Ancillaries



Volume 1 Tender and Contract
Section T2 Returnable Documents

Johannesburg Water (SOC) Ltd



CONTRACT NO. JW14060RR

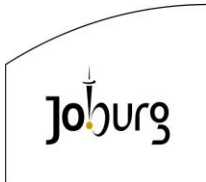
NORTHERN WASTEWATER TREATMENT WORKS

**DEWATERING BUILDING BELT PRESS REPLACE-
MENT AND ASSOCIATED ANCILLARIES**

VOLUME 1

**RETURNABLE DOCUMENTS
AND
SCHEDULES**

Employer:		Contractor:	
Witness:		Witness:	



T2.1 LIST OF RETURNABLE DOCUMENTS

The tenderer must complete the following returnable documents:

<u>Document</u>	<u>Page</u>
1. Returnable Schedules required for tender evaluation purposes	
T2.1.1 Record of addenda to tender documents	RD. 4
T2.1.2 Certificate of Authority	RD. 5
T2.1.3 Compulsory Enterprise Questionnaire	RD. 9
T2.1.4 Preferential Procurement	RD 11
MBD 6.1 Preference points claim form in terms of the preferential procurement regulations	RD.12
MBD 4 Declaration of any potential conflict of interest	RD.18
MBD 8 Declaration of bidder's past Supply Chain management practices	RD.20
MBD 5 Declaration for Procurement above R10 Million (VAT Included)	RD.22
MBD 9 Certificate of independent bid determination	RD.24
T2.1.5 Proposed qualifications	RD.27
T2.1.6 Schedule of the Tenderer's experience	RD.28
T2.1.7 Contactable reference template	RD.29
T2.1.8 Schedule of key personnel	RD.42
T2.1.9 Curriculum vitae of key personnel	RD.43

T2.2 LIST OF RETURNABLE DOCUMENTS

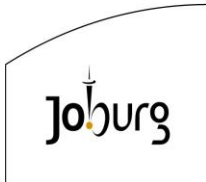
<u>Document</u>	<u>Page</u>
2. Documents required only for tender evaluation purposes	
T2.2.1 Certificate of Contractor Registration issued by the Construction Industry Development Board	RD.53
T2.2.2 SARS Tax Compliance Status Pin and Proof of CSD registration i.e. MA xxxxxxxxxx number	RD.54

T2.3 LIST OF OTHER RETURNABLE DOCUMENTS

<u>Document</u>	<u>Page</u>
3. Other documents that will be incorporated into the Contract	
T2.3.1 JW 6.4 Returnable Annexure A – SHE Acknowledgment Form	RD.55
T2.3.2 JW 6.5 Returnable Annexure B: Acknowledgement of Tender Drawings	RD.56
T2.3.3 JW 6.5 Returnable Annexure C: Acknowledgement of JW Technical Specifications	RD 59
T2.3.4 Returnable Annexure D: Belt Press Technical Data Sheet	RD 60

NOTE: The Tenderer is required to complete each and every schedule listed above to the best of his ability as the evaluation of tenders and the eventual contract will be based on the information provided by the tenderer.

Employer:		Contractor:	
Witness:		Witness:	



Contract JW14060RR
Northern Wastewater Treatment Works
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Volume 1 Tender and Contract
Section T2 Returnable Documents

T2.1.1 Record of Addenda to Tender Documents

We confirm that the following communications received from the Employer before the submission of this tender offer, amending the tender documents, have been taken into account in this tender offer:

	Date	Title or Details
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		

Attach additional pages if more space is required.

Signed

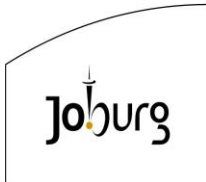
Date

Name

Position

Tenderer

Employer:		Contractor:	
Witness:		Witness:	



Contract JW14060RR
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Volume 1 Tender and Contract
Section T2 Returnable Documents

T2.1.2 Certificate of Authority

Indicate the status of the Tenderer by ticking the appropriate box hereunder. The Tenderer must complete the certificate set out below for the relevant category.

(I) COMPANY	(II) CLOSE CORPO- RATION	(III) PARTNERSHIP	(IV) JOINT VENTURE	(V) SOLE PROPRIE- TOR

i. Certificate For Company

I, ..., chairperson of the Board of Directors of, hereby confirm that by resolution of the Board (copy attached) taken on, Mr/Ms, acting in the capacity of, was authorized to sign all documents in connection with the tender for Contract No. JW14060R and any contract resulting from it on behalf of the company.

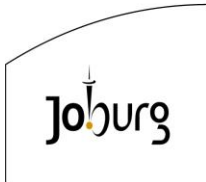
Chairman:

As Witnesses: 1.....

2.....

Date:

Employer:		Contractor:	
Witness:		Witness:	



Contract JW14060RR
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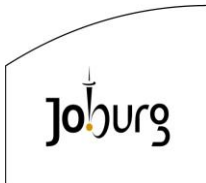
ii. **Certificate For Close Corporation**

We, the undersigned, being the key members in the business trading as
..... hereby authorize Mr/Ms , acting in the capacity of
....., to sign all documents in connection with the
tender and any contract resulting from it on our behalf.

NAME	ADDRESS	SIGNATURE	DATE

Note : This certificate is to be completed and signed by all of the key members upon whom rests the direction of the affairs of the Close Corporation as a whole.

Employer:		Contractor:	
Witness:		Witness:	



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iii. Certificate For Partnership

We, the undersigned, being the key partners in the business trading as,

....., hereby authorize Mr/Ms,

acting in the capacity of

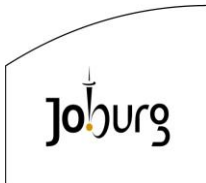
, to sign all documents in connection

with the tender and any contract resulting from it on our behalf.

NAME	ADDRESS	SIGNATURE	DATE

Note: This certificate is to be completed and signed by all of the key partners upon whom rests the direction of the affairs of the Partnership as a whole.

Employer:		Contractor:	
Witness:		Witness:	



Contract JW14060RR
Northern Wastewater Treatment Works
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Volume 1 Tender and Contract
Section T2 Returnable Documents

iv. **Certificate For Joint Venture**

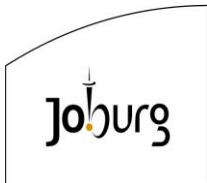
This Returnable Schedule is to be completed by joint ventures.

We, the undersigned, are submitting this tender offer in Joint Venture and hereby authorise Mr/Ms , authorised signatory of the company , acting in the capacity of lead partner, to sign all documents in connection with the tender offer and any contract resulting from it on our behalf.

NAME OF FIRM	ADDRESS	DULY AUTHORISED SIGNATORY
Lead partner		Signature. Name Designation
		Signature. Name Designation
		Signature. Name Designation
		Signature. Name Designation

Note : This certificate is to be completed and signed by all of the key partners upon whom rests the direction of the affairs of the Joint Venture as a whole.

Employer:		Contractor:	
Witness:		Witness:	



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v. **Certificate *For Sole Proprietor***

I, ..., hereby confirm that I am the sole owner of the Business.

trading as

Signature of Sole owner:

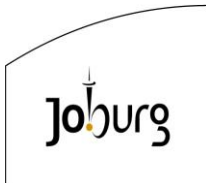
As Witnesses :

1.....

2.

Date :

Employer:		Contractor:	
Witness:		Witness:	



**Contract JW14060RR
Northern Wastewater Treatment Works
Dewatering Building Belt Press
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**Volume 1 Tender and Contract
Section T2 Returnable Documents**

T2.1.3 Compulsory Enterprise Questionnaire

The following particulars must be furnished. In the case of a joint venture, **separate** enterprise questionnaires in respect of each partner must be completed and submitted.

Section 1: Name of enterprise:

Section 2: VAT registration number, if any:

Section 3: CIDB registration number, if any:

Section 4: Particulars of sole proprietors and partners in partnerships

Name*	Identity number*	Personal income tax number*

* Complete only if sole proprietor or partnership and attach separate page if more than 3 partners

Section 5: Particulars of companies and close corporations

Company registration number

.

Close corporation number

Proof of CSD registration i.e. MA xxxxxxxx number.

.

SARS Tax Compliance status Pin number

Section 6: Record in the service of the state

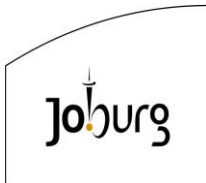
Indicate by marking the relevant boxes with a cross, if any sole proprietor, partner in a partnership or director, manager, principal shareholder or stakeholder in a company or close corporation is currently or has been within the last 12 months in the service of any of the following:

☐ a member of any municipal council	☐ an employee of any provincial department, national or provincial public entity or constitutional institution within the meaning of the Public Finance Management Act, 1999 (Act 1 of 1999)
☐ a member of any provincial legislature	☐ a member of an accounting authority of any national or provincial public entity
☐ a member of the National Assembly or the National Council of Province	☐ an employee of Parliament or a provincial legislature
☐ a member of the board of directors of any municipal entity	
☐ an official of any municipality or municipal entity	

If any of the above boxes are marked, disclose the following:

Name of sole proprietor, partner, director, manager, principal shareholder or stakeholder	Name of institution, public office, board or organ of state and position held	Status of service (tick appropriate column)	
		Current	Within last 12 months

*insert separate page if necessary



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Section 7: Record of spouses, children and parents in the service of the state

Indicate by marking the relevant boxes with a cross, if any spouse, child or parent of a sole proprietor, partner in a partnership or director, manager, principal shareholder or stakeholder in a company or close corporation is currently or has been within the last 12 months been in the service of any of the following:

☐ a member of any municipal council	☐ an employee of any provincial department, national or provincial public entity or constitutional institution within the meaning of the Public Finance Management Act, 1999 (Act 1 of 1999)
☐ a member of any provincial legislature	
☐ a member of the National Assembly or the National Council of Province	☐ a member of an accounting authority of any national or provincial public entity
☐ a member of the board of directors of any municipal entity	☐ an employee of Parliament or a provincial legislature
☐ an official of any municipality or municipal entity	

Name of spouse, child or parent	Name of institution, public office, board or organ of state and position held	Status of service (tick appropriate column)	
		Current	Within last 12 months

*insert separate page if necessary

The undersigned, who warrants that he / she is duly authorised to do so on behalf of the enterprise:

- authorizes the Employer to verify the tax compliance status from the South African Revenue Services that my / our tax matters are in order.
- confirms that neither the name of the enterprise or the name of any partner, manager, director or other person, who wholly or partly exercises, or may exercise, control over the enterprise appears on the Register of Tender Defaulters established in terms of the Prevention and Combating of Corrupt Activities Act of 2004.
- confirms that no partner, member, director or other person, who wholly or partly exercises, or may exercise, control over the enterprise appears, has within the last five years been convicted of fraud or corruption.
- confirms that I / we are not associated, linked or involved with any other tendering entities submitting tender offers and have no other relationship with any of the tenderers or those responsible for compiling the scope of work that could cause or be interpreted as a conflict of interest; and
- confirms that the contents of this questionnaire are within my personal knowledge and are to the best of my belief both true and correct.

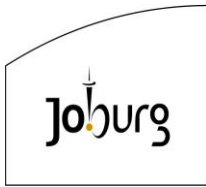
Signed

Date

Name

Position

Enterprise name



T2.1.4 Preferential Procurement

PREFERENCE POINTS CLAIM FORM IN TERMS OF THE PREFERENTIAL PROCUREMENT REGULATIONS 2022

This preference form must form part of all tenders invited. It contains general information and serves as a claim form for preference points for specific goals.

NB: BEFORE COMPLETING THIS FORM, TENDERERS MUST STUDY THE GENERAL CONDITIONS, DEFINITIONS AND DIRECTIVES APPLICABLE IN RESPECT OF THE TENDER AND PREFERENTIAL PROCUREMENT REGULATIONS, 2022

1. GENERAL CONDITIONS

- 1.1** The following preference point systems are applicable to invitations to tender:
- the 90/10 system for requirements with a Rand value above R50 000 000 (all applicable taxes included).
- 1.2** The applicable preference point system for this tender is the 90/10 preference point system.
- 1.3** Points for this tender (even in the case of a tender for income-generating contracts) shall be awarded for:
- a) Price; and
 - b) Specific Goals.

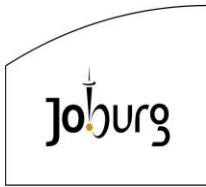
The maximum points for this tender are allocated as follows:

	POINTS
PRICE	90
SPECIFIC GOALS	10
Total points for Price and SPECIFIC GOALS	100

- 1.4** Failure on the part of a tenderer to submit proof or documentation required in terms of this tender to claim points for specific goals with the tender, will be interpreted to mean that preference points for specific goals are not claimed.
- 1.5** The organ of state reserves the right to require of a tenderer, either before a tender is adjudicated or at any time subsequently, to substantiate any claim in regard to preferences, in any manner required by the organ of state.

2. DEFINITIONS

- a) **“tender”** means a written offer in the form determined by an organ of state in



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- response to an invitation to provide goods or services through price quotations, competitive tendering process or any other method envisaged in legislation.
- b) **“price”** means an amount of money tendered for goods or services and includes all applicable taxes less all unconditional discounts.
 - c) **“Rand value”** means the total estimated value of a contract in Rand, calculated at the time of bid invitation, and includes all applicable taxes;
 - d) **“tender for income-generating contracts”** means a written offer in the form determined by an organ of state in response to an invitation for the origination of income-generating contracts through any method envisaged in legislation that will result in a legal agreement between the organ of state and a third party that produces revenue for the organ of state, and includes, but is not limited to, leasing and disposal of assets and concession contracts, excluding direct sales and disposal of assets through public auctions; and
 - e) **“the Act”** means the Preferential Procurement Policy Framework Act, 2000 (Act No. 5 of 2000).

3. FORMULAE FOR PROCUREMENT OF GOODS AND SERVICES

3.1 POINTS AWARDED FOR PRICE

3.1.1 THE 90/10 PREFERENCE POINT SYSTEMS

A maximum of 90 points is allocated for price on the following basis:

90/10

$$Ps = 90 \left(1 - \frac{Pt - P_{min}}{P_{min}} \right)$$

Where:

- Ps = Points scored for price of tender under consideration
Pt = Price of tender under consideration
Pmin = Price of lowest acceptable tender

4. POINTS AWARDED FOR SPECIFIC GOALS

- 4.1** In terms of Regulation 4(2); 5(2); 6(2) and 7(2) of the Preferential Procurement Regulations, preference points must be awarded for specific goals stated in the tender. For the purposes of this tender the tenderer will be allocated points based on the goals stated in Table 1 below as may be supported by proof/ documentation stated in the conditions of this tender:

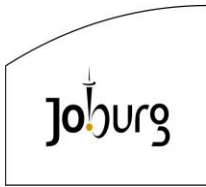


Table 1: Specific goals for the tender and points claimed are indicated per the table below.

Note to tenderers: The tenderer must indicate how they claim points for each preference point system.)

The specific goals allocated points in terms of this tender	Number of points allocated (90/10 system)	Number of points claimed (90/10 system) (To be completed by the tenderer)
Business owned by 51% or more-Women	5	
Business owned by 51% or more- by Black people.	5	
Total	10	

5. DECLARATION WITH REGARD TO COMPANY/FIRM

5.1 Name of company/firm.....

5.2 Company registration number:

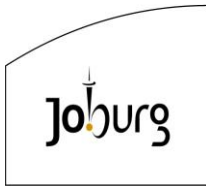
5.3 TYPE OF COMPANY/ FIRM

- ☐ Partnership/Joint Venture / Consortium
- ☐ One-person business/sole propriety
- ☐ Close corporation
- ☐ Public Company
- ☐ Personal Liability Company
- ☐ (Pty) Limited
- ☐ Non-Profit Company
- ☐ State Owned Company

[TICK APPLICABLE BOX]

5.4 I, the undersigned, who is duly authorised to do so on behalf of the company/firm, certify that the points claimed, based on the specific goals as advised in the tender, qualifies the company/ firm for the preference(s) shown and I acknowledge that:

- i) The information furnished is true and correct.
- ii) The preference points claimed are in accordance with the General Conditions as indicated in paragraph 1 of this form.
- iii) In the event of a contract being awarded as a result of points claimed as shown in paragraphs 1.4 and 4.2, the contractor may be required to furnish documentary proof to the satisfaction of the organ of state that the claims are correct.
- iv) If the specific goals have been claimed or obtained on a fraudulent basis or any of the conditions of contract have not been fulfilled, the organ of state may, in addition to any other remedy it may have –



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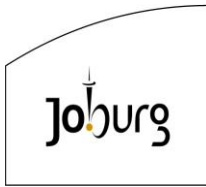
- (a) disqualify the person from the tendering process.
- (b) recover costs, losses or damages it has incurred or suffered as a result of that person's conduct.
- (c) cancel the contract and claim any damages which it has suffered as a result of having to make less favourable arrangements due to such cancellation.
- (d) recommend that the tenderer or contractor, its shareholders, and directors, or only the shareholders and directors who acted on a fraudulent basis, be restricted from obtaining business from any organ of state for a period not exceeding 10 years, after the *audi alteram partem* (hear the other side) rule has been applied; and
- (e) forward the matter for criminal prosecution, if deemed necessary.

SIGNATURE(S) OF TENDERER

SURNAME AND NAME:

DATE:

ADDRESS:
.....
.....



5.5 SUB-CONTRACTING

5.5.1 Will any portion of the contract be sub-contracted?

(Tick applicable box)

YES	☐	NO	☐

5.5.2 If yes, indicate:

i) What percentage of the contract will be subcontracted _____ (minimum of 18%)

ii) The name of the sub-contractor(s):

.....

.....

.....

iii) The black shareholders of the sub-contractor(s):

.....

.....

.....

.....

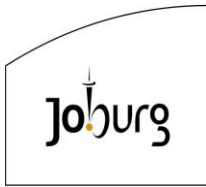
iv) Whether the sub-contractor(s) is an EME or QSE

(Tick applicable box)

YES	☐	NO	☐

v) Specify, by ticking the appropriate box, if subcontracting with an enterprise in terms of Preferential Procurement Regulations, 2022:

Designated Group: An EME or QSE which is at least 51% owned by:	EME √	QSE √
Black people		
Black people who are youth		
People who are women		
Black people with disabilities		
Black people living in rural or underdeveloped areas or townships		
Cooperative owned by black people		
Black people who are military veterans		
OR		
Any EME		
Any QSE		



5.6 DECLARATION WITH REGARD TO COMPANY/FIRM

5.6.1 Name of company/firm:

5.6.2 VAT number registration number:

5.6.3 Company registration number:

5.7 TYPE OF COMPANY/ FIRM

- ☐ Partnership/Joint Venture / Consortium
- ☐ One person business/sole propriety
- ☐ Close corporation
- ☐ Company
- ☐ (Pty) Limited

[TICK APPLICABLE BOX]

5.8 DESCRIBE PRINCIPAL BUSINESS ACTIVITIES

.....
.....
.....
.....

5.9 COMPANY CLASSIFICATION

- ☐ Manufacturer
- ☐ Supplier
- ☐ Professional service provider
- ☐ Other service providers, e.g. transporter, etc.

[TICK APPLICABLE BOX]

5.10 MUNICIPAL INFORMATION

Municipality where business is situated:

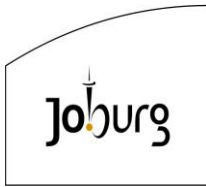
Registered Account Number:.....

Stand Number:

5.11 Total number of years the company/firm has been in business:.....

5.12 I/we, the undersigned, who is / are duly authorised to do so on behalf of the company/firm, certify that the points claimed, based on the Specific Goals in MBD 6.1 qualifies the company/ firm for the preference(s) shown and I / we acknowledge that:

- v) The information furnished is true and correct.
- vi) In the event of a contract being awarded as a result of points claimed as shown in MBD 6.1, the contractor is required to furnish documentary proof as requested in the Tender Data to the satisfaction of the purchaser that the claims are correct.



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- vii) If the specific goals points have been claimed or obtained on a fraudulent basis or any of the conditions of contract have not been fulfilled, the purchaser may, in addition to any other remedy it may have –
- (a) Disqualify the person from the bidding process.
 - (b) Recover costs, losses or damages it has incurred or suffered as a result of that person's conduct.
 - (c) Cancel the contract and claim any damages which it has suffered as a result of having to make less favourable arrangements due to such cancellation.
 - (d) Recommend that the bidder or contractor, its shareholders and directors, or only the shareholders and directors who acted on a fraudulent basis, be restricted by the National Treasury from obtaining business from any organ of state for a period not exceeding 10 years, after the *audi alteram partem* (hear the other side) rule has been applied; and
 - (e) Forward the matter for criminal prosecution.

WITNESSES

1.
2.

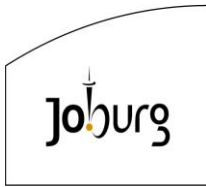
.....
SIGNATURE(S) OF BIDDERS(S)

DATE:

ADDRESS

.....

.....



MBD 4

DECLARATION OF INTEREST

1. No bid will be accepted from persons in the service of the state¹.
2. Any person, having a kinship with persons in the service of the state, including a blood relationship, may make an offer or offers in terms of this invitation to bid. In view of possible allegations of favouritism, should the resulting bid, or part thereof, be awarded to persons connected with or related to persons in service of the state, it is required that the bidder or their authorised representative declare their position in relation to the evaluating/adjudicating authority.
3. **In order to give effect to the above, the following questionnaire must be completed and submitted with the bid.**

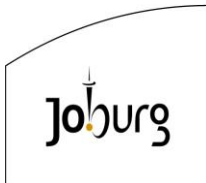
- 3.1 Full Name of bidder or his or her representative:.....
- 3.2 Identity Number:.....
- 3.3 Position occupied in the Company (director, trustee, shareholder²):.....
- 3.4 Company Registration Number:
- 3.5 Tax Reference Number:.....
- 3.6 VAT Registration Number:
- 3.7 The names of all directors / trustees / shareholders members, their individual identity numbers and state employee numbers must be indicated in paragraph 4 below.
- 3.8 Are you presently in the service of the state? **YES / NO**
 - 3.8.1 If yes, furnish particulars.

¹MSCM Regulations: "in the service of the state" means to be –

- (a) a member of –
 - (i) any municipal council.
 - (ii) any provincial legislature; or
 - (iii) the national Assembly or the national Council of provinces.
- (b) a member of the board of directors of any municipal entity.
- (c) an official of any municipality or municipal entity.
- (d) an employee of any national or provincial department, national or provincial public entity or constitutional institution within the meaning of the Public Finance Management Act, 1999 (Act No.1 of 1999).
- (e) a member of the accounting authority of any national or provincial public entity; or
- (f) an employee of Parliament or a provincial legislature.

² Shareholder" means a person who owns shares in the company and is actively involved in the management of the company or business and exercises control over the company.

- 3.9 Have you been in the service of the state for the past twelve months? YES / NO
 - 3.9.1 If yes, furnish particulars.....
- 3.10 Do you have any relationship (family, friend, other) with persons in the service of the state and who may be involved with the evaluation and or adjudication of this bid?
..... YES / NO
 - 3.10.1 If yes, furnish particulars.....



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3.11 Are you, aware of any relationship (family, friend, other) between any other bidder and any persons in the service of the state who may be involved with the evaluation and or adjudication of this bid? YES / NO

3.11.1 If yes, furnish particulars.....
.....

3.12 Are any of the company's directors, trustees, managers, principle shareholders or stakeholders in service of the state? YES / NO

3.12.1 If yes, furnish particulars.....
.....

3.13 Are any spouse, child or parent of the company's directors trustees, managers, principle shareholders or stakeholders in service of the state? YES / NO

3.13.1 If yes, furnish particulars.....
.....

3.14 Do you or any of the directors, trustees, managers, principle shareholders, or stakeholders of this company have any interest in any other related companies or business whether or not they are bidding for this contract. YES / NO

3.14.1 If yes, furnish particulars:.....
.....

4. Full details of directors / trustees / members / shareholders.

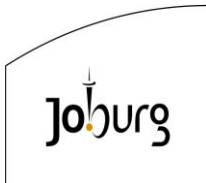
Full Name	Identity Number	State Employee Number

.....
Signature

.....
Date

.....
Capacity

.....
Name of Bidder

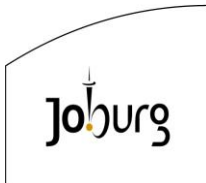


MBD 8

DECLARATION OF BIDDER'S PAST SUPPLY CHAIN MANAGEMENT PRACTICES

- 1 The bid of any bidder may be disregarded if that bidder, or any of its directors have-
 - a. abused the institution's supply chain management system;
 - b. committed fraud or any other improper conduct in relation to such system; or
 - c. failed to perform on any previous contract.
- 2 In order to give effect to the above, the following questionnaire must be completed and submitted with the bid.

Item	Question	Yes	No
4.1	Is the bidder or any of its directors listed on the National Treasury's database as companies or persons prohibited from doing business with the public sector? (Companies or persons who are listed on this database were informed in writing of this restriction by the National Treasury after the <i>audi alteram partem</i> rule was applied).	Yes ☐	No ☐
4.1.1	If so, furnish particulars:		
4.2	Is the bidder or any of its directors listed on the Register for Tender Defaulters in terms of section 29 of the Prevention and Combating of Corrupt Activities Act (No 12 of 2004)? To access this Register, enter the National Treasury's website, www.treasury.gov.za, click on the icon "Register for Tender Defaulters" or submit your written request for a hard copy of the Register to facsimile number (012) 3265445.	Yes ☐	No ☐
4.2.1	If so, furnish particulars:		
4.3	Was the bidder or any of its directors convicted by a court of law (including a court outside of the Republic of South Africa) for fraud or corruption during the past five years?	Yes ☐	No ☐
4.3.1	If so, furnish particulars:		
4.4	Was any contract between the bidder and any organ of state terminated during the past five years on account of failure to perform on or comply with the contract?	Yes ☐	No ☐
4.4.1	If so, furnish particulars:		



CERTIFICATION

I, THE UNDERSIGNED (FULL NAME)

**CERTIFY THAT THE INFORMATION FURNISHED ON THIS DECLARATION
FORM IS TRUE AND CORRECT.**

**I ACCEPT THAT, IN ADDITION TO CANCELLATION OF A CONTRACT, ACTION
MAY BE TAKEN AGAINST ME SHOULD THIS DECLARATION PROVE TO BE
FALSE.**

.....

Signature

.....

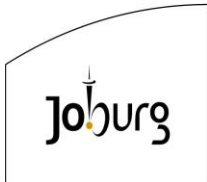
Date

.....

Position

.....

Name of Bidder

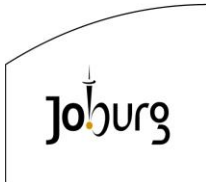


MBD 5

DECLARATION FOR PROCUREMENT ABOVE R10 MILLION (VAT INCLUDED)

For all procurement expected to exceed R10 million (VAT included), bidders must complete the following questionnaire:

- 1 Are you by law required to prepare annual financial statements for auditing? **YES / NO**
 - 1.1 If yes, submit audited annual financial statements for the past three years or since the date of establishment if established during the past three years.....
.....
.....
- 2 If the bidder is not required by law to prepare annual financial statements for auditing, they shall be required to furnish their Annual Financial Statements -
 - i. for the past three years , or
 - ii. since their establishment if established during the past three years
 - 2.1 Do you have any outstanding undisputed commitments for municipal services towards a municipality or any other service provider in respect of which payment is overdue for more than 30 days?
YES / NO
 - 2.2 If no, this serves to certify that the bidder has no undisputed commitments for municipal services towards a municipality or other service provider in respect of which payment is overdue for more than 30 days.
 - 2.3 If yes, provide particulars.....
.....
.....
- 3 Has any contract been awarded to you by an organ of state during the past five years, including particulars of any material non-compliance or dispute concerning the execution of such contract? **YES / NO**
 - 3.1 If yes, furnish particulars.....
.....
.....
- 4 Will any portion of goods or services be sourced from outside the Republic, and, if so, what portion and whether any portion of payment from the municipality / municipal entity is expected to be transferred out of the Republic? **YES / NO**
 - 4.1 If yes, furnish particulars.....
.....
...



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CERTIFICATION

I, THE UNDERSIGNED (NAME)

.....

**CERTIFY THAT THE INFORMATION FURNISHED ON THIS DECLARATION FORM IS
CORRECT.**

**I ACCEPT THAT THE STATE MAY ACT AGAINST ME SHOULD THIS DECLARATION
PROVE TO BE**

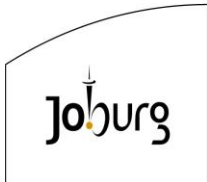
FALSE.

.....
Signature

.....
Date

.....
Position

.....
Name of Bidder



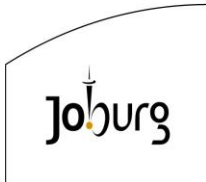
MBD 9

CERTIFICATE OF INDEPENDENT BID DETERMINATION

1. This Municipal Bidding Document (MBD) must form part of all bids¹ invited.
2. Section 4 (1) (b) (iii) of the Competition Act No. 89 of 1998, as amended, prohibits an agreement between, or concerted practice by, firms, or a decision by an association of firms, if it is between parties in a horizontal relationship and if it involves collusive bidding (or bid rigging)². Collusive bidding is a *pe se* prohibition meaning that it cannot be justified under any grounds.
3. Municipal Supply Regulation 38 (1) prescribes that a supply chain management policy must provide measures for the combating of abuse of the supply chain management system, and must enable the accounting officer, among others, to:
 - a. take all reasonable steps to prevent such abuse;
 - b. reject the bid of any bidder if that bidder or any of its directors has abused the supply chain management system of the municipality or municipal entity or has committed any improper conduct in relation to such system; and
 - c. cancel a contract awarded to a person if the person committed any corrupt or fraudulent act during the bidding process or the execution of the contract.
4. This MBD serves as a certificate of declaration that would be used by institutions to ensure that, when bids are considered, reasonable steps are taken to prevent any form of bid-rigging.
5. In order to give effect to the above, the attached Certificate of Bid Determination (MBD9) must be completed and submitted with the bid:

¹ Includes price quotations, advertised competitive bids, limited bids and proposals.

² Bid rigging (or collusive bidding) occurs when businesses, that would otherwise be expected to compete, secretly conspire to raise prices or lower the quality of goods and / or services for purchasers who wish to acquire goods and / or services through a bidding process. Bid rigging is, therefore, an agreement between competitors not to compete.



MBD 9

CERTIFICATE OF INDEPENDENT BID DETERMINATION

I, the undersigned, in submitting the accompanying bid:

(Bid Number and Description) in response to the invitation for the bid made by:

(Name of Municipality / Municipal Entity) do hereby make the following statements that I certify to be true and complete in every respect:

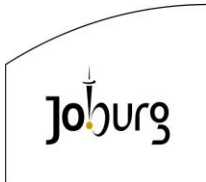
I certify, on behalf of

_____ that:

(Name of Bidder)

1. I have read, and I understand the contents of this Certificate.
2. I understand that the accompanying bid will be disqualified if this Certificate is found not to be true and complete in every respect.
3. I am authorized by the bidder to sign this Certificate, and to submit the accompanying bid, on behalf of the bidder.
4. Each person whose signature appears on the accompanying bid has been authorized by the bidder to determine the terms of, and to sign, the bid, on behalf of the bidder.
5. For the purposes of this Certificate and the accompanying bid, I understand that the word "competitor" shall include any individual or organization, other than the bidder, whether or not affiliated with the bidder, who:
 - (a) has been requested to submit a bid in response to this bid invitation.
 - (b) could potentially submit a bid in response to this bid invitation, based on their qualifications, abilities or experience; and
 - (c) provides the same goods and services as the bidder and/or is in the same line of business as the bidder
6. The bidder has arrived at the accompanying bid independently from, and without consultation, communication, agreement or arrangement with any competitor. However, communication between partners in a joint venture or consortium³ will not be construed as collusive bidding.
7. In particular, without limiting the generality of paragraphs 6 above, there has been no consultation, communication, agreement or arrangement with any competitor regarding:

³ Joint venture or Consortium means an association of persons for the purpose of combining their expertise, property, capital, efforts, skill and knowledge in an activity for the execution of a contract.



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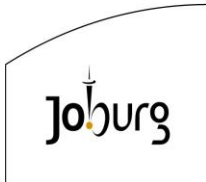
- (a) prices.
 - (b) geographical area where product or service will be rendered (market allocation)
 - (c) methods, factors or formulas used to calculate prices.
 - (d) the intention or decision to submit or not to submit, a bid.
 - (e) the submission of a bid which does not meet the specifications and conditions of the bid; or
 - (f) bidding with the intention not to win the bid.
8. In addition, there have been no consultations, communications, agreements or arrangements with any competitor regarding the quality, quantity, specifications and conditions or delivery particulars of the products or services to which this bid invitation relates.
9. The terms of the accompanying bid have not been, and will not be, disclosed by the bidder, directly or indirectly, to any competitor, prior to the date and time of the official bid opening or of the awarding of the contract.
10. I am aware that, in addition and without prejudice to any other remedy provided to combat any restrictive practices related to bids and contracts, bids that are suspicious will be reported to the Competition Commission for investigation and possible imposition of administrative penalties in terms of section 59 of the Competition Act No. 89 of 1998 and or may be reported to the National Prosecuting Authority (NPA) for criminal investigation and or may be restricted from conducting business with the public sector for a period not exceeding ten (10) years in terms of the Prevention and Combating of Corrupt Activities Act No. 12 of 2004 or any other applicable legislation.

.....
Signature

.....
Date

.....
Position

.....
Name of Bidder



Contract JW14060RR
Northern Wastewater Treatment Works
Dewatering Building Belt Press
Replacement and Associated Ancillaries



Volume 1 Tender and Contract
Section T2 Returnable Documents

T2.1.5 Proposed Amendments and Qualifications

The Tenderer should record any deviations or qualifications he may wish to make to the tender documents in this Returnable Schedule. Alternatively, a tenderer may state such qualifications in a covering letter to his tender and reference such letter in this schedule.

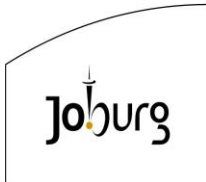
The Tenderer's attention is drawn to clause C.3.8 of the Standard Conditions of Tender referenced in the Tender Data regarding the employer's handling of material qualifications.

Page	Clause or item	Proposal

Signed _____ Date _____

Name _____ Position _____

Tenderer _____



Contract JW14060RR
Northern Wastewater Treatment Works
Dewatering Building Belt Press
Replacement and Associated Ancillaries



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Section T2 Returnable Documents

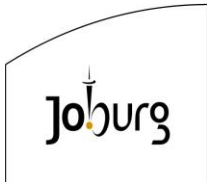
T2.1.6 Schedule of the Tenderer's Experience

EMPLOYER: CONTACT PERSON AND TELEPHONE NUMBER	EMPLOYER'S AGENT OR REPRESENTATIVE: CONTACT PERSON AND TELEPHONE NUMBER	NATURE OF WORK	VALUE OF WORK (inclusive of VAT)	DATE COMPLETED OR EXPECTED TO BE COMPLETED

Signed _____ Date _____

Name _____ Position _____

<i>Tenderer</i>	



T 2.1.7 CONTACTABLE REFERENCE

To Johannesburg Water (SOC) Ltd

CRITERIA 1

I, the undersigned being duly authorised to do so, hereby furnish a reference to Johannesburg Water relative to tender Contract No. **JW14060RR** for the **Dewatering Building Belt Press Replacement and Associated Ancillaries**

Name of Tenderer:

Description of Services provided:

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Method of construction.....

Reservoir size.....

Material type.....

Name of authorized person:

Signature :.....Date

Telephone/Mobile:

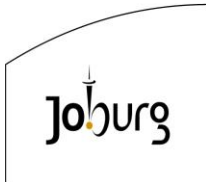
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Contract JW14060RR
Northern Wastewater Treatment Works
Dewatering Building Belt Press
Replacement and Associated Ancillaries



Volume 1 Tender and Contract
Section T2 Returnable Documents

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Reservoir size.....

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Name of authorized person:

Signature :.....**Date**

Telephone/Mobile:

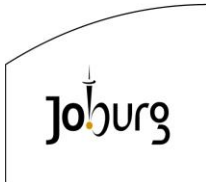
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Contract JW14060RR
Northern Wastewater Treatment Works
Dewatering Building Belt Press
Replacement and Associated Ancillaries



Volume 1 Tender and Contract
Section T2 Returnable Documents

T 2.1.7 CONTACTABLE REFERENCE

To Johannesburg Water (SOC) Ltd

CRITERIA 2

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Name of Tenderer:

Description of Services provided:

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Method of construction.....

Reservoir size.....

Material type.....

Name of authorized person:

Signature : **Date**

Telephone/Mobile:

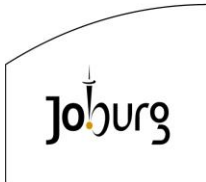
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Reservoir size.....

Material type.....

Name of authorized person:

Signature :.....Date

Telephone/Mobile:

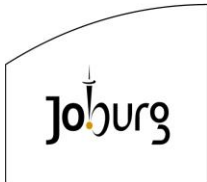
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Reservoir size.....

Material type.....

Name of authorized person:

Signature :.....Date

Telephone/Mobile:

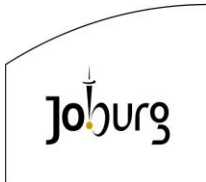
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Contract JW14060RR
Northern Wastewater Treatment Works
Dewatering Building Belt Press
Replacement and Associated Ancillaries



Volume 1 Tender and Contract
Section T2 Returnable Documents

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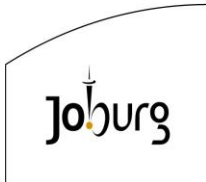
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Contract JW14060RR
Northern Wastewater Treatment Works
Dewatering Building Belt Press
Replacement and Associated Ancillaries



Volume 1 Tender and Contract
Section T2 Returnable Documents

T 2.1.7 CONTACTABLE REFERENCE

To Johannesburg Water (SOC) Ltd

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Name of Tenderer:

Description of Services provided:

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Method of construction.....

Pipe diameter size.....

Material type.....

Contract Value (Incl. VAT).....

Name of authorized person:

Signature :.....**Date**

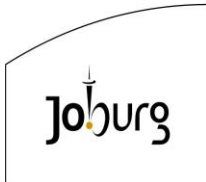
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Contract JW14060RR
Northern Wastewater Treatment Works
Dewatering Building Belt Press
Replacement and Associated Ancillaries



Volume 1 Tender and Contract
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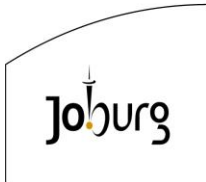
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Contract JW14060RR
Northern Wastewater Treatment Works
Dewatering Building Belt Press
Replacement and Associated Ancillaries



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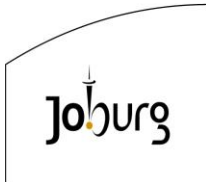
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Contract JW14060RR
Northern Wastewater Treatment Works
Dewatering Building Belt Press
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Volume 1 Tender and Contract
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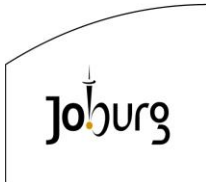
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Contract JW14060RR
Northern Wastewater Treatment Works
Dewatering Building Belt Press
Replacement and Associated Ancillaries



Volume 1 Tender and Contract
Section T2 Returnable Documents

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Contract Value (Incl. VAT).....

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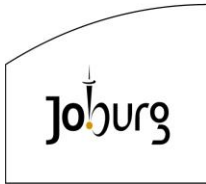
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Contract JW14060RR
Northern Wastewater Treatment Works
Dewatering Building Belt Press
Replacement and Associated Ancillaries



Volume 1 Tender and Contract
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Contract Value (Incl. VAT).....

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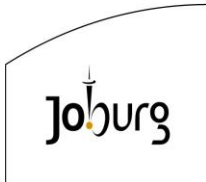
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Contract JW14060RR
Northern Wastewater Treatment Works
Dewatering Building Belt Press
Replacement and Associated Ancillaries



Volume 1 Tender and Contract
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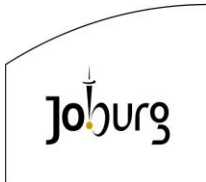
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T 2.1.8 SCHEDULE OF KEY PERSONNEL

In terms of the Project Specification and the Conditions of Tender, unskilled workers may only be brought in from outside the local community if such personnel are not available locally.

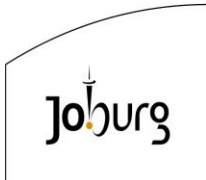
The Tenderer shall list below the personnel which they intend to utilize on the Works, including key personnel which may have to be brought in from outside if not available locally.

CATEGORY OF EMPLOYEE	NUMBER OF PERSONS					
	KEY PERSONNEL, PART OF THE TENDERER'S ORGANISATION		KEY PERSONNEL TO BE IMPORTED IF NOT AVAILABLE LOCALLY		UNSKILLED PERSON- NEL TO BE RE- CRUITED FROM LOCAL COMMUNITY	
	HDI	NON-HDI	HDI	NON-HDI	HDI	NON-HDI
Site Agent, Contracts Manager						
Foremen, Quality Control and Safety Personnel						
Technicians, Surveyors, etc.						
Artisans and other Skilled workers						
Plant Operators						
Unskilled Workers						
Others:						

SIGNATURE:

DATE:

(of person authorized to sign on behalf of the Tenderer)



Contract JW14060RR
Northern Wastewater Treatment Works
Dewatering Building Belt Press
Replacement and Associated Ancillaries



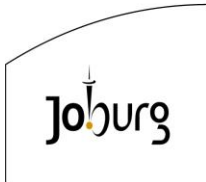
Volume 1 Tender and Contract
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Project Name and Locality	
Project Dates and Value	
Project Position (e.g. Project Manager, Engineer, etc.)	
Description of Scope and Duties	

Project Name and Locality	
Project Dates and Value	
Project Position (e.g. Project Manager, Engineer, etc.)	
Description of Scope and duties	

Project Name and Locality	
Project Position (e.g. Project Manager, Engineer, etc.)	
Description of Scope and duties	

Project Name and Locality	
Project Dates and Value	
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Description of Scope and duties	



Contract JW14060RR
Northern Wastewater Treatment Works
Dewatering Building Belt Press
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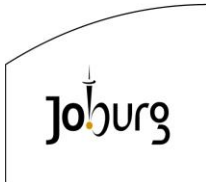
Volume 1 Tender and Contract
Section T2 Returnable Documents

Project Name and Locality	
Project Dates and Value	
Project Position (e.g. Project Manager, Engineer, etc.)	
Description of Scope and duties	

I,....., hereby declare that I am aware of the inclusion of my Curriculum Vita in the proposed project team and make myself available for this project.

Signature :

Date :



Contract JW14060RR
Northern Wastewater Treatment Works
Dewatering Building Belt Press
Replacement and Associated Ancillaries



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Section T2 Returnable Documents

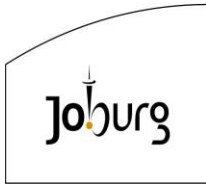
Project Position (e.g. Project Manager, Engineer, etc.)	
Description of Scope and Duties	

Project Name and Locality	
Project Dates and Value	
Project Position (e.g. Project Manager, Engineer, etc.)	
Description of Scope and duties	

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Description of Scope and duties	

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**Contract JW14060RR
Northern Wastewater Treatment Works
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Replacement and Associated Ancillaries**

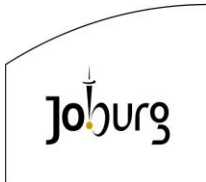


**Volume 1 Tender and Contract
Section T2 Returnable Documents**

I,....., hereby declare that I am aware of the inclusion of my Curriculum Vita in the proposed project team and make myself available for this project.

Signature :

Date :



Contract JW14060RR
Northern Wastewater Treatment Works
Dewatering Building Belt Press
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Volume 1 Tender and Contract
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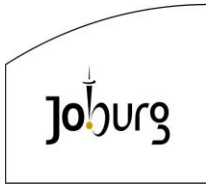
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Project Dates and Value	
Project Position (e.g. Project Manager, Engineer, etc.)	
Description of Scope and Duties	

Project Name and Locality	
Project Dates and Value	
Project Position (e.g. Project Manager, Engineer, etc.)	
Description of Scope and duties	

Project Name and Locality	
Project Position (e.g. Project Manager, Engineer, etc.)	
Description of Scope and duties	

Project Name and Locality	
Project Dates and Value	
Project Position (e.g. Project Manager, Engineer, etc.)	
Description of Scope and duties	

Project Name and Locality	
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Project Position (e.g. Project Manager, Engineer, etc.)	
Description of Scope and duties	



**Contract JW14060RR
Northern Wastewater Treatment Works
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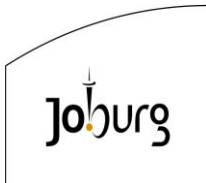


**Volume 1 Tender and Contract
Section T2 Returnable Documents**

I,....., hereby declare that I am aware of the inclusion of my Curriculum Vita in the proposed project team and make myself available for this project.

Signature :

Date :



T2.2.1 Contractor's Certificate of Registration With CIDB

NB: The Tenderer shall attach hereto the Contractor's Certificate of Registration with CIDB OR provide the CIDB registration number that JW can use to verify CIDB requirements for this tender. Failure to submit the certificate or CIDB registration number with the tender document will lead to the conclusion that the Tenderer is not registered with the CIDB and therefore not eligible to tender.

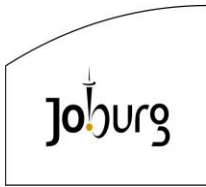
Tenderers who have made application to CIDB for registration and are capable of being so registered prior to the evaluation of submissions must attach a notification from CIDB that their application is being considered.

CIDB status to be active at the required CIDB grading at time of evaluation to avoid disqualification.

SIGNATURE:
.....

DATE:

(of person authorized to sign on behalf of the Tenderer)



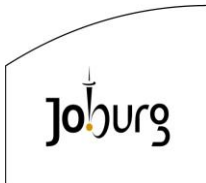
T2.2.2 SARS Tax Compliance Status Pin and Proof of CSD registration

The Tenderer must attach hereto a copy SARS Tax Compliance Status Pin and Proof of CSD registration i.e. MA xxxxxxxxxxx number.

SIGNATURE:
.....

DATE:

(of person authorized to sign on behalf of the Tenderer)



T2.3.1 JW 6.4 Returnable Annexure A: Acknowledgement of SHE Specification & Annexures

DECLARATION BY CONTRACTOR

I, the undersigned, and representing the tenderer as indicated hereby acknowledge that I have obtained copies of the following listed documentation and confirm that I fully understand the contents thereof and confirm compliance thereto in the event of being successful:

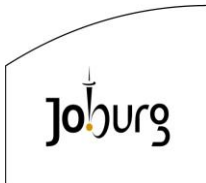
- OHS Specification (Volume 2)
- Annexure 1: Baseline Risk Assessment
- Annexure 2: Medical Screening Policy
- Annexure 3: Sign off form
- Annexure 4: Environmental Management Plan

We furthermore commit to:

- Comply with all applicable SHE related legal and other requirements.
- Inform all staff of their role in managing environmental impacts and safety hazards on site.

Signed at on this Day of 20.....

Name of tenderer	
Name of Authorized person	
Authorized Signature*	



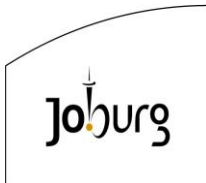
T2.3.2 JW 6.5 Returnable Annexure B: Acknowledgement of Tender Drawings

DECLARATION BY CONTRACTOR

I, the undersigned, and representing the tenderer as indicated hereby acknowledge that I have obtained copies of the following listed documentation and confirm that I fully understand the contents thereof and confirm compliance thereto in the event of being successful:

The drawings that are issued for **TENDER PURPOSES** are those noted below:

DRAWING NUMBER	DESCRIPTION	REV
GENERAL (GEN) DRAWINGS		
JW14060R-GEN-001	Drawing List	T02
JW14060R-GEN-002	Locality Plan	T02
JW14060R-GEN-003	Site Layout	T02
JW14060R-GEN-004	Typical Name Boarder	T02
CIVIL AND STRUCTURAL (CE) ENGINEERING DRAWINGS		
JW14060R-CE-001	MCC Building for Belt Press Set A - Foundation, Surface bed Layout and Details	T02
JW14060R-CE-002	MCC Building for Belt Press Set A - Sections and Details	T02
JW14060R-CE-003	MCC Building for Belt Press Set C - Foundation, Surface bed Layout and Details	T02
JW14060R-CE-004	MCC Building for Belt Press Set C - Sections and Details	T02
JW14060R-CE-005	Pump, Sludge Valve Bank and Polyelectrolyte Tank Concrete Bund Walls and Plinths Details - Sections and Details	T02
JW14060R-CE-006	Pump, Sludge Valve Bank and Polyelectrolyte Tank Concrete Bund Walls and Plinths Details - Sections and Details	T02
JW14060R-CE-007	Polyelectrolyte Silo Concrete Bund Wall - Sections and Details	T02
JW14060R-CE-008	Crawl Beam - BP1C-BP4C Sections and Details	T02
JW14060R-CE-009	Crawl Beam - BP1A-BP6A Sections and Details	T02
MECHANICAL ENGINEERING (ME) DRAWINGS		
JW14060R-ME-001	General Arrangement - Dewatering Building North-East Floor Plan	T02
JW14060R-ME-002	General Arrangement - Dewatering Building North-West Floor Plan	T02
JW14060R-ME-003	General Arrangement - Sludge Valve Bank for BP1A-6A Sections and Details	T02
JW14060R-ME-004	General Arrangement - Sludge Valve Bank for BP1C-4C Sections and Details	T02

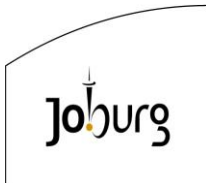


**Contract JW14060RR
Northern Wastewater Treatment Works
Dewatering Building Belt Press
Replacement and Associated Ancillaries**



**Volume 1 Tender and Contract
Section T2 Returnable Documents**

DRAWING NUMBER	DESCRIPTION	REV
JW14060R-ME-005	General Arrangement - New Polyelectrolyte Holding Tank for BP1C-4C Sections and Details	T02
JW14060R-ME-006	General Arrangement - Belt Press for BP1A-6A Sections and Details	T02
JW14060R-ME-007	General Arrangement - Belt Press for BP1C-4C Sections and Details	T02
JW14060R-ME-008	General Arrangement - Wash Water Strainer for BP1A-s6A Sections and Details	T02
JW14060R-ME-009	General Arrangement - Wash Water Supply Pumps and Strainer for BP1C-4C Sections and Details	T02
JW14060R-ME-010	General Arrangement - Sludge Supply Pumps Sections and Details	T02
JW14060R-ME-032	General Arrangement of the Unit 3 Chlorine Contact Chamber Wash Water Transfer Pumps	T02
ELECTRICAL ENGINEERING (ME) DRAWINGS		
JW14060R-ME-011	New Low Voltage Switchboard - Single Line Diagram	T02
JW14060R-ME-012	New Belt Presses MCC "C" - Single Line Diagram	T02
JW14060R-ME-013	New Belt Presses MCC "A" - Single Line Diagram	T02
JW14060R-ME-014	New Belt Presses Cables Racking Layout - Area 1	T02
JW14060R-ME-015	New Belt Presses Cables Racking Layout - Area 2	T02
JW14060R-ME-016	Building Lighting and Small Power Layout - Area 1	T02
JW14060R-ME-017	Building Lighting and Small Power Layout - Area 2	T02
JW14060R-ME-018	Typical D.O.L Schematic Diagram	T02
JW14060R-ME-019	Typical D.O.L Forward / Reverse Schematic Diagram	T02
JW14060R-ME-020	Typical VSD Schematic Diagram	T02
JW14060R-ME-021	Typical VSD Belt Drives Schematic Diagram	T02
JW14060R-ME-022	Typical Conveyor Belt Schematic Diagram	T02
JW14060R-ME-023	Typical Soft Starter Schematic Diagram	T02
JW14060R-ME-024	Typical PLC DB - Single Line Diagram	T02
JW14060R-ME-025	Typical Lighting and Small Power DB - Single Line Diagram	T02
JW14060R-ME-026	Typical Small Power DB - Single Line Diagram	T02
JW14060R-ME-027	New Belt Presses MCC "C" - Single Line Diagram	T02
JW14060R-ME-028	New Belt Presses MCC "A" - Single Line Diagram	T02
JW14060R-ME-029	New Belt Presses Earthing and Lighting Protection - Schematic Diagram for North-East "Area 1" Section	T02
JW14060R-ME-030	New Belt Presses Earthing and Lighting Protection - Schematic Diagram for North-West "Area 2" Section	T02
JW14060R-ME-031	New Belt Presses Earthing and Lighting Protection - Schematic Diagram	T02



**Contract JW14060RR
Northern Wastewater Treatment Works
Dewatering Building Belt Press
Replacement and Associated Ancillaries**

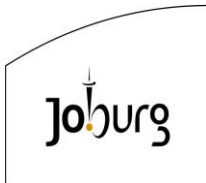


**Volume 1 Tender and Contract
Section T2 Returnable Documents**

DRAWING NUMBER	DESCRIPTION	REV
CONTROL AND INSTRUMENTATION (CI) ENGINEERING DRAWINGS		
JW14060R-CI-001	Legend Sheet - Asset Tagging Piping & Instrumentation Diagram	T02
JW14060R-CI-002	Legend Sheet - Asset Tagging Piping & Instrumentation Diagram	T02
JW14060R-CI-003	Legend Sheet - Asset Tagging Piping & Instrumentation Diagram	T02
JW14060R-CI-004	Dewatering Plant Process Flow Diagram	T02
JW14060R-CI-005	Dewatering Plant Process Flow Diagram	T02
JW14060R-CI-006	Piping and Instrumentation Diagram - Belt Press Plant BP1A-4A	T02
JW14060R-CI-007	Piping and Instrumentation Diagram - Belt Press Plant Bp5a-6a	T02
JW14060R-CI-008	Piping and Instrumentation Diagram - Belt Press Plant BP1C-4C	T02
JW14060R-CI-009	Piping and Instrumentation Diagram - Poly Dosing Make-Up and Holding Tanks	T02
JW14060R-CI-010	Piping and Instrumentation Diagram - Poly Dosing Supply to BP1A-6A	T02
JW14060R-CI-011	Piping and Instrumentation Diagram - Poly Dosing Supply to Bp1C-4C	T02
JW14060R-CI-012	Piping and Instrumentation Diagram - Main Wash Water Supply to De-watering Building	T02
JW14060R-CI-013	Piping and Instrumentation Diagram - Main Sludge Supply to Dewatering Building	T02
STANDARD (STD) DRAWINGS		
JW14060R-STD-001	Dewatering and MCC Access Door Schedule and Details	T02
JW14060R-STD-002	Typical Equipment Access Steel Stairs, Handrails Details and Grating Details	T02
JW14060R-STD-003	Typical Fencing and Access Gate Details	T02

Signed at on this Day of 20.....

Name of tenderer	
Name of Authorized person	
Authorized Signature*	



T2.3.3 JW 6.5 Returnable Annexure C: Acknowledgement of JW Technical Specifications

DECLARATION BY CONTRACTOR

I, the undersigned, and representing the tenderer as indicated hereby acknowledge that I have obtained copies of the following listed documentation and confirm that I fully understand the contents thereof and confirm compliance thereto in the event of being successful:

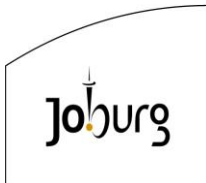
- Technical Specification

We furthermore commit to:

- Comply with all aspects of the Technical Specification

Signed at on this Day of 20.....

Name of tenderer	
Name of Authorized person	
Authorized Signature*	



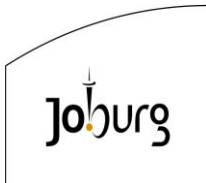
**Contract JW14060RR
Northern Wastewater Treatment Works
Dewatering Building Belt Press
Replacement and Associated Ancillaries**



**Volume 1 Tender and Contract
Section T2 Returnable Documents**

T2.3.4 Returnable Annexure D: Belt Press Technical Data Sheet

Data sheet for:		Filter Belt Presses			
Item No	Description	Unit	Symbol	Offered	Specification Deviation Yes/No
1.	General				
1.1.	Location of equipment:	-	-	Dewatering Building	
1.2.	Manufacturer:	-	-		
1.3.	Model:	-	-		
1.4.	Country of manufacture	-	-		
1.5.	Local Supplier/Agent:	-	-		
1.6.	Quantity:	No.	-	10	
1.7.	Overall Life expectancy	years	-		
2.	Process and utility Data				
2.1.	Solid Content	% w/w	-		
2.2.	Sludge dry solids feed rate	Kg DS /hr	-		
2.3.	Sludge volumetric capacity	m3/hr	-		
2.4.	Liquor pH	-	-		
2.5.	Flocculent dosing	Kg per ton of DS	-		
2.6.	Solids capture rate	%	-		
2.7.	Suspended solids on filtrate	Mg/L	-		
2.8.	Wash-water supply pressure	Bar	-		
2.9.	Wash-water quality supplied by JW has solids	Mg/L	-		
2.10.	Wash water consumption	m3/hr @ kPa	-		
3.	DESIGN DATA				
3.1.	Installation Type/Position	-	-		
3.2.	Belt press effective width	mm	-		
3.3.	Effective height	-	-		
3.4.	Effective length	-	-		
3.5.	No. of pressure rollers	-	-		
3.6.	Min. diameter of pressure rollers	mm	-		
3.7.	Material thickness of pressure roller	Mm	-		
3.8.	Pressure roller design strength per length	N/mm	-		

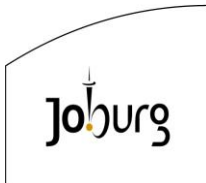


**Contract JW14060RR
Northern Wastewater Treatment Works
Dewatering Building Belt Press
Replacement and Associated Ancillaries**



**Volume 1 Tender and Contract
Section T2 Returnable Documents**

Data sheet for:		Filter Belt Presses			
Item No	Description	Unit	Symbol	Offered	Specification Deviation
					Yes/No
3.9.	Maximum deflection of rollers under load	Mm	-		
3.10.	Expected life of the filter belt	Hrs	-		
3.11.	Roller bearing life (L10)	Hr	-		
3.12.	Belt tensioning mechanism	-	-		
3.13.	Filter belt tensioning strength (min/max)	N.m	-		
3.14.	Total Installed Weight (aggregate)	kg	-		
4.	MATERIAL OF CONSTRUCTION				
5.1.	Filter belt press framework and covers	-	-		
5.2.	Sludge Pipework:	-	-		
5.3.	Gravity Flow (filtrate) Pipework	-	-		
5.4.	Internal piping	-	-		
5.5.	Inline-mixer	-	-		
5.6.	Sludge cake chutes and Belt discharge scraper:	-	-		
5.7.	Pressure Rollers	-	-		
5.8.	Perforated rollers				
5.9.	Belt Supports:				
5.10.	Sludge ploughs				
5.11.	Spray wash system:				
5.12.	Filtrate Collection Trays				
5.13.	Filter belt press material	-	-		
5.14.	Wearing Bars				
5.	Drive Unit (Motor and Gearbox or speed reducer)				
6.1.	Motor				
6.1.1.	Manufacturer:				
6.1.2.	Country of manufactured	-	-		
6.1.3.	Range or model:	-	-		
6.1.4.	Frame Size	-	-		

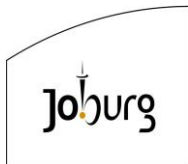


**Contract JW14060RR
Northern Wastewater Treatment Works
Dewatering Building Belt Press
Replacement and Associated Ancillaries**



**Volume 1 Tender and Contract
Section T2 Returnable Documents**

Data sheet for:		Filter Belt Presses			
Item No	Description	Unit	Symbol	Offered	Specification Deviation
					Yes/No
6.1.5.	Drive starting type	-	-		
6.1.6.	Rated power:	kW	P _R		
6.1.7.	Rated voltage:	V	V _R		
6.1.8.	Rated Speed or Pole	rpm	-		
6.1.9.	Enclosure IP rating:	-	-		
6.1.10.	Coupling type	-	-		
6.2.	Gearbox				
6.2.1.	Manufacturer:	-	-		
6.2.2.	Country manufactured in:	-	-		
6.2.3.	Housing	-	-		
6.2.4.	Lubrication System	-	-		
6.2.5.	Gear ratio	-	-		
6.2.6.	Bearing Life (L10)	-	hours	-	
6.2.7.	Service Factor	-	-	-	
6.2.8.	Overall Efficiency	%	η		
6.2.9.	Design Working Temperature	°	T		
6.2.10.	Coupling Type	-	-		
6.	Additional Information				
7.1.					
7.2.					
7.3.					
7.4.					
7.5.					
7.6.					
7.7.					
7.8.					
7.9.					
7.10.					



Johannesburg Water (SOC) Ltd



CONTRACT JW14060RR

NORTHERN WASTEWATER TREATMENT WORKS

**DEWATERING BUILDING BELT PRESS REPLACEMENT AND ASSOCIATED
ANCILLARIES**

VOLUME 1

PART 1: AGREEMENT AND CONTRACT DATA

Employer:		Contractor:	
Witness:		Witness:	

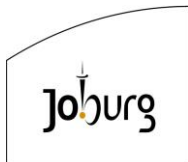
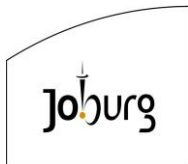


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C1.1.1	Form of Offer	C.1
C1.1.2	Form of Acceptance	C.2
C.1.1.3	Schedule of Deviations	C.3
C1.2	CONTRACT DATA	C.5
C1.2.1	Part 1: Data Provided by the Employer	C.5
C1.2.2	Part 2: Data provided by the Contractor	C.23
C1.3	FORMS AND SECURITIES	C.26
C2.1	PRICING DATA	C.32
	Bill of Quantities	C.41
	Summary of Bill of Quantities	C.86

Employer:		Contractor:	
Witness:		Witness:	



Contract: JW14060RR
Northern Wastewater Treatment Works
Dewatering Building Belt Press
Replacement and Associated Ancillaries
Volume 1 Tender and Contract
Section C1 Agreement and Contract Data



C1.1 FORM OF OFFER (ACCEPTANCE & AGREEMENT)

C1.1.1 Form of Offer

The Contractor is to complete and sign the Form of Offer.

The Employer, identified in the Acceptance signature block, has solicited offers to enter into a contract in respect of the following works:

**CONTRACT NO. JW 14060RR
Northern Wastewater Treatment Works
Dewatering Building Belt Press Replacement and Associated Ancillaries**

The Contractor, identified in the Offer signature block below, has examined the documents listed in the Tender Data and addenda thereto as listed in the Tender Schedules, and by submitting this Offer has accepted the Conditions of Tender.

By the representative of the Contractor, deemed to be duly authorised, signing this part of this Form of Offer and Acceptance, the Contractor offers to perform all of the obligations and liabilities of the Contractor under the Contract including compliance with all its terms and conditions according to their true intent and meaning for an amount to be determined in accordance with the Conditions of Contract identified in the Contract Data.

THE OFFERED TOTAL OF THE PRICES INCLUSIVE OF VALUE ADDED TAX IS

Rand (in words); R (in figures),

This offer may be accepted by the Employer by signing the Acceptance part of this Form of Offer and Acceptance and returning one copy of this document to the Contractor before the end of the period of validity stated in the Tender Data, whereupon the Contractor becomes the party named as the Contractor in the Conditions of Contract identified in the Contract Data.

Signature(s)

Name(s)

Capacity

For the Contractor

(Name and address of
organisation)

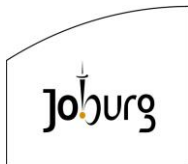
**Name and signature
of witness**

(Name)

(Signature)

Date

Employer:		Contractor:	
Witness:		Witness:	



C1.1.2 Form of Acceptance

The Employer is to complete and sign the form of acceptance

By signing this part of the Form of Offer and Acceptance, the Employer identified below accepts the Contractor's Offer. In consideration thereof, the Employer shall pay the Contractor the amount due in accordance with the Conditions of Contract identified in the Contract Data. Acceptance of the Contractor's Offer shall form an agreement between the Employer and the Contractor upon the terms and conditions contained in this Agreement and in the Contract that is the subject of this Agreement.

The terms of the contract are contained in Volume 1:

- Part 1 Agreement and Contract Data, (which includes this Agreement)
- Part 2 Pricing Data
- Part 3 Scope of Work
- Part 4 Site Information

and drawings and documents or parts thereof, which may be incorporated by reference into Parts 1 to 4 above.

Deviations from and amendments to the documents listed in the Tender Data and any addenda thereto listed in the Tender Schedules as well as any changes to the terms of the Offer agreed by the Contractor and the Employer during this process of offer and acceptance, are contained in the Schedule of Deviations attached to and forming part of this Agreement. No amendments to or deviations from said documents are valid unless contained in this Schedule, which must be duly signed by the authorised representative(s) of both parties.

The Contractor shall within twenty-eight **(28) days** after receiving a completed copy of this Agreement, including the Schedule of Deviations (if any), contact the employer's agent (whose details are given in the Contact Data) to arrange the delivery of any bonds, guarantees, proof of insurance and any other documentation to be provided in terms of the Conditions of Contract identified in the Contract Data at, or just after, the date of this Agreement comes into effect. Failure to fulfil any of these obligations in accordance with those terms shall constitute a repudiation of this Agreement.

Notwithstanding anything contained herein, this Agreement comes into effect on the date when the Contractor receives one fully completed copy of this document, including the Schedule of Deviations (if any). Unless the Contractor (now the Contractor) within five days after the date of such receipt notifies the Employer in writing of any reason why he cannot accept the contents of this Agreement, this Agreement shall constitute binding contract between the parties.

Name(s)

Capacity

For the Employer

**Johannesburg Water SOC (Ltd), Turbine Hall, 65 Ntemi Piliso Street,
Newtown.**

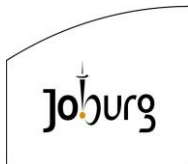
(Name and address of
organisation)

Name and signature
of witness

(Name)

(Signature)

Employer:		Contractor:	
Witness:		Witness:	



Volume 1 Tender and Contract
Section C1 Agreement and Contract Data

—Date _____

C1.1.3 Schedule of Deviations

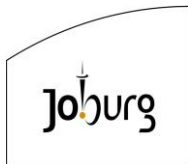
Notes:

1. The extent of deviations from the tender documents issued by the employer prior to the tender closing date is limited to those permitted in terms of the Conditions of Tender;
2. A Contractor's covering letter shall not be included in the final contract document. Should any matter in such letter, which constitutes a deviation as aforesaid become the subject of agreements reached during the process of offer and acceptance, the outcome of such agreement shall be recorded here;
3. Any other matter arising from the process of offer and acceptance either as a confirmation, clarification or change to the tender documents and which it is agreed by the Parties becomes an obligation of the contract shall also be recorded here; and
4. Any change or addition to the tender documents arising from the above arrangements and recorded here shall also be incorporated into the final draft of the Contract.

1	Subject	
	Details	
2	Subject	
	Details	
3	Subject	
	Details	
4	Subject	
	Details	
5	Subject	
	Details	
6	Subject	
	Details	
7	Subject	
	Details	
8	Subject	
	Details	

By the duly authorised representatives signing this Schedule of Deviations, the Employer and the Contractor agree to and accept the foregoing Schedule of deviations as the only deviations from and amendments to the documents listed in the Tender Data and addenda thereto as listed in the Tender Schedules, as well as any confirmation, clarification or change to the terms of the offer agreed by the Contractor and the Employer during the process of offer and acceptance.

Employer:		Contractor:	
Witness:		Witness:	



Contract: JW14060RR
Northern Wastewater Treatment Works
Dewatering Building Belt Press
Replacement and Associated Ancillaries



Volume 1 Tender and Contract
Section C1 Agreement and Contract Data

It is expressly agreed that no other matter whether in writing, oral communication or implied during the period between the issue of the tender documents and the receipt by the Contractor of a completed and signed copy of this Agreement shall have any meaning or effect in the contract between the parties arising from this Agreement.

For the Contractor:

Signature(s)

Name(s)

Capacity

For the Contractor

(Name and address of
organisation)

Name and signature
of witness

(Name)

(Signature)

Date

For the Employer:

Name(s)

Capacity

For the Employer

**Johannesburg Water SOC (Ltd), Turbine Hall, 65 Ntemi Piliso Street,
Newtown.**

(Name and address of
organisation)

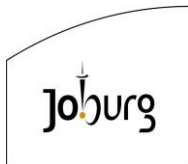
Name and signature
of witness

(Name)

(Signature)

Date

Employer:		Contractor:	
Witness:		Witness:	



C1.2 CONTRACT DATA

C1.2.1 Part 1: Data Provided by the Employer

CONDITIONS OF CONTRACT

The General Conditions of Contract for Construction Works Third Edition (2015), published by the South African Institution of Civil Engineering, is applicable to this Contract.

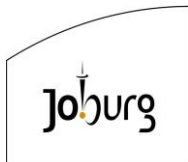
Copies of these conditions of contract may be obtained from the South African Institution of Civil Engineering (Telephone number: 011-805 5947)

C1.2.1.1 Contract Specific Data

The following contract specific data are applicable to this Contract:

GCC Clause	Information																		
1.1.1.13	The Defects Liability Period is 52 weeks from the date of the Certificate of Completion.																		
1.1.1.14	The time for achieving Practical Completion is 24 months including all non-working and special non-working days.																		
1. 1.1.15	The name of the Employer is Mr Thapelo Teane of Johannesburg Water (SOC) Limited.																		
1.1.1.16	The name of the Employer’s Agent is Hatch Consulting represented by Johan Prinsloo, who is Registered as a PrEng with the Engineering Council of South Africa.																		
1.1.1.26	The Pricing Strategy is a Re-measurement Contract.																		
1.2.1.2	The address of the Employer is: <table><tr><td>Physical</td><td>Postal</td><td>Tel: 011 688 1603</td></tr><tr><td>Turbine Hall</td><td>P.O. Box</td><td>Fax: 011 688 1521</td></tr><tr><td></td><td>61542</td><td></td></tr><tr><td>65 Ntemi Piliso Street</td><td>Marshalltown</td><td>Email:thapelo.teane@jwater.co.za</td></tr><tr><td>Newtown</td><td>2107</td><td></td></tr></table>	Physical	Postal	Tel: 011 688 1603	Turbine Hall	P.O. Box	Fax: 011 688 1521		61542		65 Ntemi Piliso Street	Marshalltown	Email:thapelo.teane@jwater.co.za	Newtown	2107				
Physical	Postal	Tel: 011 688 1603																	
Turbine Hall	P.O. Box	Fax: 011 688 1521																	
	61542																		
65 Ntemi Piliso Street	Marshalltown	Email:thapelo.teane@jwater.co.za																	
Newtown	2107																		
1.2.1.2	The address of the Employer’s Agent is: <table><tr><td>58 Emerald Parkway</td><td>Postal</td><td>Tel: 011 239 5300</td></tr><tr><td>Road</td><td></td><td>Fax: 011 239 5790</td></tr><tr><td>Greenstone Hill</td><td>Private Bag</td><td>Email:</td></tr><tr><td>Johannesburg</td><td>X20</td><td>johan.prinsloo@hatch.com</td></tr><tr><td></td><td>Gallo Manor</td><td></td></tr><tr><td></td><td>2052</td><td></td></tr></table>	58 Emerald Parkway	Postal	Tel: 011 239 5300	Road		Fax: 011 239 5790	Greenstone Hill	Private Bag	Email:	Johannesburg	X20	johan.prinsloo@hatch.com		Gallo Manor			2052	
58 Emerald Parkway	Postal	Tel: 011 239 5300																	
Road		Fax: 011 239 5790																	
Greenstone Hill	Private Bag	Email:																	
Johannesburg	X20	johan.prinsloo@hatch.com																	
	Gallo Manor																		
	2052																		
3.2.3	Specific Approval – The Employer’s Agent is required to obtain the Employer’s approval for the following: • Approval of Variation Orders • Approval to exceed the Contract Sum • Approval of Subcontracting Plan																		
4.4.2	Add the following after this clause: Apart from subcontractors identified by the Contractor for the execution of certain sections of the Works, subcontractors shall also include SMME’s (Small Medium and Micro Enterprises), who are identified from the Local Community for the execution of certain sections of the Works identified by the Contractor.																		

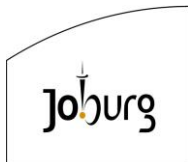
Employer:		Contractor:	
Witness:		Witness:	



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GCC Clause	Information
	The appointment of subcontractors and the allocation of work to subcontractors shall, in addition to the provisions of the General Conditions of Contract, comply with, but not be limited to, the provisions of C1.2.1.2.14 (see below). A minimum value of 15% (fifteen percent) of the Contract Price shall be subcontracted to SMME's.
4.10.1	The Contractor shall employ labour from Local Communities (otherwise known as Local Labour), in accordance with the Tender Data, Scope of Work, Site Information, and Specifications. All Local Labour shall be recruited through the Community Liaison Officer (CLO) and/or Labour Desk Officer (LDO). The Contractor remains fully responsible for all Local Labour that are employed for the execution of the Works, as if they were the Contractor's own labour.
4.11.1	Add the following to this clause: Competent Employees shall include, amongst others, the following Key Personnel: • Contracts Manager • Site Manager / Site Agent • Safety Officer The minimum requirements in terms of qualifications and experience of these Key Personnel are listed in C1.2.1.2.15 (see below).
5.3.1	The documentation required before commencement with Works execution are: • Approved Health and Safety File (Clause 4.3) • Approval of the Environmental File (Clause 4.3) • Initial programme & cashflow projections (Clause 5.6) • Guarantee from Bank or Insurance Company (Clause 6.2) • Insurance of the Works, Plant, etc. (Clause 8.6), including but not limited to: ○ SASRIA Policy ○ Liability Insurance ○ Insurance of Construction Machinery and Plant ○ Insurance of Motor Vehicle Liability, etc. • Compliance Certificate in respect of COID • Signed Notification to the Department of Labour • Construction Permit (where applicable) • Organogram of resources
5.3.2	The time to submit the documentation required before Commencement of the Works is twenty-eight (28) days.
5.3.3	Time to instruct commencement of the Works Delete Clause 5.3.3 and replace with the following: The Contractor shall commence with carrying out the Works upon written instruction from the Employer's Agent to commence with the Works.
5.4.1	Access to the Site shall be granted through written instruction from the Employer's Agent. The Employer reserves the right to limit access to any part of the Site and/or Works, at it's sole discretion.

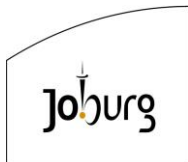
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Witness:		Witness:	



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GCC Clause	Information
5.6.1	The Programme must take into account the Employer's requirements regarding the Sequencing of the Works, as described in the Scope of Works (Section PS 5.4), and Clause 1.1.1.14.
5.8.1	Working days shall be Monday to Friday, between 07h00 to 17h00.
5.8.1	The non-working days are Sundays. The special non-working days are all Public Holidays in terms of the Public Holidays Act (as amended), and the annual "Builder's Break" as defined by SAFCEC on an annual basis.
5.13.1	The penalty for failing to complete the Works is the greater of: An amount equal to the daily Time Related P&G rate (as calculated from the Time Related P&G section in the Bill of Quantities) or R50,000.00 per day, whichever is greater.
5.14.1	The requirements for achieving Practical Completion per Phase are: First Phase: - "Set C" Belt Presses • Installation, testing & commissioning and 3 Month Trial Operation of the four (4) new "Set C" Dewatering Building Belt Presses including removal and placing into storage of the exiting Belt Presses. • Construction and completion of the two (2) new MCC Rooms and Solar battery Room. • Installation, testing & commissioning of all associated electrical and C&I infrastructure including relocation of existing equipment as specified. • Construction, testing & commissioning of all associated ancillaries as specified in the Scope of Work for the First Phase. Second Phase: - "Set A" Belt Presses • Installation, testing & commissioning and 3 Month Trial Operation of the six (6) new "Set C" Dewatering Building Belt Presses including removal and placing into storage of the exiting Belt Presses. • Complete Demolition of the existing MCC Room used for these Presses. • Installation, testing & commissioning of all associated electrical and C&I infrastructure including relocation of existing equipment as specified. • Construction, testing & commissioning of all associated ancillaries as specified in the Scope of Work for the Second Phase.
5.14.2	The Works shall be programmed to be completed in Phases, such that a Certificate of Practical Completion can be issued for each Phase.
5.14.5.1	The performance guarantee shall be returned after completion of the whole of the Works (i.e. after both Phases have been completed).
5.14.5.3	Retention shall be reduced to half, per Phase that has been completed. The value of retention to be released shall be calculated on a pro-rata basis according to the value of work that has been certified by the Employer's Agent for each Phase, after the Employer's Agent has issued the Completion Certificate for that Phase.

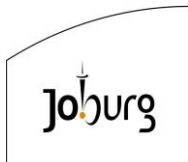
Employer:		Contractor:	
Witness:		Witness:	



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5.14.5.5	Insurance of the Works shall cease after completion of the whole of the Works (i.e. after both Phases have been completed).
5.14.7	Different dates of Practical Completion for each of the Phases will apply.
5.16.3	The latent defect period is Ten (5) years for Civil Engineering and Building Works, Three (3) years for Electrical and Mechanical engineering works; and shall apply after completion of the whole of the Works (i.e. after both Phases have been completed).
6.2.1	The time to deliver the Form of Guarantee is within 28 days from the Commencement Date. The security to be provided by the Contractor shall be in the form of a Performance Guarantee and will comply with the requirements of Clause 6.2.3. The value of the Performance Guarantee shall be ten (10) % of the Contract Sum, which sum excludes VAT.
6.8.2	The Contract Price Adjustment is applicable for this contract. The contract rates shall be adjusted by the change in CPA (as published by Statistics SA). The following formula will be applicable. $(1-x) \left[\frac{aLt}{Lo} + \frac{bPt}{Po} + \frac{cMt}{Mo} + \frac{dFt}{Fo} - 1 \right]$ In which the symbols have the following meaning as per GCC 2015: "x" is the proportion of "Ac" which is not subject to adjustment. "a", "b", "c" and "d" are the coefficients contained in the Contract Data, which are deemed, irrespective of the actual constituents of the work, to represent the proportionate value of labour, contractors' equipment, material (other than "special materials" specified in the Contract Data) and fuel respectively. "L" is the "Labour Index" "P" is the "Plant Index" "M" is the "Materials Index" "F" is the "Fuel Index" The suffix "o" denotes the base indices applicable to the base month as stated in the Contract Data. The suffix "t" denotes the current indices applicable to the month in which the last day of the period falls to which the relevant monthly statement relates. If any index relevant to any particular certificate is not known at the time when the certificate is prepared, the Engineer shall estimate the value of such index. Any correction which may be necessary when the correct indices become known, shall be made by the Engineer in subsequent payment certificates.

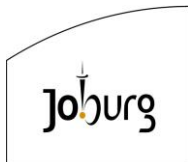
Employer:		Contractor:	
Witness:		Witness:	



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GCC Clause	Information
	The value of the payment certificates issued shall be adjusted in accordance with the Contract Price Adjustment Schedule, with the following values: The value of "x" is 0,10 The values of the coefficients are: a = 0,32 Labour b = 0,25 Contractor's equipment c = 0,33 Material d = 0,10 Fuel The province where the Site is located is Gauteng and the urban area where the project is implemented is Johannesburg. The base month is the month prior to the month in which the tender closes. The Consumer Price Indices for Labour (L), Plant (P), Material (M) and Fuel (F) are as published by Statistics South Africa for the applicable time.
6.8.3	Price adjustments for variations in the costs of special materials are NOT allowed.
6.10.1.5	The percentage advance on materials not yet built into the Permanent Works is 80%.
6.10.3	The percentage retention on the amounts due to the Contractor is 10%.
6.10.3	The limit of retention money is 10% of the Contract Price.
6.10.4	Delivery, dissatisfaction with and payment of payment certificates Delete Clause 6.10.4 and replace with the following: Payment shall be made upon: - The Contractor providing a payment certificate with all required supporting documents to the Employer's Agent on dates to be communicated to the Contractor upon award. - The payment certificate being submitted with an original tax invoice. - A statement being submitted on the last day of the month. Payment will be made within 30 days of receipt of the Contractor's final statement. Payment shall be subject to the Contractor submitting an Original Tax Invoice compliant with SARS requirements for a Valid Tax Invoice to the Employer for the amount due. Any dissatisfaction in respect of such payment certificate shall be dealt with in terms of Clause 10.2.
6.10.5	Payment of Retention Money Add to Clause 6.10.5 the following: Payment will be subject to Johannesburg Water processes as outlined in clause 6.10.4 as amended.
6.10.6.2	Delete Clause 6.10.6.2
6.11	Delete Clause 6.11.
7.8.2	Cost of making good of defects Amend Clause 7.8.2.1 as follows:

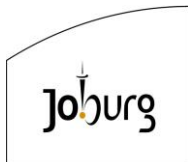
Employer:		Contractor:	
Witness:		Witness:	



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GCC Clause	Information
	In the first line, correct the spelling of 'therefore'.
8.1.1	Add to the end of Clause 8.1.1 the following text: "Although the extent of the Works and the Site are located within the boundaries of the Northern Wastewater Treatment Works (NWWTW), and the Employer may (or may not) provide security for the Treatment Works (NWWTW) as a whole, the Contractor shall remain solely responsible for the protection of the Works and the Site".
8.1.5	Add to the end of Clause 8.1.5 the following text: "Although the Employer has made certain provisions for protection of the Works and the Site in the Pricing Data, the Contractor shall ensure that any and all additional requirements for the protection of the Works and the Site are adequately catered for in his rates and/or prices."
8.4.1.1	Add to the end of Clause 8.4.1.1 the following text: "hereby indemnifies the Employer against any liability in respect of damage or physical loss of property of any person or injury or death of any person due to non-compliance with the Occupational Health and Safety Act (Act 85 of 1993).
8.6.1.1.3	The amount to cover professional fees for repairing damage and loss to be included in the insurance sum is an amount equal to 10% of the Contract Price.
8.6.1.2	Delete clause 8.6.1.2 and replace with the following: Following the introduction of legislation affecting the articles of the South African Special Risks Insurance Association (SASRIA) , insurance cover for loss or damage to the Works caused by any event defined as a risk in terms of the insurance offered by SASRIA, will be provided under a certificate issued by SASRIA.
8.6.1.3	The limit of indemnity for liability insurance is R20,000,000 (Twenty million Rand) for any single claim – the number of claims to be unlimited during the Construction and Defects Liability Periods
8.6.1.5	In addition to the insurances required in terms of General Conditions of Contract Clauses 8.6.1.1 to 8.6.1.4 the following insurance is also required: a. The Contractor shall insure all Construction Machinery and Plant (including tools, offices and other temporary structures and content) and other items, other than those intended for incorporation into the works, owned, leased or hired and brought on to the Site against all risks of physical loss or damage for the period that such Plant shall be on the Site to the full value thereof. In respect of Machinery and Plant brought on to the Site by or on behalf of Sub-Contractors, the Contractor shall be deemed to have complied with the provisions of this Sub-Clause if it has ensured that such Sub-Contractors have similarly insured such Plant and Machinery. Such insurance shall be effected with an Insurer and in terms approved by the Employer (which approval shall not be unreasonably withheld) and the Contractor shall, when required, submit to the Employer's Insurance Brokers, via the Employer's

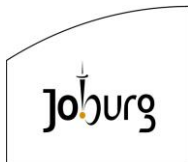
Employer:		Contractor:	
Witness:		Witness:	



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GCC Clause	Information
	Agent, the policy or policies of insurance and receipts for payment of the current premiums. b. The Contractor and the Sub-contractors shall effect and maintain at their cost, insurance under the provision of the Compensation for Occupational Injuries and Diseases Act (COID), 1993 (Act No. 130 of 1993) c. The Contractor and the Sub-Contractors shall effect and maintain at their own cost, motor vehicle liability insurance with at least indemnification for “balance of third party” risks, including passenger liability with a limit of indemnity of not less than R2,5 million. d. Where the contract involves manufacturing and/or fabrication of the works or part thereof at premises other than the Site, the Contractor shall satisfy the Employer that all materials and equipment for incorporation in the works are adequately insured during manufacture and/or fabrication. In the event of the Employer having an insurable interest in such works during manufacture or fabrication then such interest shall be noted by endorsement to the Contractor's Policies of Insurance. e. Any other Insurance cover that may be deemed necessary by the Contractor to ensure full and successful completion of the Works.
8.6	Add the following clause to 8.6 In addition to any statutory obligations, or other requirements contained in the Conditions of Contract or in the Insurance Policy and Documents the Contractor shall report in writing to the Employer's Agent every accident within 48 hours of its occurrence, whether such accident is in respect of damage to persons or property. The report shall contain full details of the accident. The Employer's Agent shall have the right to make all and any enquiries either on the Site or elsewhere as to the cause and results of any such accident and the Contractor shall give the Employer's Agent full access and facilities for carrying out such enquiries. The Employer's Agent shall be given full and immediate access to all communication, reports, findings, assessments, etc. between the Contractor and its Insurance Broker (or Insurance Provider), particularly as it relates to the processing and outcomes of any and all claims. The Contractor shall further allow and authorise the Employer's Agent to communicate with its Insurance Broker (or Insurance Provider) to obtain any and all such information as the Employer's Agent deems necessary.
10.4.2	Dispute resolution shall be by Amicable Settlement, failing which, any dispute shall be resolved by way of ad-hoc Adjudication.
10.5.3	The number of Adjudication Board Members to be appointed is one (1).
10.7.1	The determination of disputes shall be by arbitration.

Employer:		Contractor:	
Witness:		Witness:	



C1.2.1.2 Additions

The additional Conditions of Contract are:

C1.2.1.2.1 Penalties

In addition to GCC clause 5.13, during the Contract Period should the Contractor:

a) Fail to report

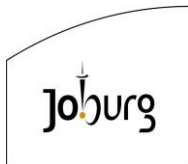
- The Employer shall levy a penalty on Contractor, should the latter fail to provide reporting as required in the specification highlighted in the Scope of Work in PS 3.2, PS 6.11 and PS 6.13, with regard to content and frequency, whilst as per the Pricing Data section no payment for work completed shall be processed.
- The penalty value shall be R5,000.00 per report per day; and
- If the Contractor fails to complete the aforementioned more than three incidents and should the Employer or his duly authorised representative find that the Contractor is hindering his (the Employer's) deliverables to JW Senior Management, he shall reserve the right to:
 - i. perform the Works internally or through another Contractor; and
 - ii. deduct additional costs incurred by the Employer from monies owed to the Contractor or from the Contractor's Guarantee. Additional costs incurred by the Employer shall include all claims from Contract affected parties, claims such as but not be limited to claims from customers, any costs associated with the loss of water, and all costs associated with the procurement of an alternative Contractor.
 - iii. terminate the Contract.

No liability in terms of this clause shall be attached to the Contractor if he can prove to the satisfaction of the Employer that the nature of the failure is due to fire, war, riot, strikes, act of God, lockout, accident or other unforeseen occurrences or circumstances beyond the Contractor's control, provided, however, that in all cases the Contractor has notified the Employer in writing within 24 hours of it first coming to his notice, that delivery shall be delayed or become impossible for the above-mentioned reasons.

b) Fail to pay any labourer or SMME

- The Employer shall levy a penalty on the Contractor, should the latter fail to provide payment to the any labourer or SMME as required in the specification highlighted in the Scope of Work and specified in the appointment agreements with the Contractor and the labourer or SMME.
- The penalty value shall be R 100,000.00 per incident per occasion; and
- The Employer shall reserve the right to settle (pay) an approved invoice (on behalf of the Contractor) to any labourer, Subcontractor, SMME, etc. by the due date for payment, which the Employer shall deduct from the Contractor's payment certificate.
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Employer:		Contractor:	
Witness:		Witness:	



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~~If the Contractor fails to complete the aforementioned more than three incidents and should the Employer or his duly authorised representative find that the Contractor is hindering his (the Employer's) deliverables to JW Senior Management, he shall reserve the right to:~~

- i. perform the Works internally or through another Contractor; and
- ii. deduct additional costs incurred by the Employer from monies owed to the Contractor or from the Contractor's Guarantee. Additional costs incurred by the Employer shall include all claims from Contract affected parties, claims such as but not be limited to claims from customers, any costs associated with the loss of water, and all costs associated with the procurement of an alternative Contractor.
- iii. terminate the Contract.

No liability in terms of this clause shall be attached to the Contractor if he can prove to the satisfaction of the Employer that the nature of the failure is due to fire, war, riot, strikes, act of God, lockout, accident or other unforeseen occurrences or circumstances beyond the Contractor's control, provided, however, that in all cases the Contractor has notified the Employer in writing within 24 hours of it first coming to his notice, that delivery shall be delayed or become impossible for the above-mentioned reasons.

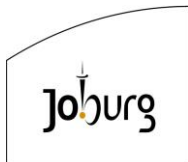
- c) Failure to achieve targets in terms of Contract Participation Goals
- If the Contractor fails to achieve the monetary value of the target set by the Employer for contract participation by local SMME Contractors in terms of Procurement and Particular Specifications in Scope of Works clause PS3.2.3, the Contractor shall be liable to the Employer for a sum calculated in accordance with the Contract Data and the aforementioned Scope of Works as a penalty for such underachievement."

The penalty for failing to achieve the monetary value of the target set by the Employer for contract participation by Targeted Enterprises and local SMME Contractors in terms of Small Contractor Development of Particular Specifications in PS3: Scope of Works, is 50% of the monetary value by which the achieved monetary value falls short of the target monetary value.

d) Environmental, Health and Safety Compliance

- i. If the Contractor fails to achieve the score as stipulated in the Environmental scorecard, the Employer will levy a penalty against the Contractor. Should the Contractor achieve a score of between 85.0% and 93.0% for 2 (two) successive months; OR achieve a score below 85.0% in any 1 (one) month, the penalty shall be levied. The penalty value shall be R10,000.00 for each non-compliant event
- ii. If the Contractor fails to achieve the score as stipulated in the Occupational Health & Safety requirements, the Employer will levy a penalty against the Contractor. Should the Contractor achieve a score of between 85.0% and 93.0% for 2 (two) successive months; OR achieve a score below 85.0% in any 1 (one) month, the penalty shall be

Employer:		Contractor:	
Witness:		Witness:	



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~~levied. The penalty value shall be R10,000.00 for each non-compliant event.~~

- e) Penalties irreversible

The Contractor shall note that all penalties once imposed shall be non-recoverable or non-reversible, even if the default is remedied.

C1.2.1.2.2 Source of instructions

The Contractor shall neither seek nor accept instructions from any authority external to the Employer's Agent in connection with the performance of his services under this Contract. The Contractor shall refrain from any action which may adversely affect the Employer and shall fulfill his commitments with fullest regard for the interest of the Employer. The Contractor may only accept and comply with instructions from the Employer's Health and Safety Representative or the Employer's Environmental Representative with regards to matters regarding Health & Safety or Environmental Management respectively, but with further approval from the Employer's Agent.

C1.2.1.2.3 Officials not to benefit

The Contractor warrants that no official of the Employer has been or shall be admitted by the Contractor to any direct or indirect benefit arising from this Contract or the award thereof. The Contractor agrees that breach of this provision is a breach of the Contract.

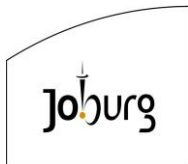
C1.2.1.2.4 Prevention of corruption

The Employer shall be entitled to cancel the Contract and to recover from the Contractor the amount of any loss resulting from such cancellation, if the Contractor has offered or given any person any gift or consideration of any kind as an inducement or reward for doing or intending to do any action in relation to the obtaining or the execution of the Contract or any other contract with the Employer or for showing or intending to show favor or disfavor to any person in relation to the Contract or any other contract with the Employer. If similar acts have been done by any persons employed by the Contractor or acting on his behalf whether with or without the knowledge of the Contractor in relation to this or any other Contract with the Employer the same consequences shall apply.

C1.2.1.2.5 Confidential nature of documents

All maps, drawings, photographs, mosaics, plans, reports, recommendations, estimates, documents and all other data compiled by or received by the Contractor under the Contract shall be the property of the Employer, shall be treated as confidential and shall be delivered only to the Employer's Agent or his duly authorized representative on completion of the Works; their contents shall not be made known by the Contractor to any person other than the personnel of the Contractor performing services under this Contract without the prior written consent of the Employer.

Employer:		Contractor:	
Witness:		Witness:	



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C1.2.1.2.6 Returns of labour, SMME, plant, equipment and material

The Contractor shall provide a return in detail in the form and at such intervals as the Employer's Agent or his duly authorized representative may prescribe showing the supervisory staff and the numbers of the several classes of labour from time to time employed by the Contractor on the Site and such information respecting construction plant, equipment and material as the Employer's Agent or his duly authorized representative may require. Reporting as per JW6.1. The supporting documents required for SMMEs include but are not limited to the following:

- Valid CIPC registration (i.e. CK, COR)
- SA ID copies of owners
- Active CIDB membership: minimum grading 1CE
- Valid CSD compliance status
- Valid EME affidavit
- COIDA certificate
- Company Profile including similar experience and skilled personnel CVs
- Health and Safety Plan
- Proof of Payments

The supporting documents required for local labourers include but are not limited to the following

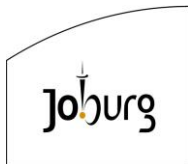
- Certified Copies of IDs
- Individual contracts
- Monthly Individual proof of payment
- Monthly Individual timesheets
- Training returns
- UIF forms (proof of registration from Labour)

C1.2.1.2.7 Materials and workmanship

All materials and workmanship shall be of the respective kinds described in the Contract and in accordance with the Employer's Agent's instructions and shall be subjected from time to time to such tests as the Employer's Agent may direct at the place of manufacture or fabrication, or on the Site or at all or any of such places. The Contractor shall provide such assistance, instruments, machines, labour and materials as are normally required for examining, measuring and testing any work and the quality, weight or quantity of any materials used and shall supply samples of materials before incorporation in the Works for testing as may be selected and required by the Employer's Agent. All testing equipment and instruments provided by the Contractor shall be used only by the Employer's Agent or by the Contractor in accordance with the instructions of the Employer's Agent.

- a) No material not conforming with the Specifications in the Contract shall be used for the Works without prior written approval of the Employer and instruction of the Employer's Agent, provided always that if the use of such material results or may

Employer:		Contractor:	
Witness:		Witness:	



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result in increasing the Contract Price, the procedure in GCC clause 6.3 (Variations) shall apply.

C1.2.1.2.8 Examination of the work before covering up

No work shall be covered up or put out of view without the approval of the Employer's Agent or his duly authorized representative and the Contractor shall afford full opportunity for the Employer's Agent or his duly authorized representative to examine and measure any work which is about to be covered up or put out of view and to examine foundations before permanent work is placed thereon. The Contractor shall give due notice to the Employer's Agent whenever any such work or foundations is or are ready or about to be ready for examination. The Employer's Agent or his duly authorized representative shall without unreasonable delay, unless he considers it unnecessary and advises the Contractor accordingly, attend for the purpose of examining and measuring such work or of examining such foundations.

C1.2.1.2.9 Employer's Agent's power to order removal of improper work and materials

The Employer's Agent or his duly authorized representative shall during the progress of the Works have power to order in writing from time to time, and the Contractor shall execute at his cost and expense, the following operations:

- a) removal from the Site within such time or times as may be specified in the order of any materials which in the opinion of the Employer's Agent are not in accordance with the Contract.
- b) substitution of proper and suitable materials; and
- c) removal and proper re-execution (notwithstanding any previous test thereof or interim payment therefore) of any work which in respect of materials or workmanship is not in the opinion of the Employer's Agent or his duly authorized representative in accordance with the Contract.

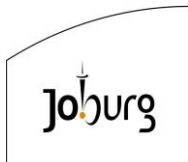
C1.2.1.2.10 Default of Contractor in carrying out Employer's Agent's or his duly authorized representative's Instructions

In case of default on the part of the Contractor in carrying out an instruction of the Employer's Agent or his duly authorized representative, the Employer shall be entitled to employ and pay other persons to carry out the same, and all expenses consequent thereon or incidental thereto shall be borne by the Contractor and shall be recoverable from him by the Employer and may be deducted by the Employer from any monies due or which may become due to the Contractor.

C1.2.1.2.11 Date falling on public holiday or weekend

Where under the terms of the Contract any act is to be done or any period is to expire upon a certain day and that day or that period fall on a day of rest or recognized public holiday or weekend, the Contract shall have effect as if the act were to be done or the period to expire upon the working day following such day.

Employer:		Contractor:	
Witness:		Witness:	



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C1.2.1.2.12 Ambiguities and inconsistencies

The Employer or the Contractor shall notify the other as soon as either becomes aware of an ambiguity or inconsistency in or between the documents, which are part of this Contract. Governed by the spirit and intention of the Contract, the Employer shall give a binding instruction resolving the ambiguity or inconsistency.

C1.2.1.2.13 False claims by the Contractor

- a. Failure, by the Contractor, to demonstrate or present any feature declared during the procurement stage shall constitute grounds for Contract termination or the market related equivalent price discount, if no market related value is available, the Employer shall give a final ruling on the amount. This shall be at the discretion of the Employer based on the implication of such omission. Should the Contractor refuse to accept the Employer's price, the Contract shall be terminated.
- b. Any false claims by the Contractor or his staff (with or without his knowledge), based on Works to be performed or completed per site stage shall constitute grounds for Contract termination and result in blacklisting on the Employer's database.

The Contractor shall note that any of the above shall constitute non-performance on the part of the Contractor, further resulting in him forfeiting his full Contract Guarantee.

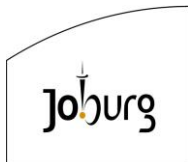
C1.2.1.2.14 Special Conditions

The successful Tenderer must subcontract a minimum of 18% of the value of this Contract to an entity(s) described below. The value of the Contract for the purposes of this calculation shall be equal to the Contract Price (excluding VAT) as described in the General Conditions of Contract.

The subcontractor/s chosen for this purpose must be registered on National Treasury's Central Supplier Database (CSD) and must be from one of the following designated groups:

- An EME or QSE which is at least 51% owned by black people;
 - An EME or QSE which is at least 51% owned by black people who are youth;
 - An EME or QSE which is at least 51% owned by black women;
 - An EME or QSE which is at least 51% owned by black people with disabilities;
 - An EME or QSE which is 51% owned by black people living in rural or underdeveloped areas or townships;
 - A cooperative which is at least 51% owned by black people;
 - An EME or QSE which is at least 51% owned by black people who are military veterans;
 - an EME or QSE .
1. Subcontractors must be chosen from National Treasury's Central Supplier Database which can be accessed on National Treasury's website.
 2. The Contractor shall identify work packages that will be allocated to Subcontractors, so that the minimum requirement of 30% can be met during the implementation of the project, as follows:

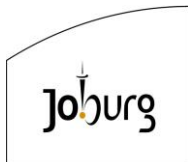
Employer:		Contractor:	
Witness:		Witness:	



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- The Contractor shall develop a Subcontracting Plan that sets out the details of the proposed Subcontracting arrangements including, but not limited to, competitive bidding process to be used for the appointment of SMME's, scope of work to be allocated, criteria for the selection of Subcontractor(s), Subcontractor agreements, cost of the work to be Subcontracted, etc.
- The Subcontracting Plan shall be developed in consultation with the Ward Councillor and / or Community Liaison Officer, who shall assist the Contractor in identifying SMME's and other skills that may be available in local and surrounding communities.
- The Subcontracting Plan shall be issued to the Employer's Agent for approval, prior to the engagement of any Subcontractor(s) by the Contractor. The activities, time periods, linkages, etc. associated with the development and approval of the Subcontracting Plan shall be included in the Project Programme, which Programme is subject to the approval of the Employer's Agent. A period of four weeks will be required for the Employer's Agent to consult with the Employer, prior to approval of the Subcontracting Plan.
- The Contractor shall ensure that rates that are tendered (during Tender Stage) for work items that are likely to be Subcontracted, are market related rates. Provision is made in the Bill of Quantities (BoQ) for the Contractor to add a mark-up for the sourcing, handling, and management of Subcontractors, SMME's, and the like, for the duration of the Contract.
- On or during appointment of Subcontractors, should Subcontractors **prove** that rates, that have been tendered by the Contractor for BoQ work items that are being subcontracted, are not market related, the Contractor will be liable to cover the cost of the difference, i.e. the difference in rate tendered by the Contractor versus the rate that is being requested by the Subcontractor. This difference in cost will be for the Contractor's account, and no Variation Orders for additional costs will be entertained by the Employer. The Contractor bears the full and complete risk for the rates that have been tendered by the Contractor during Tender Stage.
- In the event that a rate supplied by the Contractor for a specific BoQ work item is not sufficient to cover Subcontractor costs/rates for that specific item, the Contractor shall provide a detailed rate breakdown for that specific BoQ item (and each and every subsequent BoQ work item where the rate is not sufficient to cover Subcontractor cost); and shall indicate costs (amongst others) for labour, material, handling, mark-ups, etc. to prove that the rate that was submitted during tender stage was in fact market related; and in balance with other rates that were submitted for work items that will not be undertaken by Subcontractors.
- Should any delays be experienced during the period of the Contract due to the appointment of subcontractors by the Contractor, work stoppages by subcontractors, industrial action by subcontractors, etc. such delays shall be assigned to the Contractor, and no claims for Extension of Time will be entertained by the Employer.
- The Contractor will be liable to pay a penalty if the Subcontracting target of 30% has

Employer:		Contractor:	
Witness:		Witness:	

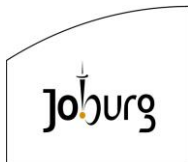


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not been met by the end of the Contract. The Employer will deduct this penalty amount through the Payment Certificate process. The Employer will have full discretion as to when the penalty will be applied (i.e. the month in which the penalty amount will be deducted). In calculating the total amount that has been (will be) paid to SMME's, all amounts that have actually been reimbursed to SMME's will be taken into account including P&G's, amounts for actual work done, etc.

- The penalty amount described above shall be equal to 50% (fifty percent) of the difference between the target Subcontract amount (i.e. 18% of the Contract Price) and the actual amount that has been spent on Subcontractors/SMME's by the end of the Contract.
3. A Subcontracting agreement between the Main Contractor and the Subcontractor shall be submitted to JW upon appointment and must include the following minimum information:
- Name of Subcontractor and BBBEE status
 - Subcontractor *domicilium* and registered address of business, as well as status of compliance with all applicable legal requirements.
 - Area and location of project
 - Scope of Work issued to the Subcontractor
 - Value of the Work issued including P&G's (this information must be submitted in a format that is readily auditable).
 - Assistance provided/to be provided to the Subcontractor by the Contractor, e.g. acquisition of materials, machinery, tools, etc.
 - A Skills Transfer Plan which will indicate, amongst others, the proposed skills that will be transferred to the Subcontractor, individuals that will be identified for skills transfer, the amount that will be spent by the Contractor on skills transfer, evidence that will be produced by the Contractor (such as training certificates, training registers, etc.), etc.
 - A specific provision that enables the Contractor to pay the Subcontractor's suppliers, labour (skilled, local, etc.) or any other service provider of the Subcontractor, should the Subcontractor fail to do so. This provision shall include (but not be limited to) the following conditions/provisos:
 - Invoices that are due for payment from suppliers and the like must be invoices that have been approved for payment and be based on work or services that have actually been completed or delivered. Payments that are due to labour will be based on approved timesheets.
 - The Contractor is to ensure that any invoice presented for payment is indeed an approved invoice, and that the necessary work or services have been delivered or completed. The approved invoice shall be settled (paid) by the Contractor (on behalf of the Subcontractor) by the due date for payment.
 - The Contractor will be entitled to deduct payments made to any third party, on behalf of the Subcontractor, from subsequent payments that may become due

Employer:		Contractor:	
Witness:		Witness:	



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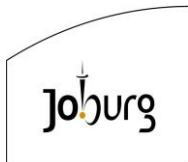
to the Subcontractor.

- The Contractor will be entitled to bill the Subcontractor a mark-up on the payments made on behalf of the sub-contractor. The mark-up shall not be more than 10% (ten percent) of the amount actually paid (i.e. the amount (excluding VAT) reflected on the invoice that has been settled). The mark-up amount shall be deducted from subsequent payments that may become due to the Subcontractor.
- Proof of any such payments made on behalf of the Subcontractor shall be issued to the Employer's Agent, on request, with all necessary supporting information that the Employer's Agent may request
- Payments made on behalf of the Subcontractor are not subject to the Contractor first being paid by the Employer. Therefore, the Contractor shall pay approved invoices, on behalf of the Subcontractor, irrespective of whether the Contractor has first been paid by the Employer. The Contractor will be entitled to levy interest on all payments that have been made in this regard, in accordance with the necessary interest payment provisions contained in the General and Special Conditions of Contract.

4. The successful Contractor shall submit periodic SMME/Subcontractor reports to the Employer's Agent as follows:

- Status of progress against the Subcontracting Plan (described above), to the approval of the Employer's Agent
- Subcontractor *domicilium* and registered address of business, as well as ongoing status of compliance with all applicable legal requirements.
- Name of Subcontractor and BBBEE status
- Area and location of project
- Scope of work issued to the Subcontractor
- Value of the work issued (this information must be submitted in a format that is readily auditable)
- Monthly payments made to the subcontractor (this information must be submitted in a format that is readily auditable)
- Assistance provided to the Subcontractor e.g. advance payments, acquisition of materials, machinery, tools, etc.
- Performance of the Subcontractor, with evidence to support this performance assessment.

Employer:		Contractor:	
Witness:		Witness:	



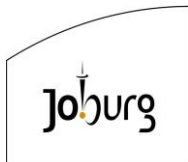
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Replacement and Associated Ancillaries



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- ~~5. Upon completion of the project, the Contractor is required to provide a final report to JW on skills transferred to / acquired by the Subcontractor(s) engaged on the Project, description and value of work performed, as well as their overall performance.~~
6. The Contractor shall also indicate whether the experience gained by the Subcontractor is sufficient to assist the Subcontractor to improve their CIDB grading, with full details of supporting information.

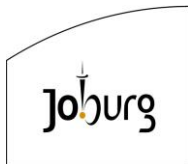
Employer:		Contractor:	
Witness:		Witness:	



C1.2.1.2.15 Competent Employees

Competent Employees	Qualifications	Experience
Contracts Manager	Minimum Qualifications of Contracts Manager: - Bachelor's degree (Civil or Mechanical or Electrical Engineering) OR - Quantity Surveying / Construction Management equivalent or higher. AND - Professional Registration (Pr. Eng. / Pr. Tech.Eng) OR PrCPM / PrCM/ PrQS	Minimum of one (2), ideally 3 or more completed Mechanical, Electrical or Civil wastewater or potable water treatment projects with a minimum value of R50mil as Contracts Manager
Site Manager / Site Agent	Minimum Qualifications of Site Agent: National Diploma (Mech/Elec) Engineering or more; AND Registered as a Candidate Professional or more will be considered.	Minimum of one (2), ideally 3 or more completed Mechanical or Electrical wastewater or potable water treatment project with a minimum value of R30mil as Site Agent/Site Manager
Safety Officer	Minimum Qualifications of Safety Officer National Diploma (Safety Management)/National Diploma (Environmental Health/Environmental Science/Environmental Management) /SAMTRAC / SHEOMTRAC/ SHEMTRAC / MESHTRAC /NEBOSH / Safety Officers Course (NQF 5) or more, AND Professional Registration with SACPCMP in the Construction Health and Safety Sector.	Minimum of one (3), ideally 3 or more completed Mechanical, Electrical or Civil Projects Completed as Safety Officer

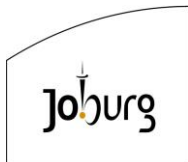
Employer:		Contractor:	
Witness:		Witness:	



C1.2.2 Part 2: Data Provided by the Contractor

GCC Clause	Information			
Clause 1.1.9	The name of the Contractor is..... The Contact person is:.....			
Clause 1.2.1.2	The address of the Contractor is: Physical Address: _____ Postal Address: _____ _____ _____ Tel: _____ Fax: _____ _____ Email: _____			
Clause 1.1.1.1 4	The time for achieving Practical Completion is 24 months from the Commencement Date			
Clause 6.2.1	The security to be provided by the Contractor shall be one of the following: “On Demand” Guarantee of 10% of the Contract Sum (which sum shall exclude VAT) under Forms and Securities Part C1.3.1.			
Clause 6.8.3	The variation in cost of special materials is <table border="0"> <tr> <td>Type</td> <td>Unit</td> <td>Rate</td> </tr> </table> NOT APPLICABLE	Type	Unit	Rate
Type	Unit	Rate		

Employer:		Contractor:	
Witness:		Witness:	



Contract: JW14060RR
Northern Wastewater Treatment Works
Dewatering Building Belt Press
Replacement and Associated Ancillaries



Volume 1 Tender and Contract
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Johannesburg Water (SOC) Ltd



CONTRACT NO. JW14060RR

NORTHERN WASTEWATER TREATMENT WORKS

**DEWATERING BUILDING BELT PRESS REPLACEMENT AND
ASSOCIATED ANCILLARIES**

VOLUME 1

PART 1.3: FORMS AND SECURITIES

Employer:		Contractor:	
Witness:		Witness:	

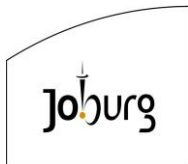
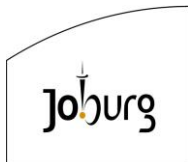


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Employer:		Contractor:	
Witness:		Witness:	



C1.3 FORMS AND SECURITIES

FORMS FOR COMPLETION BY THE CONTRACTOR

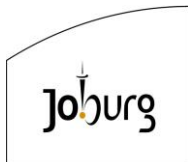
THE FOLLOWING FORMS ARE TO BE COMPLETED BY THE CONTRACTOR AFTER THE TENDER HAS BEEN AWARDED TO THE SUCCESSFUL TENDERER

- a) Form of Guarantee
- b) Blasting Indemnity
- c) Agreement in terms of the Occupational Health and Safety Act
- d) Occupational Health and Safety Indemnity Undertaking

The forms will be completed by the Contractor who will be instructed to do so in the Form of Acceptance. The completed forms will become part of the Contract.

The Form of Guarantee is a pro forma document. The Contractor will provide an original document, from a financial institution, with the same text within the time stated in the Contract Data. Only a Bank or approved Insurance Company or Guarantee Corporation is acceptable as Guarantor.

Employer:		Contractor:	
Witness:		Witness:	



C1.3.1 Form of Guarantee

C1.3.1 Form of Guarantee

TO BE PRINTED ON THE OFFICIAL LETTERHEAD OF THE GUARANTOR.

FORM OF ON DEMAND GUARANTEE IN RESPECT OF PERFORMANCE

GUARANTEE REFERENCE NUMBER: [***]

FORM OF ON DEMAND PERFORMANCE GUARANTEE

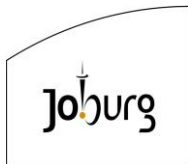
Whereas [insert the full name of the Employer], registration number: [insert registration number], of [insert full physical address] (the “Employer”) has awarded a contract for [insert a detailed description of the contract], under contract number: [insert details] (the “Contract”), to [insert full names of the Contractor], registration number [insert details], of [insert full physical address] (the “Contractor”).

And whereas the Contract requires the Contractor to provide to the Employer an on-demand performance guarantee for the due and proper performance by the Contractor of its obligations in terms of the Contract.

Now therefore: [insert full names of the Guarantor], registration number [Insert details], of [insert the full physical address] (the “Guarantor”), duly represented by the undersigned: [insert the full names of the signatory], and [insert the full names of the signatory], acting herein in their respective capacities as: [insert full title] and [insert full title] respectively, of the Guarantor, and being duly authorized to sign this on demand performance guarantee (this “Guarantee”) and to incur obligations in relation thereto, in the name, and on behalf, of the Guarantor under, and in terms of, a Resolution of the Board of Directors or other written authority of the Guarantor, hereby irrevocably and unconditionally guarantees and undertakes that:

1. The Guarantor shall pay to the *Employer* on demand any sum or sums not exceeding the following aggregate amount: R [insert the amount] (the “Guaranteed Amount”) on presentation of a written demand signed by the *Employer* (the “Demand”), supported by a written statement signed by the *Employer* certifying that the *Contractor*, in the opinion of the *Employer* as at the date of issue of such Demand, is in breach of its obligations under the Contract or that a defect had occurred following the performance by the *Contractor* of its obligations under the Contract, and without being required to prove or set out the nature of any such breach or defect.
2. Neither the failure of the *Employer* to enforce strict or substantial compliance by the *Contractor* with its obligations under the Contract nor any act, conduct or omission by the *Employer* prejudicial to the interests of the Guarantor will discharge the Guarantor from liability under this Guarantee.

Employer:		Contractor:	
Witness:		Witness:	



3. This Guarantee:

3.1 automatically comes into full force and effect on the date of signature hereof by the Guarantor.

3.2 automatically expires, whether or not returned to the Guarantor at the earlier of:

3.2.1 [the *defects date*; or]

3.2.2 90 (ninety) calendar days after the date of termination of the Contract, as notified in writing to the Guarantor by the *Employer*; or

3.2.3 **[insert time]** (Central African Time), at the abovementioned address of the Guarantor on **[insert date]**,

(the “**Expiry Date**”);

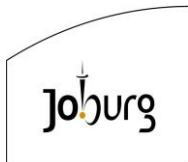
3.3 constitutes the primary obligations of the Guarantor and exists independently of the Contract or any amendment, variation or novation thereof; and

3.4 is governed by the laws of the Republic of South Africa and any dispute arising hereunder shall be subject to the jurisdiction of the South African courts. In respect of such proceedings, each of the Parties specifically consents to the non-exclusive jurisdiction of the High Court of South Africa (Gauteng Local Division, Johannesburg).

4. Any Demand must be presented at the aforementioned address of the Guarantor on or before the Expiry Date. After the Expiry Date, this Guarantee shall become null and void, whether returned to the Guarantor for cancellation or not and any Demand received after the Expiry Date shall be ineffective.

5. The *Employer* may require the *Contractor* to extend this this Guarantee or replace it if the guarantee sum has not been paid in full by the date 28 days prior to the Expiry Date. If the guaranteed sum has not been paid in full by the date 28 days prior to the Expiry Date, and the guarantee has not been extended, the Guarantor unconditionally undertakes to pay to the *Employer* any amounts which the *Contractor* has not repaid (subject to the guaranteed sum) upon receipt by the *Employer*, within such 28 day period, of written demand for payment made in accordance with the terms of the advance payment guarantee.

Employer:		Contractor:	
Witness:		Witness:	



6. Payments made in terms of this Guarantee shall be in cash, free of any set-off, with-holding, counterclaim or deduction of any nature whatsoever.
7. This Guarantee is transferable by the *Employer*, and the Guarantor consents to any transfer of this Guarantee by the *Employer* to any of its affiliates or any other person. This Guarantee is restricted to the payment of a sum of money only and limited to an aggregate amount equal to the Guaranteed Amount.
8. The Guarantor warrants that it has the power and has taken all action and obtained all licenses and approvals required for it, to grant and perform its obligations in terms of this Guarantee.
9. The Guarantor acknowledges that the *Employer* may make multiple demands under this Guarantee provided that the aggregate amount paid by the Guarantor in terms of this Guarantee shall not, at any time, exceed the Guaranteed Amount.
10. The Guarantor's obligations under this Guarantee are of a primary, independent nature and are not ancillary, accessory nor of a collateral nature, to the Contract. Any reference in this Guarantee to the Contract is made for the purpose of convenience and shall not be construed as any intention whatsoever to create an accessory obligation or any intention whatsoever to create a suretyship.
11. For the purposes of this Guarantee, the abovementioned address of the Guarantor shall be its *domicilium citandi et executandi* for all purposes in connection with this Guarantee.

SIGNED at _____ on this day of _____ 20 ____

Witnesses:

1.

For: **[insert name of the Guarantor]** _____

duly authorized and warranting such authority Full Name:

Capacity:

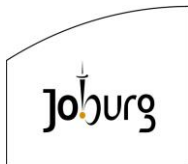
2.

For: **[insert name of Guarantor]** _____

duly authorized and warranting such authority Full Name:

Capacity:

Employer:		Contractor:	
Witness:		Witness:	



C1.3.2 Blasting Indemnity

Given by

*Company Registration No.

Address

a *Company incorporated with limited liability according to the company laws of the Republic of South Africa, *Partnership, *Close Corporation, *Public Company (hereinafter called the Contractor), represented herein by

_____ in his
capacity as the Contractor's

_____ duly authorised hereto by a resolution
of the Contractor dated

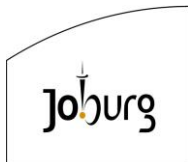
_____ a certified copy of which resolution is
attached to this Indemnity.

WHEREAS the Contractor has entered into a Contract with the Johannesburg Water (SOC) Ltd (hereinafter called the Employer) for,

and the Company requires this Indemnity from the Contractor

NOW THEREFORE THIS DEED WITNESSETH that the Contractor does hereby indemnify and hold harmless the Company in respect of all loss or damage that may be incurred or sustained by the Employer by reason of or in any way arising out of or caused by blasting operations that may be carried out by the Contractor in connection with the aforementioned Contract and also in respect of all claims that may be made against the Employer in consequence of such blasting operations, by reason of or in any way arising out of any accidents or damage to persons, life or property or any other cause whatsoever, and also in respect of all legal or other expenses that may be incurred by the

Employer:		Contractor:	
Witness:		Witness:	



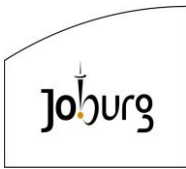
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Replacement and Associated Ancillaries



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Employer in examining, resisting or settling any such claims; for the due performance of which the Contractor binds itself according to law.

Employer:		Contractor:	
Witness:		Witness:	



Contract: JW14060RR
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THUS DONE AND SIGNED for and on behalf of the Contractor at

_____ on the

_____ day of _____ 20_____ in the
presence of the subscribing

witnesses.

As witnesses

1. _____

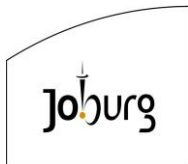
2. _____

Signature

Duly authorised to
sign on behalf of

Address

Employer:		Contractor:	
Witness:		Witness:	



C1.3.3 Health and Safety Contract Between Employer and Contractor in Terms of Section 37(2) Of The Occupational Health and Safety Act No 85 Of 1993

Written agreement between Johannesburg Water ((Proprietary) Limited (hereinafter referred to as “the Employer) and _____ (hereinafter referred to as “the mandatory”) as envisaged by Section 37(2) of the Occupational Health and Safety Act, No. 85, of 1993 as amended.

I _____
representing

_____ (mandatory) do
hereby acknowledge that

_____ (mandatory) is an employer in its own right and shall be regarded as the employer for purposes of the contract work specified in the body of the principal agreement with duties as prescribed in the Occupational Health and Safety Act, No. 85 of 1993 as amended so as to ensure that all work will be performed or machinery and plant used in accordance with the provisions of the said Act. I furthermore agree to comply with the requirements of the Employer as contained in the Occupational Health and Safety Specification included with the principal agreement and to liaise with the employer should I, for whatever reason, be unable to perform in terms of this agreement.

Signed this _____ day of _____ at _____

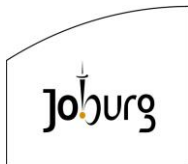
Signature on behalf of mandatory _____

Signature on behalf of Employer _____

Compensation Fund Registration No. of mandatory _____

Good Standing Certificate : ☐ yes ☐ no (tick one box)

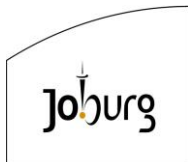
Employer:		Contractor:	
Witness:		Witness:	



C1.3.4 Health and Safety Contract: General Information

1. The Occupational Health and Safety Act comprises Sections 1 to 50 and all un-repealed regulations promulgated in terms of the former Machinery and Occupational Safety Act No 6 of 1983 as amended, as well as other regulations which may be promulgated in terms of the OHS Act.
2. 'Mandatar' is defined as including an agent, a contractor or a subcontractor for work, but without derogating from his status in his own right as an employer or user of plant and machinery.
3. Section 37 of the Occupational Health and Safety Act potentially punishes employers (principals) for the unlawful acts or omissions of mandataries (contractors) save where a written agreement between the parties has been concluded containing arrangements and procedures to ensure compliance with the said Act by the mandatar.
4. All documents attached or referred to in the above agreement form an integral part of the agreement.
5. To perform in terms of this agreement mandataries must be familiar with the relevant provisions of the Act.
6. Mandataries who utilise the services of their own mandataries (subcontractors) are advised to conclude a similar written agreement.
7. Be advised that this agreement places the onus on the mandatar to contact the Employer in the event of inability to perform as per this agreement. The Employer, however, reserves the right to unilaterally take any steps as may be necessary to enforce this agreement.
8. The contractor shall be responsible for the full and proper implementation of the terms and provisions of the Act and its regulations in the area in which the work is to be undertaken by the Contractor.
9. The Contractor shall be responsible for the well-being, in relation to health and safety, of all persons coming upon or into such area in accordance with that legislation, including the implementation of any directives issued by management of the Employer in this respect.
10. The work to be done is _____
11. The area in which the work is to be conducted is _____
12. The Contractor shall familiarise himself with such area and all risks existing thereon and undertakes to report to the representative of the Employer any hazard or risk to health and safety which arises during the contract work in the area concerned and over which the Contractor may have no control. All necessary and appropriate safety / health equipment shall be issued by the Contractor to all persons working on or coming into the area.

Employer:		Contractor:	
Witness:		Witness:	



C1.3.4.1 Occupational Health and Safety Indemnity Undertaking

I, the undersigned _____
in my capacity as _____
of the firm _____

1. Hereby undertake to ensure that I/my firm and/or employees and/or subcontractors and/or his employees -
 - 1.1 comply strictly with the provisions of the Occupational Health and Safety Act of 1993 (as amended) and/or the regulations promulgated in terms thereof, with specific reference to section 37(2) of the said act, as well as any relevant legislation, in the course of the performance/execution of any service and/or work in, to or on any of the Employer's buildings, construction sites and/or premises;
 - 1.2 ensure that consultants and/or visitors comply with any instructions and measures relating to occupational health and safety, as prescribed by the Employer; and
 - 1.3 comply strictly with the statutorily prescribed work systems, operational equipment, machinery and occupational health and safety conditions;
2. And as an independent employer and contractor, hereby indemnify, in terms of the above undertakings, the Employer -
 - 2.1 in respect of any costs that I/my firm and/or employees and/or subcontractors and their employees may incur of necessity in compliance with the above undertakings; and
 - 2.2 against any claims that may be instituted against the Employer and/or any liability that the Employer may incur, whether instituted and/or caused by me/my firm's employees, agents, consultants, subcontractors and/or their employees and visitors or the Employer's clients or neighbours in respect of any incidents related to my/my firm's activities and as a result of which the occupational health and safety of the persons involved have been detrimentally affected; and
 - 2.3 against similar claims that I, managers or directors of my firm may have against the Employer and any damages for which I, managers or directors of my firm hold the Employer liable.
3. My firm's compensation commissioner number is _____
and I confirm that my firm and its subcontractors' fees have been paid up and obligations in respect of the compensation commissioner have been complied with and further that I shall furnish proof thereof in writing on request.
4. I hereby confirm that I have the authority to sign this indemnity undertaking and that the Employer is not obliged to confirm such confirmation.

Signed at _____ This _____ day
of _____

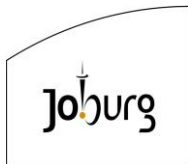
Signature

Capacity

As witnesses:

1 _____
2 _____

Employer:		Contractor:	
Witness:		Witness:	



Contract: JW14060RR
Northern Wastewater Treatment Works:
Dewatering Building Belt Press Replacement
And Associated Ancillaries



Volume 1 Tender and Contract
Section C1 Agreement and Contract Data

Johannesburg Water (SOC) Ltd



CONTRACT JW14060RR

NORTHERN WASTEWATER TREATMENT WORKS

**DEWATERING BUILDING BELT PRESS REPLACEMENT AND ASSOCIATED
ANCILLARIES**

VOLUME 1

PART 2: PRICING DATA

Employer:		Contractor:		
Witness:		Witness:		

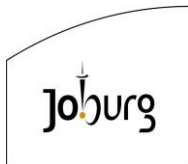
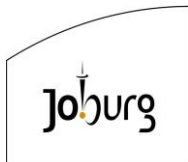


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Employer:		Contractor:		
Witness:		Witness:		



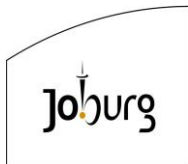
C2 PRICING DATA

C2.1 PRICING INSTRUCTIONS

C2.1.1 General Preamble to the Bill of Quantities

- a) **The Contract is to be constructed using labour intensive methods. In exceptional cases where the use of plant is required, the Contractor must motivate and obtain written permission before the work is undertaken with plant. Payment will not be made for unauthorized use of plant to carry out work.**
- b) All items in the Bill of Quantities, except where otherwise specified in Clause 8 of a Standardised Specification or in the Project Specification, shall be measured and shall cover operations as recommended in the standard system of measurement of civil engineering quantities, published under the title "Civil Engineering Quantities", by the South African Institution of Civil Engineering.
- c) The basis and principles of measurement and payment are described in this section (Pricing Instructions) and Clause 8 of each of the Standardised Specifications for Civil Engineering Construction. The applicable SANS 1200 Standardised Specifications are listed in the Scope of Work, Portion 1: Project Specification. Portion 2: comprises the Technical specifications for the works of each discipline in this contract.
- d) Descriptions in the Bill of Quantities are abbreviated and comply generally with those in the Standardised Specifications. Clause 8 of each Standardised Specification, read together with the relevant clauses of the Scope of Work, set out what ancillary or associated activities are included in the rates for the operations specified. Should any requirements of the measurement and payment clause of the applicable Standardised Specification or the Scope of Work, conflict with the terms of the Bill of Quantities, the requirements of the Standardised Specification or Scope of Work, as applicable, shall prevail.
- e) The clauses in a specification in which further information regarding the Schedule item may be found are listed in the "Payment Refers" column in the Schedule. The reference clauses indicated are not necessarily the only sources of information in respect of listed items. Further information and specifications may be found elsewhere in the Contract Documents. Standardised Specifications are identified by the letter or letters which follow SANS in the SANS 1200 series of specifications, e.g. G for SANS 1200G.
- f) Unless otherwise stated, items are measured net in accordance with the drawings, and no allowance is made for waste.
- g) Cable quantities given in the Schedule of Quantities and Cable Schedules have been measured against scaled drawings. It is the contractor's responsibility to measure the exact cable lengths before purchasing / installing cables. All cables will be subject to re-measure by the Employer's Agent once installed. Furthermore, before any material is purchased the contractor must obtain the written permission of the Employer's Agent.
- h) The quantities set out in the Bill of Quantities are the estimated quantities of the Contract Works, but the Contractor shall be required to undertake whatever quantities may be directed by the Engineer from time to time. The Contract Price for the completed Works shall be computed from the actual quantities of work done, valued at the relevant unit rates and/or prices.
- i) The rates and/or prices to be inserted in the Bill of Quantities are to be the full inclusive prices for the work described under the several items. Such rates and/or prices shall cover all costs and expenses that may be required in and for the execution of the work described, and shall cover the cost of all general risks, liabilities, and obligations set forth or implied in the documents, as well as overhead charges and profit. Reasonable charges shall be inserted as these shall be used as a basis for assessment of payment for additional work that may have to be carried out.

Employer:		Contractor:		
Witness:		Witness:		



Volume 1 Tender and Contract

Section C2 Pricing Data

- j) The units of measurement described in the Bill of Quantities are metric units. Alternatives used are as follows:

mm	=	millimetre	h	=	hour
m	=	metre	kg	=	kilogram
km	=	kilometre	t	=	ton (1000kg)
m2	=	square metre	No.	=	number
m2 pass	=	square metre pass	Sum	=	lump sum
ha	=	hectare	MN	=	meganewton
m3	=	cubic metre	MN.m	=	meganewton-metre
m3km	=	cubic metre-kilometre	P C Sum	=	Prime Cost Sum
l	=	litre	Prov sum	=	Provisional Sum
kl	=	kilolitre	%	=	percent
MPa	=	megapascal	kW	=	kilowatt

- k) For the purpose of this Bill of Quantities, where applicable, the following words shall have the meanings hereby assigned to them:

Unit : The unit of measurement for each item of work as defined in the SANS Standard Specification for South African National Standards.
Quantity : The number of units of work for each item.
Rate : The agreed payment per unit of measurement.
Amount : The product of the quantity and the agreed rate for an item.
Lump sum: An agreed amount for an item, the extent of which is described in the Bills of Quantities, but the quantity of work of which is not measured in any units.

- l) Arithmetical errors in the Bill of Quantities shall be corrected in accordance with Clause C3.9 of the Conditions of Tender. Should there be any discrepancy between rates and/or prices written in the Assessment Schedule and the Bill of Quantities, the latter shall govern.
- m) A price or rate is to be entered against each item in the Bill of Quantities, whether the quantities are stated or not. An item against which no price is entered will be considered to be covered by the other prices in the Schedule.
- n) The Bill of Quantities shall be completed by hand in INK or TYPED. The B Tenderers are permitted to complete and submit the electronic Bill of Quantities (BOQ) instead of filling out the BOQ in the tender document. The original pages of the tender document should not be removed. The electronic version may be submitted as an annexure or inserted as additional pages within the tender document. Tenderers are not permitted to alter the document by amending the descriptions and/or quantities specified in the BOQ.

C2.1.2 Special Payment Conditions

This clause shall be read in conjunction with the 'Penalties' clause(s). Where the penalty clause shall always receive precedence over this clause, should it be found that duplicative financial corrective measures exist.

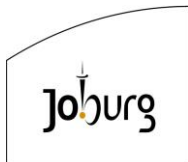
C2.1.2.1 Provided previously.

The Contractor shall not re-execute works under this Contract where he has successfully executed works for the Employer under a previous contract(s) that comply with the requirements of this Contract. However, where applicable the Contractor shall:

- clearly state this in his qualifications; and
- still provide the associated rates and prices in the schedule in the associated line item, but not calculate an associated amount.

The Employer shall at his sole discretion decide to re-execute such works.

Employer:		Contractor:		
Witness:		Witness:		



C2.1.2.2 Security

The Contractor shall have been deemed to have included all security related costs in the Provisional and General item rates, including allowing for minimum 100% (high risk areas) of the sites requiring security provision for the Employer and Engineer representative(s).

C2.1.2.3 Materials and equipment

The Employer shall not provide any works material and equipment, as this shall be provided by the Contractor and deemed to have been included in his provided activity rates or prices.

C2.1.2.4 Permits and way-leaves.

All associated costs to obtain permits and wayleaves as required for the execution of the works, where such affect other services, shall be deemed to have been included in the scheduled rates for SANS 1200A or SANS 1200AA or SANS 1200AB where pricing provision for such items have been allowed for in the pricing schedules, alternatively it shall be deemed to be included in the various scheduled activity rates or prices provided by the Contractor

C2.1.2.5 Confined space.

The Contractor shall note that work activities shall be executed within confined spaces, and it shall be deemed that allowance has been made in all activity pricing.

C2.1.2.6 Payment ONLY for works completed.

The Contractor shall note that payment shall only be made for Works activities successfully (delivering the end result) executed, complying with the quality requirements and provided to the Engineer or his duly authorised representative.

C2.1.3 Health and Safety

The principal Contractor's health and safety plan has to follow the framework as laid out in the HEALTH AND SAFETY SPECIFICATION AND ENVIRONMENTAL MANAGEMENT PLAN, as a minimum.

No payment shall be applicable where equipment is not provided and services are not rendered in terms of the approved Health and Safety Plan. Additionally, the Contractor shall also be penalised in terms of Clause (30) of the Occupational Health and Safety Act 183 (1993), Construction Regulations (2014).

C2.1.3.1 Compilation of health and safety plan

Unit: Sum

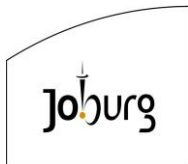
The rate shall include the complete cost for the provision of resources (human and equipment), communication, transportation and travelling, documentation of activities and reporting activities required to compile a Health and Safety Plan as per the Health and Safety Specifications contained in Volume 2, and approval of such plan thereof. Remuneration shall be a lump sum.

C2.1.3.2 Implementation of health and safety plan

Unit: Sum

The rate shall include the complete cost for the provision of resources (human and equipment), communication, transportation and travelling, documentation of activities and reporting activities required to fully comply with the implementation and maintenance of the Health and Safety Plan.

Employer:		Contractor:		
Witness:		Witness:		



Volume 1 Tender and Contract

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Remuneration shall be on a monthly basis for services rendered, by dividing the total sum tendered by the construction duration.

Safety officer

Unit: Sum

The rate shall include the wages and salary that is to be paid to the safety officer/s, whose responsibility it is to ensure that all activities required fully comply with the Health and Safety Plan as per the Health and Safety Specifications contained in Volume 2 for the duration of the Contract. The rate shall be on a monthly basis for services rendered, by dividing the total sum tendered by the construction duration.

NOTE: The Contractor shall clearly state the number of Health and Safety officers in the provided space in the Bill of Quantities that he has allowed for in his price. Where no number is provided the Employer shall assume that adequate provision, minimum one (1) per site, has been made to implement the provided Health and Safety Plan successfully.

C2.1.4 EMP Implementation and Maintenance

Unit: Sum

The rate shall include the complete cost for the provision of resources (human and equipment), communication, transportation and travelling, documentation of activities and reporting activities required to fully comply with the implementation and maintenance of the EMP contained in Volume 2 for the duration of the Contract. Remuneration shall be on a monthly basis for services rendered, by dividing the total sum tendered by the construction duration.

No payment shall be applicable where equipment is not provided and services are not rendered in terms of the approved EMP.

C2.1.5 Subcontracting

C2.1.5.1

The Contractor shall ensure that rates that are tendered (during Tender Stage) for work items that are likely to be Subcontracted, are market related rates. Provision is made in the Bill of Quantities (BoQ) for the Contractor to add a mark-up for the sourcing, handling, and management of Subcontractors, SMME's, and the like, for the duration of the Contract.

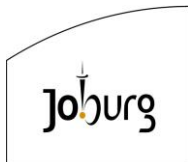
C2.1.5.2

On or during appointment of Subcontractors, should Subcontractors **prove** that rates, that have been tendered by the Contractor for BoQ work items that are being subcontracted, are not market related, the Contractor will be liable to cover the cost of the difference, i.e. the difference in rate tendered by the Contractor versus the rate that is being requested by the Subcontractor. This difference in cost will be for the Contractor's account, and no Variation Orders for additional costs will be entertained by the Employer. The Contractor bears the full and complete risk for the rates that have been tendered by the Contractor during Tender Stage.

C2.1.5.3

In the event that a rate supplied by the Contractor for a specific BoQ work item is not sufficient to cover Subcontractor costs/rates for that specific item, the Contractor shall provide a detailed rate breakdown for that specific BoQ item (and each and every subsequent BoQ work item where the rate is not sufficient to cover Subcontractor cost); and shall indicate costs (amongst others) for labour, material, handling, mark-ups, etc. to prove that the rate that was submitted during tender stage was

Employer:		Contractor:		
Witness:		Witness:		



Volume 1 Tender and Contract

Section C2 Pricing Data

in fact market related; and in balance with other rates that were submitted for work items that will not be undertaken by Subcontractors.

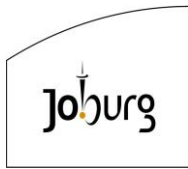
C2.1.5.4

Should any delays be experienced during the period of the Contract due to the appointment of subcontractors by the Contractor, work stoppages by subcontractors, industrial action by subcontractors, etc. such delays shall be assigned to the Contractor, and no claims for Extension of Time will be entertained by the Employer.

C2.1.6 Recommended Labour-Intensive Tasks

ACTIVITY	TOOLS	TASK
Bush clearing	Axe, saw, rope	Medium dense bush (4 to 7 bushes per 100 m ²) 350 m ² /md Dense bush (10 to 15 bushes per 100 m ²) 200 m ² /md Very dense bush (20 to 30 bushes per 100 m ²) 100 m ² /md
Grass clearing	Slasher, spade, hoe, fork, rake.	Dense grass 85 m ² /md
Stripping ground cover and grubbing out roots, haul to nearby dump and spread	Pick, shovel, fork, rake	Light vegetation, dig to 50 mm deep 150 m ² /md Medium vegetation, dig to 100 mm deep 75 m ² /md Heavy vegetation, dig to 150 mm deep 40 m ² /md
Grubbing out roots to 250 mm deep	Pick, shovel, fork, rake	Dig in soft ground to remove roots 42 m ² /md
Destumping (removal of stumps large roots)	Pick, shovel, axe	Medium dense bush 60 m ² /md
Removal of bush and tree cuttings	Bush hook, rope, axe, saw	Cut, bundle and load branches, tree trunk pieces, other vegetation 8 m ³ /md
Boulder removal	Crowbar	Daily paid
Excavation (measured in place)		Throwing distance: up to 4 m 4 to 6 m
Loose soil	Shovel	5 to 6 m ³ /md 4.5 to 5 m ³ /md
Sticky soil	Spade, fork, forked	2 to 3 m ³ /md 1.5 to 2 m ³ /md
Firm soil	hoe	3 to 4.5 m ³ /md 2.5 to 4 m ³ /md
Hard stony gravel	Pick, shovel, spade, hoe	1.5 to 2 m ³ /md 1 to 1.5 m ³ /md
	Pick, shovel, crowbar	
Loading (measured loose) into: Wheelbarrow Trailer	Shovel	Loose soil or gravel: 12 to 15 m ³ /md 7 to 10 m ³ /md

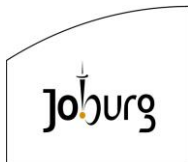
Employer:		Contractor:		
Witness:		Witness:		



Volume 1 Tender and Contract

Section C2 Pricing Data

Truck			4 to 6 m³/md			
Wheel-barrow haul (measured loose; haul and unload only)	Wheelbarrow (Note production increases 30% for good haul route and decreases 30% for poor haul route)	Equivalent haul distance = length + 10(rise + fall) 20 m 40 60 80 100 120 140 160 180 200	Production in loose m3/md over average haul route 4.44 3.16 2.44 2.00 1.70 1.44 1.28 1.15 1.02 0.95			
Levelling roadbed (measured loose)	Shovel, spreader 60 m²/md	60 m²/md				
Picking loose roadbed (bank m³)	Pick, shovel, fork	40 m²/md				
Spreading loose material (loose m³)	Shovel, spreader, hoe	Soil	12 loose m³/md			
		Gravel	10 loose m³/md			
Watering, mixing, spreading and levelling	Shovel, spreader, hoe, string-lines, water bowser	Sandy soil	4.5 m³/md			
		Gravel	3 m³/md			
		(measured tight after compaction)				
Compaction and re- levelling	Roller, string lines, straightedge, shovel, spreader.	Depends upon chosen roller (see below)				
Compaction by pedestrian-controlled double drum vibro-roller	"Stampede" rollers: R75/50 S R90/55 S	Mass kg 980 1 350	Passes 5 4	Layer 100 mm 100 mm	Output 8 m³/h 13 m³/h (tight)	
Loosen material in trench with pneumatic tools	Compressor, pneumatic tools, team of 4 people	Intermediate Rock	19 m³ for team 12 m³ for team			
Screen bedding material	Sieve, shovel	7 m³ loose /md				
Offload flat-bed truck or trailer	Shovel	15 m³ loose /md				
Trench backfill, hand compaction	Shovel, spreader, hand- stamper, watering can	Backfill, compact, clean-up and load spoil	4.5 m³/md			
Collecting loose stone	Gloves, wheelbarrows	Up to 20 m 20 to 50 m	2.5 m³/md 2.0 m³/md			
Quarrying, prying out cracked rock	Crowbar, gloves, sledgehammer.	Up to 20 m	0.5 to 1 m³/md			
Rock crushing	New Dawn Engineering hand-turned rock crusher, shovel	0.25 m³/md (depends on size of feed- stock and size of product)				
Backfill trench and compact	Shovel, watering can, hand stamper	3.0 m³/md				
Lay kerbing on level base	Shovel, rubber mallet,	Straight 6.5 to 10.0 m/md				
Employer:		Contractor:				
Witness:		Witness:				



Volume 1 Tender and Contract

Section C2 Pricing Data

	string-line, trowel, wheelbarrow	Curved 2.0 to 5.0 m/md
Stone pitching: Plain stone pitching	Club hammer, gloves, string-line, shovel, wheelbarrow, stiff broom, pliers, short crowbar	10 to 15 m ² /md, 200 mm thick
Grouted stone pitching		6 to 10 m ² /md, 200 mm thick
Wired and grouted stone pitching		3 to 5 m ² /md, 200 mm thick
Block paving: placing bedding sand, laying blocks, compacting, joint filling, clean up	Shovel, screed rails and beam, rubber mallet, plate compactor, bass broom, wheelbarrow, gloves	16 to 20 m ² /md
Stormwater drainage pipes: trimming, bedding, laying, backfilling, compaction	Shovel, rake, boning rods, hand stamper, watering can, rope and ground anchors	450 mm dia concrete: 1.2 m/md (needs team of 10) 600 mm dia concrete: 1.0 m/md (needs team of 10) 450 mm dia plastic: 3.5 m/md (needs team of 5)
Concrete base slab: batch, mix, transport, pour and finish off	Batching boxes, wheelbarrow, shovel, screed beam, wood float	0.8 m ³ /md (needs team of 5)
Stone masonry walls	Wheelbarrow, shovel, trowel, club hammer, string line, spirit level, batching box.	1.0 m ³ /md
Gabion work	Gloves, string-line, shovel, wheelbarrow, pliers, short crowbar	1.5 m ³ /md

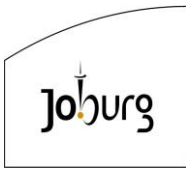
ABBREVIATIONS USED

md = man-day
 dia = diameter

Source :

Construction Education and Training Authority, Learning Material for Unity Standard 15165: "Use LIC

Employer:		Contractor:		
Witness:		Witness:		



Contract: JW14060RR
Northern Wastewater Treatment Works:
Dewatering Building Belt Press Replacement
And Associated Ancillaries



Volume 1 Tender and Contract

Section C2 Pricing Data

C2.2 BILL OF QUANTITIES

Employer:		Contractor:		
Witness:		Witness:		

C2.2 BILL OF QUANTITIES

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SCHEDULE 1 : PRELIMINARY & GENERAL						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
1	SANS 1200 A	SCHEDULE 1 : PRELIMINARY & GENERAL				
1.1	8.3	SCHEDULED FIXED-CHARGE AND VALUE RELATED ITEMS				
1.1.1	8.3.1	<u>Contractual Requirements</u>	Sum	1.00		
1.1.2	8.3.2	<u>Establishment of Facilities on Site</u>				
1.1.3	8.3.2.1	<u>Facilities for the Employer's Agent</u>				
1.1.4		a) Furnished offices (2 No.)	Sum	1.00		
1.1.5		b) Telephone	Sum	1.00		
1.1.6		c) Nameboard (1 No.)	Sum	1.00		
1.1.10	8.3.2.2	<u>Facilities for Contractor:</u>				
1.1.11		a) Offices and storage sheds	Sum	1.00		
1.1.12		b) Workshops	Sum	1.00		
1.1.13		c) Laboratories	Sum	1.00		
1.1.14		d) Living Accommodation	Sum	1.00		
1.1.15		e) Ablution and latrine facilities	Sum	1.00		
1.1.16		f) Tools and equipment	Sum	1.00		
1.1.17		g) Water supplies, electric power and communications	Sum	1.00		
1.1.18		h) Dealing with water	Sum	1.00		
1.1.19		i) Access	Sum	1.00		
1.1.20		j) Plant (Construction Equipment)	Sum	1.00		
1.1.21	8.3.3	<u>Other Fixed-charge Obligations</u>				
1.1.22		a) Compliance with the Health & Safety Specification and Plan	Sum	1.00		
1.1.23		b) Compliance with the Environmental Management Plan	Sum	1.00		
1.1.24		c) Establish Survey Control	Sum	1.00		
1.1.25		d) Subcontractor Management	Sum	1.00		
1.1.26		e) Maintaining Quality Control Plan	Sum	1.00		
1.1.27		f) Provision and Maintaining of Site Security	Sum	1.00		
1.1.28		g).....	Sum	1.00		
1.1.29	8.3.4	<u>Removal of Site Establishment</u>	Sum	1.00		
1.2	8.4	SCHEDULED TIME-RELATED ITEMS				
1.2.1	8.4.1	<u>Contractual Requirements</u>	Sum	1.00		
1.2.2	8.4.2	<u>Operation and Maintenance of Facilities on Site for the Duration of Construction, except where otherwise stated</u>				
1.2.3	8.4.2.1	<u>Facilities for Employer's Agent</u>				
1.2.4		a) Furnished Office (1 No.)	Sum	1.00		
1.2.5		b) Nameboard (1 No.)	No.	1.00		
1.2.6		c) Internet Access	Sum	1.00		
1.2.7	8.4.2.2	<u>Facilities for Contractor:</u>				
1.2.8		a) Offices and storage sheds	Sum	1.00		
1.2.9		b) Workshops	Sum	1.00		
1.2.10		c) Laboratories	Sum	1.00		
1.2.11		d) Living Accommodation	Sum	1.00		
1.2.12		e) Ablution and latrine facilities	Sum	1.00		
TOTAL CARRIED FORWARD						

SCHEDULE 1 : PRELIMINARY & GENERAL						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						
1.2.13		f) Tools and equipment	Sum	1.00		
1.2.14		g) Water supplies, electric power and communications	Sum	1.00		
1.2.15		h) Dealing with water	Sum	1.00		
1.2.16		i) Access	Sum	1.00		
1.2.17		j) Plant (Construction Equipment)	Sum	1.00		
1.2.18	PSA 8.4.3	<u>Supervision for Duration of Construction</u>	Sum	1.00		
1.2.19	8.4.4	<u>Company and Head Office Overhead Costs for the Duration of the Contract</u>	Sum	1.00		
1.2.20	8.4.5	<u>Other Time-related Obligations</u>				
1.2.21		a) Compliance with the Health and Safety Specification	Sum	1.00		
1.2.22		b) Compliance with the Environmental Management Plan	Sum	1.00		
1.2.23		c) Maintain Survey Control	Sum	1.00		
1.2.24		d) Subcontractor Management	Sum	1.00		
1.2.25		e) Maintaining Quality Control Plan	Sum	1.00		
1.2.26		f) Provision and Maintaining of Site Security	Sum	1.00		
1.2.27		g).....	Sum	1.00		
1.3	8.5	SUMS STATED PROVISIONALLY BY EMPLOYER'S AGENT				
1.3.1		Provisional sum for materials control testing and Factory Acceptance Tests of additional Equipment ordered by the Employer's Agent except those listed in Schedule 6 of this BoQ	P.Sum	1.00	R	85,000.00
1.3.2		Contractor's stated commission on the 1.3.1 provisional sum above	%			
1.3.3		Supply of hired specialist equipment for the detection of services, testing and measurement verification by the Employer's Agent or Representative	P.Sum	1.00	R	107,000.00
1.3.4		Contractor's stated commission on the 1.3.3 provisional sum above	%			
1.3.5	PS12.7.1a	Appointment of Project Communit Liason and Labour Desk Officers (CLO / LDO) for the duration of Contract Period	P.Sum	1.00	R	720,000.00
1.3.6		Contractor's stated commission on the 1.3.5 provisional sum above	%			
1.3.7		Formal Skills Development Training of all Local Labour	P.Sum	1.00	R	304,000.00
1.3.8		Contractor's stated commission on the 1.3.7 provisional sum above	%			
1.3.9	PSX 6.7	Provision of imminent or special schedule maintenance spares associated with the new equipment supplied under this project as and when identified/requested by the Employer's Agent.	P.Sum	1.00	R	1,000,000.00
1.3.10	8.5	Contractor's stated commission on the 1.3.9 provisional sum above	%			
1.3.11	PSX 6.6	Specialised Plant Operator training on all installed equipment and as a system	P.Sum	1.00	R	500,000.00
1.3.12	8.5	Contractor's stated commission on the 1.3.11 provisional sum above	%			
1.3.13		Nothern Works CCTV Security System	P.Sum	1.00	R	1,800,000.00
1.3.14		Contractor's stated commission on the 1.3.13 provisional sum above	%			
1.3.15		Provisional Sum for Forward Cover and Exchange Rate Fluctuations on Imported Equipment	P.Sum	1.00	R	3,500,000.00
1.3.16		Contractor's stated commission on the 1.3.15 provisional sum above	%			
1.3.17		Provisional Sum for Repair Work on existing Dewatering Infrastructure	P.Sum	1.00	R	5,000,000.00
1.3.18		Contractor's stated commission on the 1.3.17 provisional sum above	%			
1.3.20		Contract dispute resolution - Arbitration appointment	P.Sum	1.00	R	355,000.00
1.3.21		Contractor's stated commission on the 1.3.15 provisional sum	%			
TOTAL CARRIED FORWARD						

SCHEDULE 1 : PRELIMINARY & GENERAL						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						
1.4	PSA 8.7	DAYWORKS (Provisional)				
1.4.1		<u>Labour:</u>				
1.4.2		a) Foreman	hour	720.00		
1.4.3		b) Skilled	hour	1440.00		
1.4.4		c) Semi-skilled	hour	1440.00		
1.4.5		d) Unskilled	hour	1440.00		
1.4.6		Plant Equipment:				
1.4.7		b) Min. 6m ³ Tip truck:	hour	200.00		
1.4.8		c) TLB	hour	150.00		
1.4.9		d) Plate compactor	hour	150.00		
1.4.10		e) Generator and Breaker	hour	250.00		
1.4.11		f) Min. 10 ton Mobile Crane truck	hour	550.00		
1.4.12		g) Other (Tenderer to specify).....	hour			
1.4.13		Materials i.e. Backfilling sand, Polyelectrolyte, etc. :				
1.4.14		a) Supplied by the Contractor under Dayworks	P.Sum	1.00		R 80,000.00
1.4.15		b) Contractor's stated commission on the 1.4.23 provisional	%			
1.5		OTHER FIXED CHARGES				
1.5.1	PSA 8.9	As-Built Survey	Sum	1.00		
1.5.2		<u>Preparation of As-Built or Record Drawings</u>				
		<i>The cost shall include for the preparation, submission and acceptance by the Employer's Agent and shall only be due once the works have been successfully tested and commissioned.</i>	sum	1.00		
1.6	SANS 1200 AB	FACILITIES FOR EMPLOYER'S AGENT				
1.6.1	PSAB 8.2.5	Provision of telecommunication services	P.Sum	1.00		R 40,000.00
1.6.2	PSAB 8.2.6	Protective clothing and testing equipment	P.Sum	1.00		R 10,000.00
1.6.3	PSAB 8.2.7	Photographic record of work	P.Sum	1.00		R 100,000.00
1.6.4	PSAB 8.2.8	Stationery for the Employer's Agent's staff	P.Sum	1.00		R 12,000.00
1.6.5	PSAB 8.2.9	Computer equipment for the Employer's Agent's staff	P.Sum	1.00		R 100,000.00
1.6.6	PSAB 8.2.10	Providing augment reality 3D modelling or BIM in order to produce a 3D model of the Upgraded Belt Press Building	P.Sum	1.00		R 300,000.00
1.6.7	PSAB 8.2.11	Contractor's stated commission on the item 1.6.1 to 1.6.6 provisional sum above	%			
1.7		CONTRACTORS DOCUMENTATION FOR ALL SUPPLIED EQUIPMENT				
1.7.1		<u>Operations and Maintenance Manuals</u>				
1.7.2		<i>The cost shall include for the preparation, submission and acceptance by the Employer's Agent and shall be broken down as follows:</i>				
		• 50% on submission of the Draft O & M Manuals				
		• 25% on acceptance by the Employer's Agent of the Final O & M Manuals				
		• 25% after the successful commissioning of the works and training of the Employers Personnel	Sum	1.00		
1.8		DEFECTS LIABILITY PERIOD				
1.8.1		Servicing and Maintenance of equipment during Defects Liability Period	Months	12.00		
TOTAL FOR SCHEDULE 1 CARRIED FORWARD TO SUMMARY						

SCHEDULE 2.1 : CIVIL ENGINEERING - SITE CLEARANCE						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
2.1		SCHEDULE 2.1 : CIVIL ENGINEERING - SITE CLEARANCE				
2.1.1	SANS 1200C	SITE CLEARANCE				
2.1.2	8.2.1	<u>Clear and Grub</u>				
2.1.3		a) Contractor Site Establishment	ha	0.08		
2.1.4		b) New MCC Building for the Belt Press Set A	ha	0.08		
2.1.5		c) New MCC Building for the Belt Press Set C	ha	0.03		
2.1.6		d) Perimeter fencing	m	350.00		
2.1.7	8.2.2	<u>Remove and grub large trees and tree stumps of girth</u>				
2.1.8		Over 1 m and up to and including 2 m				
2.1.9		a) Contractor Site Establishment	No.	1.00		
2.1.10		b) MCC for the Belt Press Set A - removal of paving	No.	1.00		
2.1.11		c) MCC for the Belt Press Set C - removal of paving	No.	1.00		
2.1.12	8.2.8	<u>Demolish and remove structures/buildings and dismantle steelwork, etc.</u>				
2.1.13		Miscellaneous concrete debris smaller than 1m ³ in volume				
2.1.14		a) Contractor Site Establishment	No.	1.00		
2.1.15		b) MCC for the Belt Press Set A - removal of paving	No.	1.00		
2.1.16		c) MCC for the Belt Press Set C - removal of paving	No.	1.00		
2.1.17		d) Existing MCC for the A & C Belt Press - Demolish	No.	2.00		
2.1.18		d) Demolishing of existing concrete floor to construct	m ³	3.00		
2.1.19	PSC 8.2.9	<u>Transport materials and debris:</u>				
2.1.20		Rates tendered shall include for all haul to a registered municipal dump including any dumping charges levied.				
2.1.21		Demolished building and structures (see clause payment clause 8.2.8)	m ³ .km	100.00		
TOTAL CARRIED FORWARD TO SCHEDULE 2.2						

SCHEDULE 2.2 : CIVIL ENGINEERING - NEW MCC FOR BELT PRESS SET A (6 no. off)						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD FROM SECTION 2.1						
2.2		SCHEDULE 2.2 : CIVIL ENGINEERING - NEW MCC FOR BELT PRESS SET A (6 no. off)				
		Ref DWG: JW14060R-CE-001 & 002				
	SANS 1200D	<u>Earth Works</u>				
2.2.1	8.3.1	Site Preparation				
2.2.2	8.3.1.1	Clear and strip site	m ²	136.65		
2.2.3	8.3.1.2	Remove topsoil to nominal depth 150mm, stockpile and maintain	m ²	136.65		
2.2.4	8.3.8.1	Location				
2.2.5		Excavate by hand in soft material to expose existing services:	m ³	78.69		
2.2.6	8.3.3	Restricted Excavation				
2.2.7		Extra-over for:				
2.2.8		1) Intermediate excavation	m ³	27.19		
2.2.9		2) Hard Rock excavation	m ³	27.19		
2.2.10	8.3.9	Extra-over for Backfill Material against Structures	m ³	57.25		
2.2.11	SANS 1200G	<u>Concrete Structural</u>				
2.2.12	8.2	Scheduled Formwork Items				
2.2.13	8.2.1	Rough				
2.2.14		(1) Vertical to Strip Footing Foundations	m ²	40.83		
2.2.15		(2) Vertical to cable trench floor slab	m ²	11.44		
2.2.16	8.2.4	Special Smooth, Repaired and Rubbed Vertical to				
2.2.17		(1) Vertical to Roof Slab Edge	m ²	14.85		
2.2.18		(2) Horizontal to Roof slab	m ²	166.12		
2.2.19	8.3	Scheduled Replacement Items				
2.2.20	8.3.1	Steel Bars				
2.2.21		High-tensile steel				
2.2.22		Nominal size 25mm to:				
2.2.23		Strip Footing Foundations	t	1.22		
2.2.24		Concrete Floor Slabs	t	1.54		
2.2.25		Cable Trench Floor Slab	t	0.73		
2.2.26		Roof Slab	t	4.98		
2.2.27	8.3.2	High-Tensile Welded Mesh:				
2.2.28		(1) Floor Slab - Mesh Ref. 193				
2.2.29		Slab to entrances plus apron slabs	m ²	56.50		
2.2.30	8.4	<u>Scheduled Concrete Items</u>				
2.2.31	8.4.2	Blinding Layer				
2.2.32		(1) 15 Mpa no-fines concrete 50 mm thick	m ³	13.01		
2.2.33	8.4.3	Strength Grade Concrete				
2.2.34		(1.1) Floor Slab	m ³	12.33		
2.2.35		(1.2) Strip Footing Foundations	m ³	0.77		
2.2.36		(1.3) Cable Trench Floor Slab	m ³	5.84		
2.2.37		(1.4) Ramps to doorways	m ³	11.30		
2.2.38		(1.5) Roof Slab	m ³	27.69		
2.2.39		(1.6) Apron slabs	m ³	4.12		
TOTAL CARRIED FORWARD						

SCHEDULE 2.2 : CIVIL ENGINEERING - NEW MCC FOR BELT PRESS SET A (6 no. off)						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						
2.2.40	8.4.4	Unformed Surface Finishes				
2.2.41		(1) Wood-floated finish to				
2.2.42		Steel Fasteners (various sizes) for mounting of structural steelwork items including washers and corrosion isolation materials between dissimilar metals e.g. M16 or M20 threaded bolts, nuts and washers	t	0.40		
2.2.43		(1.2) Cable trench floor	m ²	78.69		
2.2.44		(1.3) Ramp to FGL	m ²	4.58		
2.2.45		(1.4) Roof Slab	m ²	3.13		
2.2.46		(1.5) Apron slabs	m ²	41.16		
2.2.47		Steel-floated finish to Floor Slab	m ²	72.55		
2.2.48	8.5	JOINTS				
2.2.49		10mm Softboard with 10x10mm Polyurethane Sealant	m	62.82		
2.2.50		Grooved Joint with Polyurethane Sealant	m	20.10		
2.2.51	SANS 1200H	STRUCTURAL STEELWORK				
2.2.52	8.3.1	Supply and Fabrication				
2.2.53	8.3.1.1	Preparation of shop detail drawings				
2.2.54		(1) Angle Frame (50x50x6mm L Iron, including R8 lugs and 6x6mm Square Bar)	t	0.34		
2.2.55	8.3.1.2	Supply and fabrication of steelwork				
2.2.56		(1) Angle Frame (50x50x6mm L Iron, including R8 lugs and 6x6mm Square Bar)	t	0.34		
2.2.57	8.3.2	Delivery to Site				
2.2.58	8.3.2.1	Normal Delivery				
2.2.59		(1) Angle Frame (50x50x6mm L Iron, including R8 lugs and 6x6mm)	t	0.34		
2.2.60	8.3.9	Flooring, Complete and Installed with Frames				
2.2.61		(b) Floorplate Floors				
2.2.62		VASTRAP ® flooring, 6.0mm thick	m ²	34.33		
2.2.63	SANS 1200HC	CORROSION PROTECTION OF STRUCTURAL STEELWORK				
2.2.64	8.2.3	Surface Preparation and Coating Application				
2.2.65		a) in the shop	t	0.34		
2.2.66		b) on Site	t	0.03		
2.2.67	SANS 1200LC	CABLE DUCTS				
2.2.68	8.2.5	Supply, Lay, Bed, and Prove Ducts (Including Draw Wires)				
2.2.69		(1) Electrical cable ducts				
2.2.70		(1.1) 160mm diam uPVC (Class 34) Heavy Duty to be infilled with "Sika Boom Expanding Polyurethane Foam" or similar approved.	No.	4.00		
TOTAL CARRIED FORWARD						

SCHEDULE 2.2 : CIVIL ENGINEERING - NEW MCC FOR BELT PRESS SET A (6 no. off)						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						
2.2.71	PWB	BUILDING SPECIFICATION				
2.2.72	PWB 13.1	Brickwork				
2.2.73	PWB 13.1.1	230mm Thick				
2.2.74		(1) Face brick - Exterior Walls - Makoro Dark Face Bricks in class II cement mortar	m ²	173.56		
2.2.75		(2) Interior Walls - Clay Stock Bricks in class II cement mortar	m ²	173.56		
2.2.76		(3) Cable Trench Walls - Clay Stock Bricks in class II cement mortar	m ²	24.49		
2.2.91		Brickwork Sundries				
2.2.92		Bagging of 1:6 cement sand mixture				
2.2.93		(1) On outer face of inner skin of brick surfaces	m ²	167.90		
2.2.94		Brickwork reinforcement				
2.2.95		(1) Reinforcement built in horizontally in one brick wall	m	279.84		
2.2.96		Pre-stressed fabricated lintels				
2.2.97		(1) 110 x 90mm Lintels in lengths not exceeding 3m	m	2.00		
2.2.98		Plastering				
2.2.99		One coat cement plaster on brickwork walls (internal)	m ²	153.91		
2.2.100		Paintwork				
2.2.101		On internal walls one coat Plascon UC56 plaster primer (thinned down 20% with mineral turpentine), and two coats Plascon Double Velvet paint	m ²	153.91		
2.2.102	PWB 13.5	Iron Mongery				
2.2.103	13.5.1	Steel Doors and Frames				
2.2.104		(1) Standard 1.2mm for a single and double door access frame Mild Steel Door and Jamb combination type DV with full louvres (2mm steel plate riveted to inside face of louvres)	No.	3.00		
2.2.105		Building louvres Size 495x1000mm (HxL), painted with vermin proof mesh	No.	4.00		
2.2.106	PWB 13.8	<u>Miscellaneous Work</u>				
2.2.107		(1) 290 x 290mm Standard PVC safety signs to comply with	No.	12.00		
2.2.108		Slip Joint between brickwork and underside roof slab , 2 layers 3 ply malthoid over 2 mm thick tempered Masonite over smooth mortar bed (Typical see "Detail 2" on dwg JW14060R-CE-001 & 2)	m	62.82		
TOTAL CARRIED FORWARD						

SCHEDULE 2.2 : CIVIL ENGINEERING - NEW MCC FOR BELT PRESS SET A (6 no. off)						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						
2.2.109		<u>Draw pits / manholes</u>				
2.2.110		1600 mm x 1600 mm x 920 mm (internal dimensions) cable manhole including excavations, backfilling, 170 mm concrete floor slab, 200 mm concrete walls, 200 mm concrete roof slab. Inclusive of single size 30mm crushed stone in 200 mm x 800 mm x 1200 mm in recess slab.	No	1.00		
2.2.111		<u>Ancillaries to Draw pits/manholes</u>				
2.2.112		Supply, place and cast into position angle supports and protection complete with Fish Lugs	No	1.00		
2.2.113		Lockable Manhole Cover "Akses 800" or similar approved as per SANS 50124	No	1.00		
2.2.114		<u>Waterproofing</u>				
2.2.115		a) 4mm Derbigum SP4 fully bonded waterproofing membrane	m ²	127.92		
2.2.116		b) One layer of 375 micron "Consol Plastics Gunplas USB Green"	m ²	202.11		
2.2.117		(c) One layer of 375 micron Brikgrip DPC embossed damp proof	m ²	153.91		
2.2.118		(d) Two coats "Brixéal" bitumen emulsion waterproof coating on	m ²	139.92		
TOTAL CARRIED FORWARD TO SCHEDULE 2.3						

SCHEDULE 2.3 : CIVIL ENGINEERING - NEW MCC FOR BELT PRESS SET C (4 no. off)						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD FROM SECTION 2.2						
2.3		SCHEDULE 2.3 : CIVIL ENGINEERING - NEW MCC FOR BELT PRESS SET C (4 no. off)				
		Ref DWG: JW14060-CE-003 & 002				
	SANS 1200D	<u>Earth Works</u>				
2.3.1	8.3.1	Site Preparation				
2.3.2	8.3.1.1	Clear and strip site	m ²	91.69		
2.3.3	8.3.1.2	Remove topsoil to nominal depth 150mm, stockpile and maintain	m ²	91.69		
2.3.4	8.3.8.1	Location				
2.3.5		c) Excavate by hand in soft material to expose existing services:	m ³	39.63		
2.3.6	8.3.3	Restricted Excavation				
2.3.7		b) Extra-over for:				
2.3.8		1) Intermediate excavation	m ³	60.95		
2.3.9		2) Hard Rock excavation	m ³	30.48		
2.3.10	8.3.9	Extra-over for Backfill Material against Structures	m ³	21.32		
2.3.11	SANS 1200G	<u>Concrete Structural</u>				
2.3.12	8.2	Scheduled Formwork Items				
2.3.13	8.2.1	Rough				
2.3.14		(1) Vertical to Strip Footing Foundations	m ²	33.33		
2.3.15		(2) Vertical to cable trench floor slab	m ²	9.06		
2.3.16	8.2.4	Special Smooth, Repaired and Rubbed Vertical to				
2.3.17		(1) Vertical to Roof Slab Edge	m ²	12.07		
2.3.18		(2) Horizontal to Roof slab	m ²	112.81		
2.3.19	8.3	<u>Scheduled Replacement Items</u>				
2.3.20	8.3.1	Steel Bars				
2.3.21		High-tensile steel, Nominal size 25mm to:				
2.3.22		Strip Footing Foundations	t	1.00		
2.3.23		Concrete Floor Slabs	t	0.83		
2.3.24		Cable Trench Floor Slab	t	1.00		
2.3.25		Roof Slab	t	2.82		
2.3.26	8.3.2	High-Tensile Welded Mesh:				
2.3.27		(1) Floor Slab - Mesh Ref. 193				
2.3.28		Slab to entrances plus apron slabs	m ²	37.50		
2.3.29	8.4	<u>Scheduled Concrete Items</u>				
2.3.30	8.4.2	Blinding Layer				
2.3.31		(1) 15 Mpa no-fines concrete 50 mm thick	m ³	9.50		
2.3.32	8.4.3	Strength Grade Concrete				
2.3.33		(1) 30Mpa/19mm concrete				
2.3.34		(1.1) Floor Slab	m ³	6.65		
2.3.35		(1.2) Strip Footing Foundations	m ³	0.77		
TOTAL CARRIED FORWARD						

SCHEDULE 2.3 : CIVIL ENGINEERING - NEW MCC FOR BELT PRESS SET C (4 no. off)						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						
2.3.36		(1.3) Cable Trench Floor Slab	m ³	5.28		
2.3.37		(1.4) Ramps to doorways	m ³	7.50		
2.3.38		(1.5) Roof Slab	m ³	18.80		
2.3.39		(1.6) Apron slabs	m ³	2.15		
2.3.40	8.4.4	Unformed Surface Finishes				
2.3.41		(1) Wood-floated finish to				
2.3.42		Steel Fasteners (various sizes) for mounting of structural	t	0.40		
2.3.43		(1.2) Cable trench floor	m ²	26.42		
2.3.44		(1.3) Ramp to FGL	m ²	37.50		
2.3.45		(1.4) Roof Slab	m ²	94.01		
2.3.46		Steel-floated finish to Floor Slab	m ²	33.26		
2.3.47	8.5	JOINTS				
2.3.48		10mm Softboard with 10x10mm Polyurethane Sealant	m	42.35		
2.3.49		Grooved Joint with Polyurethane Sealant	m	13.55		
2.3.50	SANS 1200H	STRUCTURAL STEELWORK				
2.3.51	8.3.1	Supply and Fabrication				
2.3.52	8.3.1.1	Preparation of shop detail drawings				
2.3.53		(1) Angle Frame (50x50x6mm L Iron, including R8 lugs and 6x6mm Square Bar)	t	0.26		
2.3.54	8.3.1.2	Supply and fabrication of steelwork				
2.3.55		(1) Angle Frame (50x50x6mm L Iron, including R8 lugs and 6x6mm Square Bar)	t	0.26		
2.3.56	8.3.2	Delivery to Site				
2.3.57	8.3.2.1	Normal Delivery				
2.3.58		(1) Angle Frame (50x50x6mm L Iron, including R8 lugs and 6x6mm)	t	0.26		
2.3.59	8.3.9	Flooring, Complete and Installed with Frames				
2.3.60		(b) Floorplate Floors				
2.3.61		VASTRAP ® flooring, 6.0mm thick	m ²	26.42		
2.3.62	SANS1200HC	CORROSION PROTECTION OF STRUCTURAL STEELWORK				
2.3.63	8.2.3	Surface Preparation and Coating Application				
2.3.64		a) in the shop	t	0.26		
2.3.65		b) on Site	t	0.03		
2.3.66	SANS1200 LC	CABLE DUCTS				
2.3.67	8.2.5	Supply, Lay, Bed, and Prove Ducts (Including Draw Wires)				
2.3.68		(1) Electrical cable ducts				
2.3.69		(1.1) 160mm diam uPVC (Class 34) Heavy Duty to be infilled with "Sika Boom Expanding Polyurethane Foam" or	No.	4.00		
TOTAL CARRIED FORWARD						

SCHEDULE 2.3 : CIVIL ENGINEERING - NEW MCC FOR BELT PRESS SET C (4 no. off)						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						
2.3.70	PWB	BUILDING SPECIFICATION				
2.3.71	PWB 13.1	Brickwork				
2.3.72	PWB 13.1.1	230mm Thick				
2.3.73		(1) Face brick - Exterior Walls - Makoro Dark Face Bricks in class II cement mortar	m ²	140.77		
2.3.74		(2) Interior Walls - Clay Stock Bricks in class II cement mortar	m ²	140.77		
2.3.75		(3) Cable Trench Walls - Clay Stock Bricks in class II cement mortar	m ²	15.39		
2.3.76		Brickwork Sundries				
2.3.77		Bagging of 1:6 cement sand mixture				
2.3.78		(1) On outer face of inner skin of brick surfaces	m ²	140.98		
2.3.79		Brickwork reinforcement				
2.3.80		(1) Reinforcement built in horizontally in one brick wall	m	234.96		
2.3.81		Pre-stressed fabricated lintels				
2.3.82		(1) 110 x 90mm Lintels in lengths not exceeding 3m	m	2.00		
2.3.83		Plastering				
2.3.84		One coat cement plaster on brickwork walls (internal)	m ²	129.23		
2.3.85		Paintwork				
2.3.86		On internal walls one coat Plascon UC56 plaster primer (thinned down 20% with mineral turpentine), and two coats Plascon Double Velvet paint	m ²	129.23		
2.3.87	PWB 13.5	Iron Mongery				
2.3.88	13.5.1	Steel Doors and Frames				
2.3.89		(1) Standard 1.2mm for a single and double door access frame Mild Steel Door and Jamb combination type DV with full louvres (2mm steel plate riveted to inside face of louvres)	No.	3.00		
2.3.90	PWB 13.8	<u>Miscellaneous Work</u>				
2.3.91		(1) 290 x 290mm Standard PVC safety signs to comply with SANS 1186	No.	12.00		
2.3.92		Slip Joint between brickwork and underside roof slab , 2 layers 3 ply malthoid over 2 mm thick tempered Masonite over smooth mortar bed (Typical see "Detail 2" on dwg JW14060R-CE-003 & 4)	m	42.35		
2.3.93		<u>Draw pits / manholes</u>				
2.3.94		1600 mm x 1600 mm x 920 mm (internal dimensions) cable	No	1.00		
2.3.95		<u>Ancillaries to Draw pits/manholes</u>				
2.3.96		Supply, place and cast into position angle supports and protection complete with Fish Lugs	No	1.00		
2.3.97		Lockable Manhole Cover "Akse 800" or similar approved as per SANS 50124	No	1.00		
TOTAL CARRIED FORWARD						

SCHEDULE 2.3 : CIVIL ENGINEERING - NEW MCC FOR BELT PRESS SET C (4 no. off)						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						
2.3.98		<u>Waterproofing</u>				
2.3.99		a) 4mm Derbigum SP4 fully bonded waterproofing membrane	m ²	89.76		
2.3.100		b) One layer of 375 micron "Consol Plastics Gunplas USB	m ²	141.821		
2.3.101		(c) One layer of 375 micron Brikgrit DPC embossed damp	m ²	129.228		
2.3.102		(d) Two coats "Brixéal" bitumen emulsion waterproof coating	m ²	117.48		
TOTAL CARRIED FORWARD TO SCHEDULE 2.4						

SCHEDULE 2.4 : CIVIL ENGINEERING - NEW SOLAR BATTERY ROOM						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD FROM SECTION 2.3						
2.4		SCHEDULE 2.4 : CIVIL ENGINEERING - NEW SOLAR BATTERY ROOM				
		Ref DWG: JW14060-CE-003 & 002				
	SANS 1200D	<u>Earth Works</u>				
2.4.1	8.3.1	Site Preparation				
2.4.2	8.3.1.1	Clear and strip site	m²	18.34		
2.4.3	8.3.1.2	Remove topsoil to nominal depth 150mm, stockpile and maintain	m²	18.34		
2.4.4	8.3.8.1	Location				
2.4.5		c) Excavate by hand in soft material to expose existing services:	m³	7.93		
2.4.6	8.3.3	Restricted Excavation				
2.4.7		b) Extra-over for:				
2.4.8		1) Intermediate excavation	m³	29.25		
2.4.9		2) Hard Rock excavation	m³	14.62		
2.4.10	8.3.9	Extra-over for Backfill Material against Structures	m³	4.26		
2.4.11	SANS 1200G	<u>Concrete Structural</u>				
2.4.12	8.2	Scheduled Formwork Items				
2.4.13	8.2.1	Rough				
2.4.14		(1) Vertical to Strip Footing Foundations	m²	6.67		
2.4.15		(2) Vertical to cable trench floor slab	m²	1.81		
2.4.16	8.2.4	Special Smooth, Repaired and Rubbed Vertical to				
2.4.17		(1) Vertical to Roof Slab Edge	m²	2.41		
2.4.18		(2) Horizontal to Roof slab	m²	4.51		
2.4.19	8.3	<u>Scheduled Replacement Items</u>				
2.4.20	8.3.1	Steel Bars				
2.4.21		High-tensile steel, Nominal size 25mm to:				
2.4.22		Strip Footing Foundations	t	0.20		
2.4.23		Concrete Floor Slabs	t	0.17		
2.4.24		Cable Trench Floor Slab	t	0.16		
2.4.25		Roof Slab	t	0.11		
2.4.26	8.3.2	High-Tensile Welded Mesh:				
2.4.27		(1) Floor Slab - Mesh Ref. 193				
2.4.28		Slab to entrances	m²	1.30		
2.4.29	8.4	<u>Scheduled Concrete Items</u>				
2.4.30	8.4.2	Blinding Layer				
2.4.31		(1) 15 Mpa no-fines concrete 50 mm thick	m³	1.90		
2.4.32	8.4.3	Strength Grade Concrete				
2.4.31		(1) 30Mpa/19mm concrete				
2.4.32		(1.1) Floor Slab	m³	1.33		
2.4.33		(1.2) Strip Footing Foundations	m³	0.15		
TOTAL CARRIED FORWARD						

SCHEDULE 2.4 : CIVIL ENGINEERING - NEW SOLAR BATTERY ROOM						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						
2.4.34		(1.3) Cable Trench Floor Slab	m ³	1.06		
2.4.35		(1.4) Ramps to doorways	m ³	0.26		
2.4.36		(1.5) Roof Slab	m ³	0.75		
2.4.37		(1.6) Apron slabs	m ³	0.43		
2.4.38	8.4.4	Unformed Surface Finishes				
2.4.39		(1) Wood-floated finish to				
2.4.40		Steel Fasteners (various sizes) for mounting of structural	t	0.08		
2.4.41		(1.2) Cable trench floor	m ²	5.28		
2.4.42		(1.3) Ramp to FGL	m ²	1.30		
2.4.43		(1.4) Roof Slab	m ²	3.76		
2.4.44		(1.5) Apron slabs	m ²	4.30		
2.4.45		Steel-floated finish to Floor Slab	m ²	6.65		
2.4.46	8.5	JOINTS				
2.4.47		10mm Softboard with 10x10mm Polyurethane Sealant	m	8.47		
2.4.48		Grooved Joint with Polyurethane Sealant	m	2.71		
2.4.49	SANS 1200H	STRUCTURAL STEELWORK				
2.4.50	8.3.1	Supply and Fabrication				
2.4.51	8.3.1.1	Preparation of shop detail drawings				
2.4.52		(1) Angle Frame (50x50x6mm L Iron, including R8 lugs and 6x6mm Square Bar)	t	0.05		
2.4.53	8.3.1.2	Supply and fabrication of steelwork				
2.4.54		(1) Angle Frame (50x50x6mm L Iron, including R8 lugs and 6x6mm Square Bar)	t	0.05		
2.4.55	8.3.2	Delivery to Site				
2.4.56	8.3.2.1	Normal Delivery				
2.4.57		(1) Angle Frame (50x50x6mm L Iron, including R8 lugs and 6x6mm)	t	0.05		
2.4.58	8.3.9	Flooring, Complete and Installed with Frames				
2.4.59		(b) Floorplate Floors				
2.4.60		VASTRAP ® flooring, 6.0mm thick	m ²	5.28		
2.4.61	SANS 1200HC	CORROSION PROTECTION OF STRUCTURAL STEELWORK				
2.4.62	8.2.3	Surface Preparation and Coating Application				
2.4.63		a) in the shop	t	0.05		
2.4.64		b) on Site	t	0.01		
2.4.65	SANS1200 LC	CABLE DUCTS				
2.4.66	8.2.5	Supply, Lay, Bed, and Prove Ducts (Including Draw Wires)				
2.4.67		(1) Electrical cable ducts				
2.4.68		(1.1) 160mm diam uPVC (Class 34) Heavy Duty to be infilled with "Sika Boom Expanding Polyurethane Foam" or similar approved.	No.	0.00		
2.4.69	PWB	BUILDING SPECIFICATION				
2.4.70	PWB 13.1	Brickwork				
2.4.71	PWB 13.1.1	230mm Thick				
TOTAL CARRIED FORWARD						

SCHEDULE 2.4 : CIVIL ENGINEERING - NEW SOLAR BATTERY ROOM						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						
2.4.72		(1) Face brick - Exterior Walls - Makoro Dark Face Bricks in class II cement mortar	m ²	28.15		
2.4.73		(2) Interior Walls - Clay Stock Bricks in class II cement mortar	m ²	28.15		
2.4.74		(3) Cable Trench Walls - Clay Stock Bricks in class II cement mortar	m ²	3.08		
2.4.75		Brickwork Sundries				
2.4.76		Bagging of 1:6 cement sand mixture				
2.4.77		(1) On outer face of inner skin of brick surfaces	m ²	51.48		
2.4.78		Brickwork reinforcement				
2.4.79		(1) Reinforcement built in horizontally in one brick wall	m	99.00		
2.4.80		Pre-stressed fabricated lintels				
2.4.81		(1) 110 x 90mm Lintels in lengths not exceeding 3m	m	1.00		
2.4.82		Plastering				
2.4.83		One coat cement plaster on brickwork walls (internal)	m ²	54.45		
2.4.84		Paintwork				
2.4.85		On internal walls one coat Plascon UC56 plaster primer (thinned down 20% with mineral turpentine), and two coats Plascon Double Velvet paint	m ²	54.45		
2.4.86	PWB 13.5	Iron Mongery				
2.4.87	13.5.1	Steel Doors and Frames				
2.4.88		(1) Standard 1.2mm for a single door access frame Mild Steel Door and Jamb combination type DV with full louvres (2mm steel plate riveted to inside face of louvres) with electronic access	No.	1.00		
2.4.89	PWB 13.8	<u>Miscellaneous Work</u>				
2.4.90		(1) 290 x 290mm Standard PVC safety signs to comply with SANS 1186	No.	12.00		
2.4.91		Slip Joint between brickwork and underside roof slab , 2 layers 3 ply malthoid over 2 mm thick tempered Masonite over smooth mortar bed (Typical see "Detail 2" on dwg JW14060-CE-003 & 4)	m	8.47		
2.4.92		<u>Waterproofing</u>				
2.4.93		a) 4mm Derbigum SP4 fully bonded waterproofing membrane	m ²	16.632		
2.4.94		b) One layer of 375 micron "Consol Plastics Gunplas USB	m ²	26.279		
2.4.95		(c) One layer of 375 micron Brikrip DPC embossed damp	m ²	54.45		
2.4.96		(d) Two coats "Brixeal" bitumen emulsion waterproof coating	m ²	49.5		
TOTAL CARRIED FORWARD TO SCHEDULE 2.5						

SCHEDULE 2.5 : CIVIL ENGINEERING - BELT PRESS STRUCTURAL SUPPORT AND GENERAL ITEMS						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD FROM SCHEDULE 2.4						
2.5		SCHEDULE 2.5 : CIVIL ENGINEERING - BELT PRESS STRUCTURAL SUPPORT AND GENERAL ITEMS				
2.5.1	SANS 1200D	Earthworks				
2.5.2	8.3.1	Site Preparation				
2.5.3	8.3.1.1	Clear and strip site	m ²	10.70		
2.5.4	8.3.1.2	Break existing concrete and remove material to nominal depth 150mm, stockpile and maintain location	m ²	10.70		
2.5.5		Excavate by hand in soft material to expose existing services (e.g. sludge pipe tie-in point and wash water supply pumps:	m ³	47.12		
2.5.6	8.3.3	Restricted Excavation				
2.5.7		Extra-over for:				
2.5.8		1) Intermediate excavation	m ³	16.49		
2.5.9		2) Hard Rock excavation	m ³	16.49		
2.5.10	8.3.9	Extra-over for Backfill Material against Structures	m ³	47.12		
2.5.1	SANS 1200G	Structural Concrete				
2.5.12		<u>Scheduled formwork Items</u>				
2.5.13	8.2.5	Rough	m ²	67.20		
2.5.14	8.2.2	Smooth	m ²	60.64		
2.5.15		<u>Scheduled Concrete Items</u>				
2.5.16	8.4.3	<u>Strength Concrete, Grade, Concrete class 30MPa/19mm</u>				
2.5.17	8.4.3 a)	In Foundations - Bund walls, pump and tanks plinths				
2.5.18		Bund walls as per JW14060-CE-005	m ³	8.12		
2.5.19		Bund walls as per JW14060-CE-006	m ³	3.66		
2.5.20		Bund walls as per JW14060-CE-007	m ³	0.84		
2.5.21		Belt Press bund walls as per JW14060-ME-006 & JW14060-ME-007	m ³	6.22		
2.5.22		<u>Levelling Screed - Class 10MPa</u>				
2.5.23		Bund walls as per JW14060-CE-005	m ²	121.61		
2.5.24		Bund walls as per JW14060-CE-006	m ²	78.51		
2.5.25		Bund walls as per JW14060-CE-007	m ²	2.56		
2.5.26		Belt Press bund walls as per JW14060-ME-006/7	m ²	20.72		
2.5.27	8.4.3 b)	In stub columns - Belt Press supports base	m ³	10.78		
2.5.28	8.5	<u>Joints</u>				
2.5.29		10mm Softboard with 10x10mm Polyurethane Sealant	m	123.00		
2.5.30	8.3	Scheduled Reinforcement Items				
2.5.31		Steel bar in stub columns: High tensile-25mm	t	0.94		
2.5.32		Steel bar in Foundations and Bund walls: High tensile-25mm	t	1.50		
2.5.33		Bundwall floors Slab - Mesh Ref. 193	m ²	223.40		
TOTAL CARRIED FORWARD						

SCHEDULE 2.5 : CIVIL ENGINEERING - BELT PRESS STRUCTURAL SUPPORT AND GENERAL ITEMS						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						
2.5.34	8.7 a)	30 Mpa Non-Shrink grout under structural steel bases	m ³	0.75		
2.5.35	SANS 1200H	STRUCTURAL STEEL WORK (Supply, fabrication, delivery and installation)				
2.5.36	8.30	SCHEDULED ITEMS				
2.5.37	8.3.1.2	<i>Rates quoted for structural steel items shall include cost of supply, fabrication, transport, erection on site and shop detailing. The Contractor shall submit shop drawings of all the structural items required and material list to the Employer's Agent for approval at least two weeks prior to the commencement of fabrication.</i>				
		<i>All rolled steel sections including hollow sections are to conform to SANS 1431 grade 350WA</i>				
		<i>The rates quoted shall include cost of all necessary nuts, bolts, washers etc</i>				
		<i>All carbon structural steel members and sections including nuts, Isolation material against galvanic corrosion shall be used where required</i>				
2.5.38	8.3.1.2 i)	Hot rolled 152x152x23 H Steel Sections for Belt Press Supports	t	0.92		
2.5.39	8.3.1.2 iii)	304L Stainless Steel Equal Angles (L50X50X5) in bracings for	t	0.14		
2.5.40	8.3.1.2 iv)	Base plates and Cleats/gussets etc with shaped plates, thickness	t	0.50		
2.5.41		4.5mm 304L Stainless Sludge Cake Extension Chute	m ²	45.00		
2.5.42		<u>Open grid floors and Stair case.</u>				
		<i>NB: Rates to include for all steel material the appropriate Corrosion protection i.e. Hot dipped galvanized to SANS 121</i>				
		Platform and Staircases steelwork including welding to include;				
2.5.43		· Universal support beams - 152x152x23 · Parallel flange channels - 180x70PFC · Rolled steel angles - 50X50X6L AND 60X60X6L	t	2.64		
2.5.44		Platform or walkway grating; 40mm Bearer Bars @ 43mm centers, 7,6mm Transverse Bars @ 50mm centers Serrated, Banded , Galvanized	m ²	257		
2.5.45		Sump or drain covers; 30mm Bearer Bars @ 43mm centers 7,6mm Transverse Bars @ 50mm centers Serrated, Banded , Galvanized	m ²	4		
2.5.46		Stair treadS standard rectagrid with 30 x 4.5 bearer bars & 750 x 245/25mm wide Galvanized	No.	96		
TOTAL CARRIED FORWARD						

SCHEDULE 2.5 : CIVIL ENGINEERING - BELT PRESS STRUCTURAL SUPPORT AND GENERAL ITEMS						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						
2.5.47		Non-slip nosing on all stair threads or landing edges	m	73.5		
2.5.48		kick-flat 130x8mm galvanized	m	126		
2.5.49		Handrails fabrication, supply and installation complete from Yellow and Black painted Hot dipped galvanized steel - Twin Rails of 34mm OD	m	252		
2.5.50		Steel Fasteners (various sizes) for mounting of structural steelwork items including washers and corrosion isolation materials between dissimilar metals e.g. M16 or M20 threaded bolts, fixing clips, nuts and washers	sum	1		
2.5.51		Shop detailing drawings preparation	sum	1		
2.5.52		<u>Scheduled Miscellaneous Items</u>				
2.5.53		<u>Access Doors</u>				
2.5.54		Galvanised steel sliding door (Industrial type) for main access to the Belt Press Building of 2800mm wide x 6000 mm high opening	No.	5.00		
2.5.55		<u>Plant room louvers</u>				
2.5.56		Ventilation Aluminium Panels retrofitted into Building sheeting Louvre panel of size 500 x 300mm	No.	8.00		
2.5.57	SANS 1200 HB	<u>Structural Steelwork</u> Supply and install Fasteners , and re-bolting of the existing Sheeting to the existing building's Architectural requirements	P. sum	1.00		R 50,000.00
2.5.58		New Crawl beams and Refurbishment of the old	P. sum	1.00		R 90,000.00
2.5.59		Contractor's stated commission on the 2.5.57 and 2.5.58 provisional sum above	%		R 140,000.00	
2.5.60		<u>Dewatering building floor coating - Specialist coating to be applied</u> <i>Mechanically prepare surface and vacuum clean. Prime and apply "Vuka Crete LC or similar approved) at a minimal thickness of 2mm in strict accordance with the manufacturer's instructions</i>				
2.5.61		Bund walls as per drawings JW14060-CE-005,6&7	m ²	163.69		
2.5.62		Dewatering building concrete floor walkways and demarcation as per drawing JW14060-ME-001&2	m ²	767.86		
2.5.63		<u>Ventilation for the MCC Room</u>				
2.5.64		Ventilation MCC Filters mesh (600x600) Complete Unit Supply	No.	8.00		
2.5.65		<u>Safety shower and eye bath</u>				
2.5.66		304L Stainless steel safety shower and eye baths as per the requirements specified on Johannesburg Water M30 Polyelectrolyte handling, storage and dosing equipment Particular specification	No.	2.00		
2.5.67		<u>Fencing Around the Dewatering Building as per JW14060-STD-003</u>				
TOTAL CARRIED FORWARD						

SCHEDULE 2.5 : CIVIL ENGINEERING - BELT PRESS STRUCTURAL SUPPORT AND GENERAL ITEMS						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						
2.5.68		Security palisade/ steel fencing complete as per details in drawing JW14060R-STD-003 including all material, resources and labour for fabrication, supply and installation	m	400.00		
2.5.69		Painting and Coating of fence and access gates complete	sum	1.00		
2.5.70		Fabrication, supply, delivery and Installation of Vehicular Access Gate	No.	3.00		
2.5.71		Fabrication, supply, delivery and Installation of Gate for Pedestrian Access	No.	1.00		
TOTAL FOR SCHEDULE 2 CARRIED FORWARD TO SUMMARY						

SECTION 3.1 : MECHANICAL ENGINEERING - SUPPLY OF POLYELECTROLYTE, SLUDGE AND WASH WATER MAIN						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
3.1		SECTION 3.1 : MECHANICAL ENGINEERING - SUPPLY OF POLYELECTROLYTE, SLUDGE AND WASH WATER MAIN Ref Dwg: JW14060-ME-001 to 006 & JW14060-CI-001 to 012				
3.1.1	PSX 6.2	Decommission, Dismantle, handle (loading & offloading) and transport to an on/offsite storage facility				
3.1.1.1		Removal of redundant Polyelectrolyte Hopper, preparation, delivery and storage associated equipment	sum	1.00		
3.1.1.2		Polyelectrolyte Transfer and Dosing pumps	No.	6.00		
3.1.1.3		Polyelectrolyte mixers or stirrers unit	No.	3.00		
3.1.1.4		Screw feeder and hopper	No.	1.00		
3.1.1.5		Polyelectrolyte pipework and redundant associated equipment	sum	1.00		
3.1.1.6		Washwater Feed and Transfer pumps with associated drive units	No.	5.00		
3.1.1.7		Washwater feed and transfer pipework and associated equipment	sum	1.00		
3.1.1.8		Removal of Sludge supply pumps with associated drive units	No.	2.00		
3.1.1.9		Removal of Sludge pipework and associated equipment	sum	1.00		
3.1.1.10		Decommissioning, dismantling and NDT inspection of existing Poly Silo	sum	1.00		
3.1.1.11		Assets Disposal	ton/km	3.75		
3.1.2	PSX 6.3	Fabricate, Supply, Deliver and Store (if required) on site with documentation				
		Polyelectrolyte Preparation and Storage Silo Equipment				
		· Silo paint rehabilitation				
		· Filling Pipe Assembly				
		· Proximity Switch for Filter Start/Stop				
		· Flanged Pneumatic Conveying blow-line				
		· Silo Supporting Structure				
		· Silo Handrailing and Access Cat Ladder				
		· Silo Inspection Manhole Cover				
3.1.2.1	PSX 6.4	· Over pressure valve	P. sum	1.00	R	600,000.00
		· Load Cells				
		· Dehumidifier				
		· Silo Overfilling Safety System				
		· Emergency Level Switch				
		· Vibrating Bin Discharge c/w motor				
		· Side mount filter housing and reverse jet filter c/w fan motor				
		· Pulsating sequential controller				
		· Compressed air regulation station				
		Weather Cover for the Roof Instrumentation				
3.1.2.2		Powder Polyelectrolyte Dosing Equipment (from Silo to Poly make up tanks)				
		· Discharge Control valve				
		· Dosing screw surge bin				
		· Dosing screw and air eductor with drive motor at 180kg/hr				
		· Jet fan blower with drive motor at 250m3/hr @ 35kPa	P. sum	1.00	R	270,000.00
		· Associated High and low level protection instrumentation				
TOTAL CARRIED FORWARD						

SECTION 3.1 : MECHANICAL ENGINEERING - SUPPLY OF POLYELECTROLYTE, SLUDGE AND WASH WATER MAIN						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						
3.1.2.3		Interconnecting galvanised piping, associated fittings and ancillaries	P. sum	1.00		R 50,000.00
3.1.2.4		Contractor's stated commission on the 3.1.2.1 to 3.1.2.3 provisional sum above	%		R 920,000.00	
3.1.2.5		<u>Polyelectrolyte Solution Make-up Tanks (Ref: JW14060-CI-010 & JW14060-ME-001)</u>				
3.1.2.6		Complete Polyelectrolyte Transfer (positive displacement) Pumps incl. motor, coupling, baseplate etc. (1 Duty/ 1 Standby) at 28.8m³/hr	No.	6.00		
3.1.2.7		Stirrer/Mixer with drive unit (motor, speed reducer, etc..)	No.	2.00		
3.1.2.8		Interconnecting galvanised piping, associated fittings and bolting ancillaries	sum	1.00		
3.1.2.9		Isolation ball Valves - sizes between DN25 and DN 50	No.	18.00		
3.1.2.10		DN25 Polyelectrolyte Discharge Control valves with actuators	No.	2.00		
3.1.2.11		DN25 Pressure relief valves for each valve discharge	No.	6.00		
3.1.2.12		Drain, clean and refurb where required of the stainless steel 35m³ and 49m³ Polyelectrolyte make-up tanks	sum	1.00		
3.1.2.13		DN50 Solenoids valve for wash water feed	No.	6.00		
3.1.2.14		<u>Polyelectrolyte Manual Loading onto x2 Make-up tanks</u>				
3.1.2.15		Polyelectrolyte Hopper and structural support	No.	1.00		
3.1.2.16		Propeller or Screw Feeder with Drive unit	No.	1.00		
3.1.2.17		Jet filter c/w fan motor for powder dosing	No.	1.00		
3.1.2.18		Associated steelwork including discharge feed troughs or chutes and bolting ancillaries	sum	1.00		
3.1.2.19		<u>Wash Water Transfer Pumps with Associated equipment</u> <u>Refer drawing JW14060-CI-011 & JW14060-ME-032</u>				
3.1.2.20		Wash water transfer pumps (End-suction Centrifugal type) with drive units @ 540m³/hr at 15m	No.	2.00		
3.1.2.21		Wash water transfer by-pump (self-priming Centrifugal type) with drive units for the Unit 3 Chlorine contact chamber @ 540m³/hr at 15m	No.	1.00		
3.1.2.22		Wash water Isolation resilient seated non-rising valves DN250	No.	6.00		
3.1.2.23		Wash water Non-return valve with flanges DN250	No.	3.00		
3.1.2.24		80NB Waste water air and vacuum valve	No.	4.00		
3.1.2.26		Pipework as per the schedule listed on drawing JW14060-ME-032 except those items listed between 3.1.2.19 to 3.1.2.25	sum	1.00		
3.1.2.27		Glycerine filled Pressure gauges with tell tale installed with each ancillaries as per detail in drawing JW14060-ME-032	No.	6.00		
3.1.2.28		<u>Wash Water Supply Pumps with Associated equipment (Ref: JW14060-ME-008, JW14060-ME-009 & JW14060-CI-012)</u>				
3.1.2.29		Washwater supply (End-suction centrifugal type) pumps at the Dewatering Building with drive units @ 250m³/hr at 85m	No.	4.00		
3.1.2.30		Wash water Isolation resilient seated non-rising valves DN300	No.	6.00		
3.1.2.31		Wash water Isolation resilient seated non-rising valves DN200	No.	3.00		
3.1.2.32		Wash water Non-return valve with flanges DN200	No.	3.00		
3.1.2.33		Wash water Isolation resilient seated non-rising valves DN150	No.	7.00		
3.1.2.34		Wash water Automatic backwash Strainer DN150	No.	2.00		
TOTAL CARRIED FORWARD						

SECTION 3.1 : MECHANICAL ENGINEERING - SUPPLY OF POLYELECTROLYTE, SLUDGE AND WASH WATER MAIN						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						
3.1.2.35		Wash water manual bypass Strainer DN150	No.	2.00		
3.1.2.36		Wash water control valves (DN150 pressure reducing and flow control)	No.	7.00		
3.1.2.37		80NB Waste water air and vacuum valve	No.	1.00		
3.1.2.38		Interconnecting piping, associated fittings and bolting ancillaries as per pipe schedule in drawing JW14060-ME-008	sum	1.00		
3.1.2.39		Glycerine filled Pressure gauges with tell tale installed with each ancillaries as	No.	8.00		
3.1.2.40		<u>Sludge Supply Pumps and Associated equipment (Ref: JW14060-ME-010 & JW14060-CI-012)</u>				
3.1.2.41		Sludge transfer (self-priming) pump with drive motor @ 396m ³ /hr at 20m	No.	2.00		
3.1.2.42		Glycerine filled Pressure gauges with tell tale	No.	4.00		
3.1.2.43		Pipework for Tie-in Point for the Belt Press Set C	sum	1.00		
3.1.2.44		Isolation Knife gate valves DN250	No.	3.00		
3.1.2.45		Pipework relating to modifications mainline flowmeter bypass as schedule in drawings JW14060-ME-010	sum	1.00		
3.1.2.46		Glycerine filled Pressure gauges with tell tale installed with each ancillaries as per detail 8 in drawing JW14060-ME-009	No.	4.00		
3.1.3	PSX 6.4	Handle and Install				
3.1.3.1		Polyelectrolyte Preparation and Storage Silo Equipment · Silo paint rehabilitation · Filling Pipe Assembly · Proximity Switch for Filter Start/Stop · Flanged Pneumatic Conveying blow-line · Silo Supporting Structure · Silo Handrailing and Access Cat Ladder · Silo Inspection Manhole Cover · Over pressure valve · Emergency Level Switch · Vibrating Bin Discharge c/w motor · Side mount filter housing and reverse jet filter c/w fan motor · Pulsating sequential controller · Compressed air regulation station · Weather Cover for the Roof Instrumentation	sum	1.00		
3.1.3.2		Powder Polyelectrolyte Dosing Equipment (from Silo to Poly make up tanks) · Discharge Control valve · Dosing screw surge bin · Dosing screw and air eductor with drive motor at 180kg/hr · Jet fan blower with drive motor at 250m ³ /hr @ 35kPa · Associated High and low level protection instrumentation	sum	1.00		
3.1.3.3		Interconnecting piping, associated fittings and bolting ancillaries	sum	1.00		
TOTAL CARRIED FORWARD						

SECTION 3.1 : MECHANICAL ENGINEERING - SUPPLY OF POLYELECTROLYTE, SLUDGE AND WASH WATER MAIN						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						
3.1.3.4		<u>Polyelectrolyte Solution Make-up Tanks (Ref: JW14060-CI-010 & JW14060-ME-001)</u>				
3.1.3.5		Polyelectrolyte Transfer (positive displacement) Pumps (1 Duty/ 1 Standby) at 28.8m ³ /hr	No.	6.00		
3.1.3.6		Stirrer/Mixer with drive unit (motor, speed reducer, etc..)	No.	2.00		
3.1.3.7		Interconnecting piping, associated fittings and bolting ancillaries	sum	1.00		
3.1.3.8		Isolation Valves	No.	18.00		
3.1.3.9		Polyelectrolyte Discharge Control valves with actuators	No.	2.00		
3.1.3.10		Pressure relief valves for each valve discharge	No.	6.00		
3.1.3.11		Solenoids valve for wash water feed x2 per tank	No.	4.00		
3.1.3.12		<u>Polyelectrolyte Manual Loading onto x2 Make-up tanks</u>				
3.1.3.13		Polyelectrolyte Hopper and structural support	No.	1.00		
3.1.3.14		Propeller or Screw Feeder with Drive unit	No.	1.00		
3.1.3.15		Jet filter c/w fan motor for powder dosing	No.	1.00		
3.1.3.16		Associated steelwork including discharge feed troughs or chutes and bolting ancillaries	sum	1.00		
3.1.3.17		<u>Wash Water Transfer Pumps with Associated equipment</u> <u>Refer drawing JW14060-CI-011 & JW14060-ME-032</u>				
3.1.3.18		Wash water transfer pumps (End-suction Centrifugal type) with drive units @ 540m ³ /hr at 15m	No.	2.00		
3.1.3.19		Wash water transfer by-pump (self-priming Centrifugal type) with drive units for the Unit 3 Chlorine contact chamber @ 540m ³ /hr at 15m	No.	1.00		
3.1.3.20		Wash water Isolation resilient seated non-rising valves DN300	No.	6.00		
3.1.3.21		Wash water Non-return valve with flanges DN300	No.	3.00		
3.1.3.22		80NB Waste water air and vacuum valve	No.	4.00		
3.1.3.23		Pipework as per the schedule listed on drawing JW14060-ME-032 except those items listed between 3.1.2.19 to 3.1.2.25	sum	1.00		
3.1.3.24		Glycerine filled Pressure gauges with tell tale installed with each ancillaries as per detail in drawing JW14060-ME-032	No.	6.00		
3.1.3.25		<u>Wash Water Distribution Pumps with Associated equipment (Ref: JW14060-ME-008, JW14060-ME-009 & JW14060-CI-011)</u>				
3.1.3.26		Wash water supply pumps at the Dewatering Building with drive units @ 250m ³ /hr at 85m	No.	4.00		
3.1.3.27		Wash water Isolation resilient seated non-rising valves DN300	No.	6.00		
3.1.3.28		Wash water Isolation resilient seated non-rising valves DN200	No.	3.00		
3.1.3.29		Wash water Non-return Ball valve with flanges DN200	No.	3.00		
3.1.3.30		Wash water Isolation resilient seated non-rising valves DN150	No.	7.00		
3.1.3.31		Wash water Automatic backwash Strainer DN150	No.	2.00		
3.1.3.32		Wash water manual bypass Strainer DN150	No.	2.00		
3.1.3.33		Wash water control valves (pressure reducing and flow control)	No.	7.00		
3.1.3.34		80NB Waste water air and vacuum valve	No.	1.00		
3.1.3.35		Interconnecting piping, associated fittings and bolting ancillaries	sum	1.00		
3.1.3.36		Glycerine filled Pressure gauges with tell tale installed with each ancillaries as per detail 8 in drawing JW14060-ME-009	No.	8.00		
TOTAL CARRIED FORWARD						

SECTION 3.1 : MECHANICAL ENGINEERING - SUPPLY OF POLYELECTROLYTE, SLUDGE AND WASH WATER MAIN						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						
3.1.3.37		<u>Sludge Supply Pumps and Associated equipment (Ref: JW14060-ME-010 & JW14060-CI-012)</u>				
3.1.3.38		Sludge transfer pump with drive motor @ 396m ³ /hr at 20m	No.	2.00		
3.1.3.39		Glycerine filled Pressure gauges with tell tale	No.	4.00		
3.1.3.40		Pipework for Tie-in Point for the Belt Press Set C	sum	1.00		
3.1.3.41		Pipework relating to modifications mainline flowmeter bypass	sum	1.00		
3.1.3.42		Isolation Knife gate valves DN250	No.	3.00		
3.1.4		<u>MCC A, B, C and Solar system Battery room HVAC</u> <u>NB. Capacity of fans and aircon to be recalculated before procurement</u>				
3.1.4.1	PSX 6.3	Fabricate, Supply, Deliver and Store (if required) on site with documentation 1.1kW 400V/50hz/3ph IP65 rated axial forced ventilation fan, with a capacity of 1.6m ³ /hr, wall mounted with a pocket filter and a 1.2mm THK 3CR12 expocy coated 500X500mm louvre and cover/casing sheet with support ancillaries and complete with magnahelic gauge	No.	2.00		
3.1.4.2			No.	2.00		
3.1.4.3		1.1kW 400V/50hz/3ph IP65 rated axial forced ventilation fan, with a capacity of 1m ³ /hr, wall mounted with a pocket filter and a 1.2mm THK 3CR12 expocy coated 500X500mm louvre and cover/casing sheet with support ancillaries and complete with magnahelic gauge	No.	2.00		
3.1.4.4		Split type Air-Conditioning Unit for the PLC and Control room with a capacity of 20000 Btu's/hr with associated ancillaries	No.	1.00		
3.1.4.1	PSX 6.4	Handle and Install 1.1kW 400V/50hz/3ph IP65 rated axial forced ventilation fan, with a capacity of 1.6m ³ /hr, wall mounted with a pocket filter and a 1.2mm THK 3CR12 expocy coated 500X500mm louvre and cover/casing sheet with support ancillaries and complete with magnahelic gauge	No.	2.00		
3.1.4.2			No.	2.00		
3.1.4.3		1.1kW 400V/50hz/3ph IP65 rated axial forced ventilation fan, with a capacity of 1m ³ /hr, wall mounted with a pocket filter and a 1.2mm THK 3CR12 expocy coated 500X500mm louvre and cover/casing sheet with support ancillaries and complete with magnahelic gauge	No.	2.00		
3.1.4.4		Split type Air-Conditioning Unit for the PLC and Control room with a capacity of 20000 Btu's/hr with associated ancillaries	No.	1.00		
TOTAL CARRIED FORWARD TO SCHEDULE 3.2						

SECTION 3.2 : MECHANICAL ENGINEERING - SUPPLY OF NEW and REFURBISHMENT OF BELT PRESS WITH ASSOCIATED EQUIPMENT						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD FROM SCHEDULE 3.1						
3.2		SECTION 3.2 : MECHANICAL ENGINEERING - SUPPLY OF NEW and REFURBISHMENT OF BELT PRESS WITH ASSOCIATED EQUIPMENT Ref Dwg: JW14060-ME-001 to 006 & JW14060-CI-001 to 012				
3.2.1	PSX 6.2	Decommission, Dismantle, handle (loading & offloading) and transport to an offsite storage facility <i>NB. Cost to include all required resources e.g. crane, manpower, tools, cleaning, etc....</i>				
3.2.1.1		Removal of existing belt press	No.	10.00		
3.2.1.2		Removal of conveyor belt equipment for replacement of the x4 4M9BP1C-4C belt presses	m	23.00		
3.2.1.3		Removal of redundant the Belt Press associated wash water, Polyelectrolyte & sludge pipework	Sum	1.00		
3.2.1.4		Polyelectrolyte dosing pumps	No.	11.00		
3.2.1.5		Assets Disposal	ton/km	7.92		
					4.00	
3.2.2	PSX 6.1 (d)	Engineering and Project Management				
3.2.2.1		Coordination design drawings, project & quality management and selecting the appropriate belt press based on the specification provided.	Sum	1.00		
3.2.2.2		Sludge testing to identify and verify Site Sludge Loading, condition and Properties (The cost if for sludge testing before procurement but post contract award and during trail operation for performance guarantee)	Sum	1.00		
3.2.3	PSX 6.2	Fabricate, Supply, Deliver and Store (if required) on site with documentation				
3.2.3.1		<u>Dewatering Equipment</u> <u>New Belt Press with 14 roller type including:</u> · Pre-dewatering section · High pressure dewatering section				
3.2.3.2		· Drive units for operation · Set of Dewatering belts · Hydraulic Units · Emergency trip wires	No.	10.00		
3.2.3.3		Sludge and Polyelectrolyte Inline Mixing unit per belt	No.	10.00		
3.2.3.4		Set of electrical actuators for automatic spray pipe	No.	10.00		
3.2.3.5		Centralized lubrication system	No.	10.00		
3.2.3.6		Delivery: Packing, handling and freight to site for items 3.2.3.1 to 3.2.3.5	No.	10.00		
3.2.3.7		<u>Auxiliary Equipment</u>				
3.2.3.8		<u>Polyelectrolyte Storage/Holding Tank and Dosing (Ref: JW14060-ME-003 to 004 & JW14060-CI-006 to 010)</u>				
3.2.3.9		VSD controlled Polyelectrolyte Dosing (positive displacement) Pump including drive motor, units and VSD per Belt Press at 0-1.9 m3/hr	No.	20.00		
3.2.3.10		Stirrer/Mixer with drive unit (motor, speed reducer, etc..)	No.	2.00		
TOTAL CARRIED FORWARD						

SECTION 3.2 : MECHANICAL ENGINEERING - SUPPLY OF NEW and REFURBISHMENT OF BELT PRESS WITH ASSOCIATED EQUIPMENT						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						
3.2.3.11		New 304L Stainless Steel 49m³ (Dia. 4600mm by 3200mm High) Polyelectrolyte Holding Tank (open tank)	No.	1.00		
3.2.3.12		Interconnecting galvanised Pipework and fittings from tanks to Belt Press	P. sum	1.00		R 300,000.00
3.2.3.13		Contractor's stated commission on 3.2.3.12 provisional sum	%			
3.2.3.14		DN50 Isolation ball valves for the new holding tank on the downstream	No.	3.00		
3.2.3.15		Dosing pump isolation ball valves, DN25 per Belt Press	No.	60.00		
3.2.3.16		Dosing pump Non-return valve, DN25 per dosing pump for each Belt Press	No.	20.00		
3.2.3.17		DN25 Dosing pump Pressure relief valve per dosing pump for each Belt Press	No.	20.00		
3.2.3.18		Inline static mixer and dosing device unit as per JW14060-ME-006	No.	10.00		
3.2.3.19		<u>New Sludge Feed Line to the New Belt Presses (Ref: JW14060-ME-003 & JW14060-ME-004)</u>				
3.2.3.20		Manifold isolation gate valve DN200	No.	6.00		
3.2.3.21		Manifold sludge return control valve DN200	No.	2.00		
3.2.3.22		Dedicated Sludge feed Isolation valves per feed line to the Belt Press DN150	No.	20.00		
3.2.3.23		Dedicated Sludge feed control valve to Belt Press per belts DN150 with Actuator	No.	10.00		
3.2.3.24		Sludge manifold, interconnecting pipework and fittings	sum	1.00		
3.2.3.25		<u>New Wash Water Supply Line for the New Belts</u>				
3.2.3.26		DN50 Wash water feed isolation valves per belt press	No.	10.00		
3.2.3.27		Interconnecting pipework	P. sum	1.00		R 100,000.00
3.2.3.28		Contractor's stated commission on the 3.2.3.27 provisional sum above	%			
3.2.3.29		<u>Strip and Quote for refurbishment (and supply new where required and</u>				
3.2.3.30		Striping of conveyor equipment	Sum	1.00		
3.2.3.31		Conveyor belt ancillaries incl. drive unit, belt, idlers and associated steelwork	P. sum	1.00		R 150,000.00
3.2.3.32		Contractor's stated commission on the 3.2.3.31 provisional sum above	%			
TOTAL CARRIED FORWARD						

SECTION 3.2 : MECHANICAL ENGINEERING - SUPPLY OF NEW and REFURBISHMENT OF BELT PRESS WITH ASSOCIATED EQUIPMENT						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						
3.2.4	PSX 6.4	Handle and Install				
		<i>NB: The cost shall include for retrieving all required units and its</i>				
3.2.4.1		New Dewatering Belt Press and associated equipment	No.	10.00		
3.2.4.2		Sludge and Polyelectrolyte Inline Mixing unit per belt	No.	10.00		
3.2.4.3		Installation Supervision	Sum	1.00		
3.2.4.4		<u>Auxiliary Equipment</u>				
3.2.4.5		<u>Polyelectrolyte Storage/Holding Tank and Dosing (Ref: JW14060-ME-003 to 004 & JW14060-CI-006 to 010)</u>				
3.2.4.6		VSD controlled Polyelectrolyte Dosing (positive displacement) Pump including drive motor, units and VSD per Belt Press at 0-1.9 m³/hr	No.	20.00		
3.2.4.7		Stirrer/Mixer with drive unit (motor, speed reducer, etc..)	No.	2.00		
3.2.4.8		New 304L Stainless Steel 50m³ (Dia. 5150mm by 2400mm High) Polyelectrolyte Holding Tank (open tank)	No.	1.00		
3.2.4.9		Interconnecting Pipework and fitting to the Belt Press	sum	1.00		
3.2.4.10		Isolation valves for the new holding tank on the downstream side	No.	3.00		
3.2.4.11		Polyelectrolyte dosing pump flowmeter/flow switch indicator	No.	10.00		
3.2.4.12		Dosing pump Electric Controlled valves per Belt Press	No.	40.00		
3.2.4.13		Dosing pump Non-return valve per dosing pump for each Belt Press	No.	40.00		
3.2.4.14		Dosing pump Pressure relief valve per dosing pump for each Belt Press	No.	40.00		
3.2.4.15		<u>New Sludge Feed Line to the New Belt Presses (Ref: JW14060-ME-003 & JW14060-ME-004)</u>				
3.2.4.16		Manifold isolation gate valve DN200	No.	6.00		
3.2.4.17		Manifold sludge return control valve DN200	No.	2.00		
3.2.4.18		Dedicated Sludge feed Isolation valves per feed line to the Belt Press DN150	No.	20.00		
3.2.4.19		Dedicated Sludge feed control valve to Belt Press per belts DN150 with Actuator	No.	10.00		
3.2.4.20		Sludge manifold, interconnecting pipework and fittings	sum	1.00		
3.2.4.21		<u>New Wash Water Supply Line for the New Belts</u>				
3.2.4.22		Wash water feed isolation valves per belt press	No.	10.00		
3.2.4.23		Interconnecting pipework and fittings	sum	1.00		
3.2.4.24		<u>Conveyor Belt</u>				
		Conveyor belt ancillaries incl. drive unit, belt, idlers and associated steelwork				
3.2.4.25	PSX 6.4	Refurbishment of the conveyor belt associated ancillaries associated with the Set A Belt Presses that is approximately 35m.	sum	1.00		
3.2.4.26	PSX 6.4	Refurbishment of the conveyor belt ancillaries associated with the Set B Belt Presses that is approximately 46m.	sum	1.00		
3.2.4.27		Design, fabrication, and installation of a NEW conveyor belt associated with Set C belt press with an approximate length of 20m.	sum	1.00		
TOTAL CARRIED FORWARD						

SECTION 3.2 : MECHANICAL ENGINEERING - SUPPLY OF NEW and REFURBISHMENT OF BELT PRESS WITH ASSOCIATED EQUIPMENT						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						
3.2.5	PSX 6.3 & 6.4	<u>Maintanance spares for the Existing x4 Belt Press (set B)</u>				
3.2.5.1		<u>Strip and Quote for refurbishment (and supply new where required and</u>	sum	1.00		
3.2.5.2		<u>General Items</u>				
3.2.5.3		Top filter Belt - 24760 x 2000 mm	No.	1.00		
3.2.5.4		bottom filter belt - 19560 x 2000 mm	No.	1.00		
3.2.5.5		S20 Unison 620 Scrapper blade	No.	4.00		
3.2.5.6		SDU Brush seal SCW90 (1m lengths)	No.	24.00		
3.2.5.7		U620 UHMWPE Bottom tray grid wear strips	No.	0.00		
3.2.5.8		U620 UHMWPE Top tray grid wear strips	No.	0.00		
3.2.5.9		UHMWPE sludge plough blocks complete assembly	No.	0.00		
3.2.5.10		<u>Belt Tracking system</u>				
3.2.5.11		Belt limit switch	No.	48.00		
3.2.5.12		slew shaft and nut assembly	No.	8.00		
3.2.5.13		Belt broken sensor	No.	8.00		
3.2.5.14		Limit switch paddles	No.	16.00		
3.2.5.15		slew actuator drive SK ONF 71 I/4 0.37kW @ 179rpm	No.	8.00		
3.2.5.16		<u>Belt Wash system on the Belt Assembly</u>				
3.2.5.17		spay bar nozzle	No.	88.00		
3.2.5.18		spray bar gasket	No.	88.00		
3.2.5.19		wash pressure gauge	No.	8.00		
3.2.5.20		wash box Brush seal SCW90 (1m lengths)	No.	32.00		
3.2.5.21		<u>Roller Bearings</u>				
3.2.5.22		Drive roller (DS) bearing kit	No.	8.00		
3.2.5.23		Drive roller (DNS) bearing kit	No.	8.00		
3.2.5.24		Press & Wedge roller bearing kit	No.	64.00		
3.2.5.25		Guide roller bearing kit	No.	40.00		
3.2.5.26		Hydraulic tension rollers bearing kit	No.	16.00		
3.2.5.27		Slew rollers (fixed) bearing kit	No.	8.00		
3.2.5.28		lew rollers (slew) bearing kit	No.	8.00		
3.2.5.29		Tension arm (needle)	No.	16.00		
3.2.5.30		<u>Rollers</u>				
3.2.5.31		Drive 12inch Sche 10	No.	2.00		
3.2.5.32		Press 12inch Sch 10	No.	2.00		
3.2.5.33		Press 458 x 4mm	No.	2.00		
3.2.5.34		Drive 608 x 4mm	No.	2.00		
3.2.5.35		Wedge 758 x 4mm	No.	2.00		
3.2.5.36		Drive 12inch Sche 10	No.	2.00		
3.2.5.37		Tension 12inch Sche 10	No.	4.00		
3.2.5.38		Guide 12inch Sche 10	No.	4.00		
3.2.5.39		Guide 8inch Sche 10	No.	2.00		
3.2.5.40		Slew 8inch Sche 10	No.	4.00		
TOTAL CARRIED FORWARD						

SECTION 3.2 : MECHANICAL ENGINEERING - SUPPLY OF NEW and REFURBISHMENT OF BELT PRESS WITH ASSOCIATED EQUIPMENT						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						
3.2.5.41		<u>PLC</u>				
3.2.5.42		Provisional Sum for PLC upgrade and standardisation	P. sum	1.00		R 500,000.00
3.2.5.43		Contractor's stated commission on the 3.2.5.43 provisional sum above	%			
3.2.6	PSX 6.4	<u>Handle and Install</u>				
		<i>NB: The cost shall include for retrieving all required units and its ancillaries from an on-site store if required and installing (using appropriate resources for installation) within the proposed location in the Belt Pres facility</i>				
3.2.6.1		Maintenance spares for the existing Dewatering Belt Press per belt press	sum	4.00		Price Only
3.2.6.2		Installation Supervision	Sum	1.00		Price Only
TOTAL FOR SCHEDULE 3 CARRIED FORWARD TO SUMMARY						

SECTION 4: ELECTRICAL ENGINEERING REQUIREMENTS						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
4		SECTION 4: ELECTRICAL ENGINEERING REQUIREMENTS				
4.1	PSY20.1	<u>PART 1: PROCUREMENT AND DELIVERY</u>				
4.1.1	PSY20.15	Dismantle and removal of old MCCs and electrical field installations	P. sum	1.00		R 240,000.00
4.1.2		Contractor's stated commission on the 3.2.5.43 provisional sum above	%			
4.1.3	PSY20.9	<u>Motor Control Centres (MCC) and switchboards</u>				
4.1.3.1		MCC2 - 4 new Belt Press	No	1		
4.1.3.2		MCC3 - 6 New Belt Press	No	1		
4.1.3.3		Dewatering Substation Main LV switchboard	No	1		
4.1.3.4		Busbar to Main LV switchboard	Sum	1.00		
4.1.3.5		Replace Washwater transfer Pump Starter cubicle	Sum	2.00		
4.1.3.6		New Washwater transfer by-pass pump starter cubicle	Sum	1.00		
4.1.4	PSY20.9	<u>Distribution boards</u>				
4.1.4.1		Area 1 Small Power DB	No	1.00		
4.1.4.2		Area 2 Small Power DB	No	1.00		
4.1.4.3		Area 3 Small Power DB	No	1.00		
4.1.4.4		PLC DB	No	12.00		
4.1.4.5		Lighting DB	No	1.00		
4.1.4.6		Instrumentation DB	No	1.00		
4.1.5		<u>Instrument Power Supply</u>				
4.1.5.1	PSY20.13	3kVA UPS	No	5.00		
4.1.5.2		24V DC power supply	No	12.00		
4.1.6		<u>400V Drives</u>				
4.1.6.1		110kW Soft Starter for Wash Water Pumps	No	4.00		
4.1.7	PSY20.16	<u>Solar Photovoltaic (PV) Installation</u>				
4.1.7.1		Engineering (including radiation study, selection and design of solar panels and review/assessment of the roof structure to accommodate the installation of the solar panels)	Sum	1.00		
4.1.7.2		Solar panels	Sum	1.00		
4.1.7.3		Electrical equipment and cabling	Sum	1.00		
4.1.7.4		Batteries	Sum	1.00		
4.1.7.5		Supporting and Mounting Steelwork for solar panels and batteries	Sum	1.00		
4.1.8	PSY20.4	<u>600/1000 V, Cu/PVC/SWA/PVC cables</u>				
4.1.8.1		4 core, 185 mm ²	m	450.00		
4.1.8.2		4 core, 120 mm ²	m	100.00		
4.1.8.3		4 core, 16 mm ²	m	150.00		
4.1.8.4		4 core, 10 mm ²	m	200.00		
4.1.8.5		4 core, 4 mm ²	m	6050.00		
4.1.8.6		4 core, 1.5 mm ²	m	1250.00		
4.1.8.7		3 core, 6 mm ²	m	620.00		
4.1.8.8		3 core, 4 mm ²	m	600.00		
4.1.8.9		3 core, 1.5 mm ²	m	600.00		
TOTAL CARRIED FORWARD						

SECTION 4: ELECTRICAL ENGINEERING REQUIREMENTS						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						
4.1.9	PSY20.5	<u>600/1000 V, Cu/PVC/SWA/PVC cable terminations</u>				
4.1.9.1		4 core, 185 mm ²	No	6.00		
4.1.9.2		4 core, 120 mm ²	No	4.00		
4.1.9.3		4 core, 16 mm ²	No	6.00		
4.1.9.4		4 core, 10 mm ²	No	8.00		
4.1.9.5		4 core, 4 mm ²	No	240.00		
4.1.9.6		4 core, 1.5 mm ²	No	50.00		
4.1.9.7		3 core, 6 mm ²	No	44.00		
4.1.9.8		3 core, 4 mm ²	No	24.00		
4.1.9.9		3 core, 1.5 mm ²	No	24.00		
4.1.10	PSY20.4	<u>Bare copper earth wire</u>				
4.1.10.1		70 mm ²	m	450.00		
4.1.10.2		16 mm ²	m	150.00		
4.1.10.3		10 mm ²	m	200.00		
4.1.10.4		4 mm ²	m	1600.00		
4.1.11	PSY20.5	<u>Bare copper earth wire terminations</u>				
4.1.11.1		70 mm ²	No	6.00		
4.1.11.2		16 mm ²	No	6.00		
4.1.11.3		10 mm ²	No	8.00		
4.1.11.4		4 mm ²	No	64.00		
4.1.12	PSY20.10	<u>Cable Trenches</u>				
4.1.12.1		800 mm deep x 800 mm wide trench in soft material	m	500.00		
4.1.12.2		800 mm deep x 800 mm wide trench in hard material	m	20.00		
4.1.12.3		Pre-cast concrete cable route markers	No	10.00		
4.1.12.4		Protective tiles	m	500.00		
4.1.13	PSY20.4	<u>Lighting circuit wiring in conduit</u>				
4.1.13.1		DB01 - DB03	Sum	3.00		
4.1.14	PSY20.4	<u>Power circuit wiring in conduit</u>				
4.1.14.1		DB01 - DB03	Sum	3.00		
4.1.15	PSY20.8	<u>Light switches</u>				
4.1.15.1		Type S1 - IP65, 1way	No	10.00		
4.1.15.2		Type S2 - IP65, 2way	No	5.00		
4.1.15.3		Type S3 - Indoor, 1way	No	6.00		
4.1.15.4		Photocell	No	3.00		
TOTAL CARRIED FORWARD						

SECTION 4: ELECTRICAL ENGINEERING REQUIREMENTS						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						
4.1.16	PSY20.8	<u>Luminaires</u>				
4.1.16.1		Type F01 - Beka VLN LED 30N	No	30.00		
4.1.16.2		Type B01 - Beka LEDnova-mi16/37N5068A1Gp (pole mounted)	No	57.00		
4.1.16.3		Type B01 - Beka LEDnova-mi16/37N5068A1Gmv	No	40.00		
4.1.16.4		Type B01 - Beka LEDnova-mi16/37N5068A1Gsh	No	10.00		
4.1.16.5		4m mounting pole	No	57.00		
4.1.17	PSY20.8	<u>Switch socket outlets and isolators</u>				
4.1.17.1		Type P1 - single phase - IP65	No	12.00		
4.1.17.2		Type P2 - three phase - IP65	No	4.00		
4.1.17.3		Type P3 - single phase - Indoor	No	6.00		
4.1.17.4		Type P4 - single phase red essential indoor	No	6.00		
4.1.17.5		Type I1 isolators - three phase, IP65, wall mounted	No	32.00		
4.1.17.6		Type I2 isolators - single phase, indoor, wall mounted	No	5.00		
4.1.18	PSY20.14	<u>E/Stop and LCS on 1.2 pedestal</u>				
4.1.18.1		Emergency stop pushbuttons	No	20.00		
4.1.18.2		Local control stations (start/stop)	No	32.00		
4.1.18.3		Belt Press Local control stations	No	10.00		
4.1.18.4		Conveyor local isolator and control stations (start/stop)	No	4.00		
4.1.18.5		Actuator valve local isolator	No	32.00		
4.1.18.6		Actuator valve local control station	No	32.00		
4.1.19	PSY20.12	<u>Earthing and lightning protection</u>				
4.1.19.1		500 mm deep x 300 mm wide trench in soft material	m	200.00		
4.1.19.2		500 mm deep x 300 mm wide trench in hard material	m	20.00		
4.1.19.3		70 mm ² Green PVC Insulated Cu conductor	m	10.00		
4.1.19.4		Copper earth bars complete with stand-off insulators	No	3.00		
4.1.19.5		1.5 m b1 Metallic Earth rods, incl. couplings and accessories	No	20.00		
4.1.19.6		Earth well test point complete with concrete inspection lid	No	20.00		
4.1.19.7		Exothermic weld	No	60.00		
4.1.19.8		Down conductor from steel roof	No	10.00		
4.1.20	PSY20.6	<u>Heavy duty powder coated 3CR12 color coded covered cable ladder - straight section including covers</u>				
4.1.20.1		600 mm wide	m	450.00		
4.1.20.2		300 mm wide	m	150.00		
4.1.20.3		150 mm wide	m	150.00		
4.1.21	PSY20.6	<u>Heavy duty powder coated 3CR12 color coded cable ladder - 90 degree covered flat bend</u>				
4.1.21.1		600 mm wide	No	15.00		
4.1.21.2		300 mm wide	No	15.00		
4.1.21.3		150 mm wide	No	20.00		
TOTAL CARRIED FORWARD						

SECTION 4: ELECTRICAL ENGINEERING REQUIREMENTS						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						
4.1.22	PSY20.6	<u>Heavy duty powder coated 3CR12 color coded cable ladder- internal/external covered 90 degree bend</u>				
4.1.22.1		600 mm wide	No	15.00		
4.1.22.2		300 mm wide	No	10.00		
4.1.22.3		150 mm wide	No	20.00		
4.1.23	PSY20.6	<u>Heavy duty powder coated 3CR12 color coded covered cable ladder - T-piece</u>				
4.1.23.1		600 mm wide	No	18.00		
4.1.23.2		300 mm wide	No	10.00		
4.1.23.3		150 mm wide	No	20.00		
4.1.24	PSY20.9	<u>Conduit and support steel</u>				
4.1.24.1		20 mm diameter steel conduit	m	600.00		
4.1.24.2		25 mm diameter steel conduit	m	200.00		
4.1.24.3		50 mm diameter steel conduit	m	50.00		
4.1.24.4		Unistrut	m	50.00		
4.1.24.5		Angle iron	m	50.00		
4.1.25		<u>Miscellaneous</u>				
4.1.25.1		Safety equipment and notice boards	Sum	4.00		
4.2	PSY20.2	<u>PART 2: INSTALLATION</u>				
4.2.1		<u>Dismantle and removal of old MCCs and electrical field installations</u>				
4.2.2	PSY20.9	<u>Motor Control Centres and switchboards</u>				
4.2.2.1		MCC2 - 4 new Belt Press	No	1		
4.2.2.2		MCC3 - 6 New Belt Press	No	1		
4.2.2.3		Dewatering Substation Main LV switchboard	No	1		
4.2.2.4		Busbar to Main LV switchboard	Sum	1.00		
4.2.2.5		New Washwater transfer by-pass pump starter cubicle	Sum	1.00		
4.2.3	PSY20.9	<u>Distribution boards</u>				
4.2.3.1		Area 1 Small Power DB	No	1.00		
4.2.3.2		Area 2 Small Power DB	No	1.00		
4.2.3.3		Area 3 Small Power DB	No	1.00		
4.2.3.4		PLC DB	No	12.00		
4.2.3.5		Lighting DB	No	1.00		
4.2.3.6		Instrumentation DB	No	1.00		
4.2.4	PSY20.13	<u>Instrument Power Supply</u>				
4.2.4.1		3kVA UPS	No	14.00		
4.2.4.2		24V DC power supply	No	12.00		
4.2.5		<u>400V Drives</u>				
4.2.5.1		110kW Soft Starter for Wash Water Pumps	No	4.00		
TOTAL CARRIED FORWARD						

SECTION 4: ELECTRICAL ENGINEERING REQUIREMENTS						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						
4.2.6	PSY20.16	<u>Solar Photovoltaic (PV) Installation</u>				
4.2.6.1		Labour	Sum	1.00		
4.2.7	PSY20.4	<u>600/1000 V, Cu/PVC/SWA/PVC cables</u>				
4.2.7.1		4 core, 185 mm ²	m	450.00		
4.2.7.2		4 core, 120 mm ²	m	100.00		
4.2.7.3		4 core, 16 mm ²	m	150.00		
4.2.7.4		4 core, 10 mm ²	m	200.00		
4.2.7.5		4 core, 4 mm ²	m	6050.00		
4.2.7.6		4 core, 1.5 mm ²	m	1250.00		
4.2.7.7		3 core, 6 mm ²	m	620.00		
4.2.7.8		3 core, 4 mm ²	m	600.00		
4.2.7.9		3 core, 1.5 mm ²	m	600.00		
4.2.8	PSY20.5	<u>600/1000 V, Cu/PVC/SWA/PVC cable terminations</u>				
4.2.8.1		4 core, 185 mm ²	No	6.00		
4.2.8.2		4 core, 120 mm ²	No	4.00		
4.2.8.3		4 core, 16 mm ²	No	6.00		
4.2.8.4		4 core, 10 mm ²	No	8.00		
4.2.8.5		4 core, 4 mm ²	No	240.00		
4.2.8.6		4 core, 1.5 mm ²	No	50.00		
4.2.8.7		3 core, 6 mm ²	No	44.00		
4.2.8.8		3 core, 4 mm ²	No	24.00		
4.2.8.9		3 core, 1.5 mm ²	No	24.00		
4.2.9	PSY20.4	<u>Bare copper earth wire</u>				
4.2.9.1		70 mm ²	m	450.00		
4.2.9.2		16 mm ²	m	150.00		
4.2.9.3		10 mm ²	m	200.00		
4.2.9.4		4 mm ²	m	1600.00		
4.2.10	PSY20.5	<u>Bare copper earth wire terminations</u>				
4.2.10.1		70 mm ²	No	6.00		
4.2.10.2		16 mm ²	No	6.00		
4.2.10.3		10 mm ²	No	8.00		
4.2.10.4		4 mm ²	No	64.00		
4.2.11	PSY20.10	<u>Cable Trenches</u>				
4.2.11.1		800 mm deep x 800 mm wide trench in soft material	m	500.00		
4.2.11.2		800 mm deep x 800 mm wide trench in hard material	m	20.00		
4.2.11.3		Pre-cast concrete cable route markers	No	10.00		
4.2.11.4		Protective tiles	m	500.00		
4.2.12	PSY20.8	<u>Lighting circuit wiring in conduit</u>				
4.2.12.1		DB01 - DB03	Sum	3.00		
TOTAL CARRIED FORWARD						

SECTION 4: ELECTRICAL ENGINEERING REQUIREMENTS						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						
4.2.13	PSY20.8	<u>Power circuit wiring in conduit</u>				
4.2.13.1		DB01 - DB03	Sum	3.00		
4.2.14	PSY20.8	<u>Light switches</u>				
4.2.14.1		Type S1 - IP65, 1way	No	10.00		
4.2.14.2		Type S2 - IP65, 2way	No	5.00		
4.2.14.3		Type S3 - Indoor, 1way	No	6.00		
4.2.14.4		Photocell	No	3.00		
4.2.15	PSY20.8	<u>Luminaires</u>				
4.2.15.1		Type F01 - Beka VLN LED 30N	No	30.00		
4.2.15.2		Type B01 - Beka LEDnova-mi16/37N5068A1Gp (pole mounted)	No	57.00		
4.2.15.3		Type B01 - Beka LEDnova-mi16/37N5068A1Gmv	No	40.00		
4.2.15.4		Type B01 - Beka LEDnova-mi16/37N5068A1Gsh	No	10.00		
4.2.15.5		4m mounting pole	No	57.00		
4.2.16	PSY20.8	<u>Switch socket outlets and isolators</u>				
4.2.16.1		Type P1 - single phase - IP65	No	12.00		
4.2.16.2		Type P2 - three phase - IP65	No	4.00		
4.2.16.3		Type P3 - single phase - Indoor	No	6.00		
4.2.16.4		Type P4 - single phase red essential indoor	No	6.00		
4.2.16.5		Type I1 isolators - three phase, IP65, wall mounted	No	32.00		
4.2.16.6		Type I2 isolators - single phase, indoor, wall mounted	No	5.00		
4.2.17	PSY20.14	<u>E/Stop and LCS on 1.2 pedestal</u>				
4.2.17.1		Emergency stop pushbuttons	No	20.00		
4.2.17.2		Local control stations (start/stop)	No	32.00		
4.2.17.3		Belt Press Local control stations	No	10.00		
4.2.17.4		Conveyor local isolator and control stations (start/stop)	No	4.00		
4.2.17.5		Actuator valve local isolator	No	32.00		
4.2.17.6		Actuator valve local control station	No	32.00		
4.2.18	PSY20.12	<u>Earthing and lightning protection</u>				
4.2.18.1		500 mm deep x 300 mm wide trench in soft material	m	200.00		
4.2.18.2		500 mm deep x 300 mm wide trench in hard material	m	20.00		
4.2.18.3		70 mm ² Green PVC Insulated Cu conductor	m	10.00		
4.2.18.4		Copper earth bars complete with stand-off insulators	No	3.00		
4.2.18.5		1.5 m b1 Metallic Earth rods, incl. couplings and accessories	No	20.00		
4.2.18.6		Earth well test point complete with concrete inspection lid	No	20.00		
4.2.18.7		Exothermic weld	No	60.00		
4.2.18.8		Down conductor from steel roof	No	10.00		
TOTAL CARRIED FORWARD						

SECTION 4: ELECTRICAL ENGINEERING REQUIREMENTS						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						
4.2.19	PSY20.6	Heavy duty powder coated 3CR12 color coded covered cable ladder - straight section including covers				
4.2.19.1		600 mm wide	m	450.00		
4.2.19.2		300 mm wide	m	150.00		
4.2.19.3		150 mm wide	m	150.00		
4.2.20	PSY20.6	Heavy duty powder coated 3CR12 color coded cable ladder - 90 degree covered flat bend				
4.2.20.1		600 mm wide	No	15.00		
4.2.20.2		300 mm wide	No	15.00		
4.2.20.3		150 mm wide	No	20.00		
4.2.21	PSY20.6	Heavy duty powder coated 3CR12 color coded cable ladder- internal/external covered 90 degree bend				
4.2.21.1		600 mm wide	No	15.00		
4.2.21.2		300 mm wide	No	10.00		
4.2.21.3		150 mm wide	No	20.00		
4.2.22	PSY20.6	Heavy duty powder coated 3CR12 color coded covered cable ladder - T-piece				
4.2.22.1		600 mm wide	No	18.00		
4.2.22.2		300 mm wide	No	10.00		
4.2.22.3		150 mm wide	No	20.00		
4.2.23	PSY20.9	Conduit and support steel				
4.2.23.1		20 mm diameter steel conduit	m	600.00		
4.2.23.2		25 mm diameter steel conduit	m	200.00		
4.2.23.3		50 mm diameter steel conduit	m	50.00		
4.2.23.4		Unistrut	m	50.00		
4.2.23.5		Angle iron	m	50.00		
4.2.24		Miscellaneous				
4.2.24.1		Safety equipment and notice boards	Sum	4.00		
TOTAL FOR SCHEDULE 4 CARRIED FORWARD TO SUMMARY						

SECTION 5: CONTROL AND INSTRUMENTATION ENGINEERING REQUIREMENTS						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
5		SECTION 5: INSTRUMENTATION AND CONTROL ENGINEERING REQUIREMENTS				
5.1	PSY20.1	<u>PART 1: PROCUREMENT AND DELIVERY</u>				
5.1.1	PSY20.4	<u>Multicore Dekoron CU/PVC/ALUMINIUM MYLAR/PVC/SWA/PVC cable</u>				
5.1.1.1		37 core, 1.5mm ²	m	1560.00		
5.1.1.2		24 core, 1.5mm ²	m	550.00		
5.1.1.3		12 core, 1.5mm ²	m	570.00		
5.1.1.4		7 core, 1.5mm ²	m	3560.00		
5.1.1.5		4 core, 1.5mm ²	m	5280.00		
5.1.1.6		3 core, 1.5mm ²	m	40.00		
5.1.2	PSY20.4	<u>Individually and overall screened Dekoron CU/PVC/ALUMINIUM MYLAR/PVC/SWA/PVC cable</u>				
5.1.2.1		12 pair, 0.5mm ²	m	700.00		
5.1.2.2		4 pair, 0.5mm ²	m	1400.00		
5.1.2.3		2 pair, 0.5mm ²	m	600.00		
5.1.3	PSY20.5	<u>Multicore Dekoron CU/PVC/ALUMINIUM MYLAR/PVC/SWA/PVC cable termination</u>				
5.1.3.1		37 core, 1.5mm ²	No	76.00		
5.1.3.2		24 core, 1.5mm ²	No	20.00		
5.1.3.3		12 core, 1.5mm ²	No	116.00		
5.1.3.4		7 core, 1.5mm ²	No	118.00		
5.1.3.5		4 core, 1.5mm ²	No	200.00		
5.1.3.6		4 core, 1.5mm ²	No	16.00		
5.1.4	PSY20.5	<u>Individually and overall screened Dekoron CU/PVC/ALUMINIUM MYLAR/PVC/SWA/PVC cable termination</u>				
5.1.4.1		12 pair, 0.5mm ²	No	40.00		
5.1.4.2		4 pair, 0.5mm ²	No	44.00		
5.1.4.3		2 pair, 0.5mm ²	No	60.00		
5.1.5	PSY20.6	<u>Heavy duty powder coated 3CR12 color coded covered cable ladder - straight section including covers</u>				
5.1.5.1		600 mm wide	m	450.00		
5.1.5.2		300 mm wide	m	150.00		
5.1.5.3		150 mm wide	m	150.00		
5.1.6	PSY20.6	<u>Heavy duty powder coated 3CR12 color coded cable ladder - 90 degree covered flat bend</u>				
5.1.6.1		600 mm wide	No	15.00		
5.1.6.2		300 mm wide	No	15.00		
5.1.6.3		150 mm wide	No	20.00		
TOTAL CARRIED FORWARD						

SECTION 5: CONTROL AND INSTRUMENTATION ENGINEERING REQUIREMENTS						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						
5.1.7	PSY20.6	<u>Heavy duty powder coated 3CR12 color coded cable ladder-internal/external covered 90 degree bend</u>				
5.1.7.1		600 mm wide	No	15.00		
5.1.7.2		300 mm wide	No	10.00		
5.1.7.3		150 mm wide	No	20.00		
5.1.8	PSY20.6	<u>Heavy duty powder coated 3CR12 color coded covered cable ladder - T-piece</u>				
5.1.8.1		600 mm wide	No	18.00		
5.1.8.2		300 mm wide	No	10.00		
5.1.8.3		150 mm wide	No	20.00		
5.1.9	PSYC20.1	<u>PLCs for Belt Press (1 per Belt Press)</u>				
5.1.9.1		Local control cabinet	No	10.00		
5.1.9.2		PLC cabinet with all accessories	No	10.00		
5.1.9.3		Marshalling terminals	Sum	1.00		
5.1.9.4		Processor (CPU)	No	10.00		
5.1.9.5		16 point digital input module	No	70.00		
5.1.9.6		16 point digital output module	No	20.00		
5.1.9.7		8 channel analogue input module	No	20.00		
5.1.9.8		4 channel analogue output module	No	30.00		
5.1.9.9		All other accessories to complete installation	Sum	1.00		
5.1.10	PSYC20.1	<u>PLC's for common services</u>				
5.1.10.1		Marshalling terminals	Sum	1.00		
5.1.10.2		PLC cabinet with all accessories	No	2.00		
5.1.10.3		Processor (CPU)	No	2.00		
5.1.10.4		16 point digital input module	No	18.00		
5.1.10.5		16 point digital output module	No	4.00		
5.1.10.6		8 channel analogue input module	No	4.00		
5.1.10.7		4 channel analogue output module	No	1.00		
5.1.10.8		All other accessories to complete installation	Sum	1.00		
5.1.11	PSYC20.1	SCADA hardware and network switches	Sum	1.00		
5.1.12	PSYC20.1	<u>PLC and SCADA software</u>				
5.1.12.1		PLC software and programming	Sum	1.00		
5.1.12.2		SCADA software and programming	Sum	1.00		
5.1.13	PSYC20.6	<u>Flow measurement</u>				
5.1.13.1		Sludge flow (250NB)	No	1.00		
5.1.13.2		Return sludge flow (200NB)	No	1.00		
5.1.13.3		Belt Press sludge inflow (150NB)	No	10.00		
5.1.13.4		Dilution water flow (25NB)	No	10.00		
5.1.13.5		Poly electrolyte flow (25NB)	No	10.00		
5.1.13.6		PCP Sludge flow (110NB)	No	10.00		
TOTAL CARRIED FORWARD						

SECTION 5: CONTROL AND INSTRUMENTATION ENGINEERING REQUIREMENTS						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						
5.1.14	PSYC20.7	<u>Pressure measurement</u>				
5.1.14.1		Return sludge flow pressure	No	1.00		
5.1.14.2		Wash water pressure	No	10.00		
5.1.15	PSYC20.8	<u>Level measurement</u>				
5.1.15.1		WAS sludge sump level	No	1.00		
5.1.15.2		Digested sludge sump level	No	1.00		
5.1.15.3		Poly dosing tank level	No	1.00		
5.1.15.4		Poly make-up tank level	No	1.00		
5.1.16	PSYC20.9	<u>Position indication</u>				
5.1.16.1		Limit switches	No	140.00		
5.1.17	PSYC20.5	<u>Junction boxes</u>				
5.1.17.1		Poly dosing hand valves junction box	No	10.00		
5.1.17.2		Belt Press junction box	No	10.00		
5.1.17.3		Poly make-up tank junction box	No	2.00		
5.1.17.4		Pratley type, size 0, 3 way junction box	No	11.00		
5.1.18	PSYC20.3	<u>Access Control</u>				
5.1.18.1		MCC rooms + battery room	Sum	4.00		
5.1.19	PSYC20.4	<u>Fire Detection</u>				
5.1.19.1		MCC rooms + battery room	Sum	4.00		
5.2		PART 2: INSTALLATION				
5.2.1	PSYC20.4	<u>MYLAR/PVC/SWA/PVC cable</u>				
5.2.1.1		37 core, 1.5mm ²	m	1560.00		
5.2.1.2		24 core, 1.5mm ²	m	550.00		
5.2.1.3		12 core, 1.5mm ²	m	570.00		
5.2.1.4		7 core, 1.5mm ²	m	3560.00		
5.2.1.5		4 core, 1.5mm ²	m	5280.00		
5.2.1.6		3 core, 1.5mm ²	m	40.00		
TOTAL CARRIED FORWARD						

SECTION 5: CONTROL AND INSTRUMENTATION ENGINEERING REQUIREMENTS						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						
5.2.2	PSY20.4	<u>CU/PVC/ALUMINIUM MYLAR/PVC/SWA/PVC cable</u>				
5.2.2.1		12 pair, 0.5mm ²	m	700.00		
5.2.2.2		4 pair, 0.5mm ²	m	1400.00		
5.2.2.3		2 pair, 0.5mm ²	m	600.00		
5.2.3	PSY20.5	<u>Multicore Dekoron CU/PVC/ALUMINIUM</u>				
5.2.3.1		37 core, 1.5mm ²	No	76.00		
5.2.3.2		24 core, 1.5mm ²	No	20.00		
5.2.3.3		12 core, 1.5mm ²	No	116.00		
5.2.3.4		7 core, 1.5mm ²	No	118.00		
5.2.3.5		4 core, 1.5mm ²	No	200.00		
5.2.3.6		3 core, 1.5mm ²	No	16.00		
5.2.4	PSY20.5	<u>Individually and overall screened Dekoron</u>				
5.2.4.1		12 pair, 0.5mm ²	No	40.00		
5.2.4.2		4 pair, 0.5mm ²	No	44.00		
5.2.4.3		2 pair, 0.5mm ²	No	60.00		
5.2.5	PSY20.6	<u>Heavy duty powder coated 3CR12 color coded covered cable ladder - straight section including covers</u>				
5.2.5.1		600 mm wide	m	450.00		
5.2.5.2		300 mm wide	m	150.00		
5.2.5.3		150 mm wide	m	150.00		
5.2.6	PSY20.6	<u>Heavy duty powder coated 3CR12 color coded cable ladder - 90 degree covered flat bend</u>				
5.2.6.1		600 mm wide	No	15.00		
5.2.6.2		300 mm wide	No	15.00		
5.2.6.3		150 mm wide	No	20.00		
5.2.7	PSY20.6	<u>Heavy duty powder coated 3CR12 color coded cable ladder- internal/external covered 90 degree bend</u>				
5.2.7.1		600 mm wide	No	15.00		
5.2.7.2		300 mm wide	No	10.00		
5.2.7.3		150 mm wide	No	20.00		
5.2.8	PSY20.6	<u>Heavy duty powder coated 3CR12 color coded covered cable ladder - T-piece</u>				
5.2.8.1		600 mm wide	No	18.00		
5.2.8.2		300 mm wide	No	10.00		
5.2.8.3		150 mm wide	No	20.00		
5.2.9	PSYC20.1	<u>PLCs for Belt Press (1 per Belt Press)</u>				
5.2.9.1		Local control cabinet	No	10.00		
5.2.9.2		PLC cabinet with all accessories	No	10.00		
5.2.9.3		Marshalling terminals	Sum	1.00		
5.2.9.4		Processor (CPU)	No	10.00		
5.2.9.5		16 point digital input module	No	70.00		
TOTAL CARRIED FORWARD						

SECTION 5: CONTROL AND INSTRUMENTATION ENGINEERING REQUIREMENTS						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						
5.2.9.6	PSYC20.1	16 point digital output module	No	20.00		
5.2.9.7		8 channel analogue input module	No	20.00		
5.2.9.8		4 channel analogue output module	No	30.00		
5.2.9.9		All other accessories to complete installation	Sum	1.00		
5.2.10		<u>PLC's for common services</u>				
5.2.10.1		Marshalling terminals	Sum	1.00		
5.2.10.2		PLC cabinet with all accessories	No	2.00		
5.2.10.3		Processor (CPU)	No	2.00		
5.2.10.4		16 point digital input module	No	18.00		
5.2.10.5		16 point digital output module	No	4.00		
5.2.10.6	PSYC20.1	8 channel analogue input module	No	4.00		
5.2.10.7		4 channel analogue output module	No	1.00		
5.2.10.8		All other accessories to complete installation	Sum	1.00		
5.2.11		SCADA hardware and network switches	Sum	1.00		
5.2.12		<u>PLC and SCADA software</u>				
5.2.12.1		PLC software and programming	Sum	1.00		
5.2.12.2		SCADA software and programming	Sum	1.00		
5.2.13		<u>Flow meter</u>				
5.2.13.1	PSYC20.6	Sludge flow meter	No	1.00		
5.2.13.2		Return sludge flow meter	No	1.00		
5.2.13.3		Belt Press sludge inflow meter	No	10.00		
5.2.13.4		Dilution water flow meter	No	10.00		
5.2.13.5		Poly electrolyte flow meter	No	10.00		
5.2.13.6		Clamp on flow meter on belt press filtrate flow	No	10.00		
5.2.14		<u>Pressure measurement</u>				
5.2.14.1	PSYC20.7	Return sludge flow pressure	No	1.00		
5.2.14.2		Wash water pressure	No	10.00		
5.2.15		<u>Level measurement</u>				
5.2.15.1	PSYC20.8	WAS sludge sump level	No	1.00		
5.2.15.2		Digested sludge sump level	No	1.00		
5.2.15.3		Poly dosing tank level	No	1.00		
5.2.15.4		Poly make-up tank level	No	1.00		
5.2.16		<u>Position indication</u>				
5.2.16.1	PSYC20.9	Limit switches	No	140.00		
TOTAL CARRIED FORWARD						

SECTION 5: CONTROL AND INSTRUMENTATION ENGINEERING REQUIREMENTS						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						
5.2.17	PSYC20.5	<u>Junction boxes</u>				
5.2.17.1		Poly dosing hand valves junction box	No	10.00		
5.2.17.2		Belt Press junction box	No	10.00		
5.2.17.3		Poly make-up tank junction box	No	2.00		
5.2.17.4		Pratley type, size 0, 3 way junction box	No	11.00		
5.2.18	PSYC20.3	<u>Access Control</u>				
5.2.18.1		MCC rooms + battery room	Sum	4.00		
5.2.19	PSYC20.4	<u>Fire Detection</u>				
5.2.19.1		MCC rooms + battery room	Sum	4.00		
TOTAL FOR SCHEDULE 5 CARRIED FORWARD TO SUMMARY						

SECTION 6: TESTING AND COMMISSIONING REQUIREMENTS						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
6		SECTION 6: TESTING AND COMMISSIONING REQUIREMENTS				
6.1		Factory Acceptance Tests				
6.1.1	PSX 6.4	<u>Mechanical Equipment</u>				
6.1.1.1		Phase 1 - The associated equipment listed to be Factory tested as per the Project and technical specification	Sum	1.00		
6.1.1.2		Phase 2 - The associated equipment listed to be Factory tested as per the Project and technical specification	Sum	1.00		
6.1.2		<u>Control Equipment and Instrumentation</u>				
6.1.2.1		Phase 1 - The cost shall include for the provision of FAT for Instrument calibration with valid issue of certificates	Sum	1.00		
6.1.2.2		Phase 2 - The cost shall include for the provision of FAT for Instrument calibration with valid issue of certificates	Sum	1.00		
6.1.3		<u>Electrical Equipment</u>				
6.1.3.1		Phase 2 - The cost shall include for the provision of FAT tests conducted on MCC panels and cables with associated as Requested by the Employer's Agent certificates	Sum	1.00		
6.1.3.2		Phase 2 - The cost shall include for the provision of FAT tests conducted on MCC panels and cables with associated as Requested by the Employer's Agent certificates	Sum	1.00		
6.2	PSX 6.4 & PSX 6.5	Site Acceptance Tests or Commissioning/Trial Operation				
6.2.1		<u>Phase 1 :</u>				
6.2.1.1		Belt Press Performance demonstration including the Poly Preparation, sludge feed, wash water and auxiliary systems	Sum	1.00		
6.2.1.2		Control Equipment and Instrumentation	Sum	1.00		
6.2.1.3		Electrical Equipment	Sum	1.00		
6.2.2		<u>Phase 2 :</u>				
6.2.2.1		Belt Press Performance demonstration including the Poly Preparation, sludge feed, wash water and auxiliary systems	Sum	1.00		
6.2.2.2		Control Equipment and Instrumentation	Sum	1.00		
6.2.2.3		Electrical Equipment	Sum	1.00		
TOTAL FOR SCHEDULE 6 CARRIED FORWARD TO SUMMARY						

SUMMARY OF SCHEDULE OF QUANTITIES		
DESCRIPTION	AMOUNT	
SCHEDULE 1: PRELIMINARY & GENERAL	R	
SCHEDULE 2: CIVIL ENGINEERING AND BUILDINGS WORKS	R	
SCHEDULE 3: MECHANICAL ENGINEERING WORKS	R	
SCHEDULE 4: ELECTRICAL ENGINEERING WORKS	R	
SCHEDULE 5: CONTROL AND INSTRUMENTATION ENGINEERING WORKS	R	
SCHEDULE 6: TESTING AND COMMISSIONING	R	
SUB TOTAL 1	R	
ADD:	Escalation at 7.5% on subtotal 1	R
ADD:	Contingency at 10% on subtotal 1	R
SUB TOTAL 2	R	
ADD:	15% of above sub-total (2) for VALUE ADDED TAX (VAT)	R
TOTAL CARRIED TO FORM OF OFFER	R	

Johannesburg Water (SOC) Ltd



Northern Wastewater Treatment Works Dewatering Building Belt Press Replacement and Associated Ancillaries

VOLUME 2A

PART 3: SCOPE OF WORK

Employer:		Contractor:	
Witness:		Witness:	

C3 SCOPE OF WORK

GENERAL

This section specifies and describes the supplies, services, engineering and construction works which are to be provided and any other requirements and constraints relating to the way the contract work is to be performed.

SCOPE

The Scope of the Work is set out in five portions:

PORTION 1: PROJECT SPECIFICATION (covers a general description of the project, the facilities available and the general requirements to be met).

PORTION 2: PROJECT SPECIFICATION FOR CIVIL WORKS

PORTION 3: PROJECT SPECIFICATION FOR MECHANICAL WORKS

PORTION 4: PROJECT SPECIFICATION FOR ELECTRICAL WORKS

PORTION 5: PROJECT SPECIFICATION FOR CONTROL AND INSTRUMENTATION WORKS

DETAIL STANDARDISED GENERIC SPECIFICATIONS are included in Volume 2B of the Tender Document.

Should any requirement of the Project Specification conflict with any requirement of the standard generic specifications or project specifications, the requirements of the Project Specifications shall prevail.

Employer:		Contractor:	
Witness:		Witness:	

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Employer:		Contractor:	
Witness:		Witness:	

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Employer:		Contractor:	
Witness:		Witness:	

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Employer:		Contractor:	
Witness:		Witness:	

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PORTION 1 : PROJECT SPECIFICATION

PS 1. DESCRIPTION OF THE WORKS

PS 1.1. Employer's Objectives

Johannesburg Water SOC Ltd wishes to appoint a single multidisciplinary Contractor to perform the Scope of Works required to replace the Dewatering Belt Presses and the associated ancillary equipment.

Northern Wastewater Treatment Works (NWWTW) - Dewatering Building Belt Press Replacement and Associated Ancillaries requires the installation of ten (10) new filter Belt Presses and associated infrastructure.

The objective of the project is to restore and improve the reliability of the Dewatering plant. This will be achieved by upgrading, replacing, refurbishment, and rehabilitation of the identified dewatering Belt Presses and associated equipment at NWWTW. The sludge capacity to be treated is currently estimated at 128 209 kg DS /day and the production of sludge cake is estimated at a minimum of 75 ton DS /day.

The project will be implemented inside the existing Dewatering Building which currently houses fourteen (14) existing Belt Presses with ten (10) Belt Presses earmarked for replacement under this project. The project will be implemented in two (2) phases. The first phase covers the installation of the four "Set C" Belt Presses and associated ancillaries (i.e. poly dosing system, MCC, wash water system, and the sludge supply system). The second phase covers the installation of the six "Set A" Belt Presses and associated ancillaries (i.e. poly dosing system, MCC, wash water system, and the sludge supply system).

In summary, the Dewatering Building belt press replacement and associated ancillaries Scope of Work comprises of the following:

- Replacement of ten (10) filter Belt Presses (Set A and C)
- Upgrade of the Wash Water System;
- Upgrade of the Poly Dosing System;
- Replacement of the sludge pumps and amendment of the inline flowmeter for the main sludge line.
- Upgrade of the lifting equipment within the dewatering building;
- Installation of new ventilation systems;
- Poly Silo Refurbishment;
- Rehabilitation of the dewatering building and security upgrade;
- Construction of two MCC rooms;
- Installation of new MCC's and electrical equipment associated with the identified equipment; and
- Upgrade and replacement of the Control and Instrumentation system.

Employer:		Contractor:	
Witness:		Witness:	

PS 1.2. Scope of Works

The detailed scope of works to be carried out is identified in the discipline-specific sections i.e. Portion 2, 3, 4 & 5 of this document. The disciplines include but are not limited to the Civil, Mechanical, Electrical, and Control & Instrumentation works and shall be constructed in accordance with the Employer's specifications.

The project scope shall be read in conjunction with the tender drawings listed in the drawing list JW14060R-GEN-001 and the Johannesburg Water Particular Standard Specifications contained in Volume 2B.

The design of the Permanent Works outside the battery limits of Mechanical, Electrical, Control & Instrumentation, and Civil Works is the responsibility of the Employer unless indicated otherwise.

The General Conditions of Contract make several references to the Contract Data for specific data, which together with these conditions collectively describe the risks, liabilities, and obligations of the contracting parties and the procedures for the administration of the Contract. The Contract Data shall have precedence in the interpretation of any ambiguity or inconsistency between it and the general conditions of the contract. The Contract Data also provides for the multidisciplinary nature of the Works.

The General Conditions of Contract shall be read in conjunction with the variations, amendments and additions set out in the Contract Specific Data and the Project Specification below.

All documents forming the Contract are to be taken as mutually explanatory of one another. For the purposes of interpretation, the priority of the documents shall be in accordance with the following sequence.

- Form of Offer and Acceptance,
- Contract Specific Data within the Contract Data,
- General Conditions of Contract for Construction Works, Third Edition, 2015,
- Drawings,
- Scope of Work and Project Specification,
- Johannesburg Water (SOC) LTD Generic Particular Specification,
- Pricing Data, and
- The Conditions of Tender, the Tender Data and Tender Schedules.

If an ambiguity or discrepancy is found in the documents, the Employer's Agent shall issue any necessary clarification or instructions.

The project will be implemented on a live, operational plant and the proposed Tenders must, therefore, take cognisance of this fact when compiling their

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respective Occupational Health and Safety Plans and shall accommodate appropriate working procedures. It is considered essential that the final effluent licenced quality and the associated health and safety requirements shall take precedence over the Contractor's rate of progress when performing the work and the Contractor shall in the construction programme make adequate allowance thereof. The contractor shall ensure that the necessary, lockout procedure, shutdown plans, and permits are prepared and submitted to the Employer's Agent or Representative for review before such tie-in works of the new plant to the existing plants is undertaken.

The Contractor before initiating any equipment procurement shall furnish the Employer's Agent or Representative with all the necessary technical documentation for the purpose of review and approval by the Employer's Agent and Representative. Furthermore, in selecting the replacement Belt Presses the Contractor shall conduct the necessary sludge testing in order to ensure that the suitable filter Belt Press is selected for the NWWTW specific sludge.

The design and construction work involved is summarised below. While this summarises the Permanent Works, it is not intended to define the Scope of the Works comprehensively. The summary does not relieve the Contractor of their obligation to provide the complete installation as detailed in the discipline-specific portions of this document.

The work to be carried out under this Contract for the NWWTW- Dewatering Plant comprises inter alia the following:

PS 1.2.1. First Phase –Replacement of four “Set C” Belt Presses and associated equipment:

PS 1.2.1.1. Civil Scope

- Complete demolition of the existing Motor Control Centre (MCC) Building for Set C Belt Presses, Site clearance, and disposal of material to the designated off-site location(s)/ the nearest certified landfill in accordance with the approved Disposal Method Statement as provided by the Contractor.
- Rehabilitation of the identified structural and civil elements of the Dewatering Building including the cladding and sheeting.
- Construction of two (2) MCC Buildings and one (1) Solar Battery Room,
- Construction of support plinths and bund walls for the four (4) new Set C Belt Presses.
- Fabrication and Installation of the access platforms for the four (4) new Set C Belt Presses and associated equipment.
- Construction of bund walls for the following structures;
 - o Polyelectrolyte Silo,
 - o Two (2) Polyelectrolyte make-up tanks with associated transfer pumps and manual hopper,
 - o New Polyelectrolyte holding tank for Set C Belt Presses,
 - o The new sludge valve bank for Set C Belt Presses,

Employer:		Contractor:	
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- o Wash water distribution pumps located at the dewatering building.
- Refurbishment of the existing crawl beam, and design, manufacture, supply, installation and testing of new crawl beams and the jib crane as highlighted in drawing JW14060R-CE-009 associated with Set C Belt Presses; and
- Rehabilitation of the existing east and west DAF tanks for wash water storage.

PS 1.2.1.2. Mechanical Scope

- Decommissioning of the existing Set C Belt Presses with associated mechanical equipment and dispose thereof as per the approved disposal method statement.
- Supply, Installation and commissioning of the Four (x4) Set C Belt Presses and associated equipment,
- Refurbishment, replacement and upgrade of the Polyelectrolyte Storage with associated equipment, Make-up tank (4M9TK02) and Polyelectrolyte Solution Transfer System as per drawing JW14060R-CI-011
- Maintenance and refurbishment of the Conveyor Belts within the vicinity of the Dewatering Building,
- Supply and Installation of the two (2) wash water distribution pumps servicing the four (4) Set C Belt Presses.
- Supply and Installation of two (2) transfer pump at the existing Unit 3 Chlorine Contact chamber.
- Supply and Installation of an extra transfer pump at the Unit 3 Chlorine Contact chamber by-pass channel.
- Tie-in the Set C Belt Press sludge feed pipeline into the main sludge ring pipeline on the feed and return side.
- Replacement of the Sludge supply pumps in a staggered manner without disrupting the sludge feed to the operational Belt Presses.
- Design and installation of HVAC units for the existing MCC building, new MCC buildings and upgrade of Dewatering Building ventilation.

PS 1.2.1.3. Electrical, Control and Instrumentation Scope

- Decommissioning of the existing Set C Belt Presses MCC and associated electrical equipment including cabling and disposing thereof as per the approved method statement,
- Supply and Installation of MCC and PLC panels including the hardware and accessories associated with the four (4) new Set C Belt Presses,
- Supply and Installation of the electrical cables and instrumentation associated with the four (4) new Set C Belt Presses and the associated Polyelectrolyte storage, make-up, dosing, and wash water facilities,
- Supply and Installation of the associated cabling and instrumentation for the wash water distribution pumps and sludge feed pumps,
- Supply and installation of MCC bucket/chassis components for Unit 3 Chlorine Contact chamber wash water transfer pumps and the sludge feed pumps.

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- Supply and install the MV cables from the Dewatering Substation to the respective MCC buildings and planning a shutdown for the switchover, and
- Upgrade of the Main Power Supply and provision of Alternative Solar Back-up Power,
- Upload and configuration of the Plant PLC and SCADA software for the four (4) Set C Belt Presses and associated equipment,

PS 1.2.1.4. Testing, Commissioning and Trial Operation Scope

- Testing, commissioning, and trial operation to validate the performance of the newly installed Set C Belt Presses and associated equipment installed, refurbished and upgraded in the first phase.

PS 1.2.2. Second Phase – Replacement of the six Set A Belt Presses and associated equipment:

PS 1.2.2.1. Civil Scope

- Complete demolition of the existing MCC Room for the six (6) Set A Belt Presses, site clearance and dispose of material to the designated off-site location(s) or certified landfill per approved disposal method statement,
- Construction of the new bund wall for sludge valve bank for six (6) Set A Belt Presses,
- Rehabilitation and modification of the polyelectrolyte holding tanks bund wall,
- Construction of the six (6) Set A Belt Press plinths and bund walls,
- Design, supply, installation, and testing of new crawl beams for the Set A Belt Presses as per drawing No. JW14060R-CE-009,
- Fabrication and Installation of the access platforms for Set A Belt Presses and associated equipment,
- Construction and installation of the Dewatering Building access doors and interlocking pavement,
- Design, supply, and installation of security fence around the dewatering building, and
- Rehabilitation of the Dewatering Building floor.

PS 1.2.2.2. Mechanical Scope

- Decommissioning of the existing six (x6) Set A Belt Presses with associated mechanical equipment and disposal thereof as per the approved method statement,
- Installation and commissioning of the six (x6) Set A Belt Presses and associated mechanical equipment,
- Refurbishment, replacing (supply) and upgrading the associated equipment of the Polyelectrolyte holding (4M9TK05) and Dosing System as per drawing No. JW14060R-CI-010,
- Maintenance and Refurbishment of the Conveyor Belt section associated with six (6) Set A Belt Presses within the vicinity of the Dewatering Building,
- Supply and installation of the last two (2) off the four (4) Dewatering Building wash water distribution pumps associated with the six (6) Set A Belt Presses

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in a staggered manner without disrupting the wash water feed to the operational four (4) Set B Belt Presses,

- Refurbishment and modifications of the pipework for installation of the new self-cleaning strainer and manual strainer, and
- Design, supply and installation of a bypass pipeline for the existing inline flow meter on the sludge ring pipeline on the feed side.

PS 1.2.2.3. Electrical and Control & Instrumentation Scope

- Supply and installation of the electrical cables and instrumentation for the six (6) Set A Belt Presses with the associated polyelectrolyte storage, dosing, and wash water facilities,
- Amendment and configuration of the Plant PLC and SCADA software for all the Belt Presses installed in the Dewatering Building and associated equipment,
- Supply and installation of the Dewatering area lighting, fire detection, access control and CCTV, and
- Supply and Installation of the Solar Panels and related equipment.

PS 1.2.2.4. Testing, Commissioning and Trial Operation Scope

- Testing and commissioning of the new Set A Belt Presses and associated equipment,
- Trial operation of all installed Dewatering Building equipment for a specified period in accordance with the Contract Data requirements and Johannesburg Water (SOC) LTD's Particular Specifications; and
- Training of Employer's Operational and Maintenance personnel to competently operate and maintain all permanent installation.

PS 1.3. Location of the Works (Site)

Northern Wastewater Treatment Works is located on the south of Diepsloot in Gauteng Province of Republic of South Africa.

Access to the Works is possible by road The Works can be access from two National Roads, the R114 and the R511- William Nicol via old school road. Refer to drawing JW14060R-GEN-003 depicting the Works access routes and geographic location. The Works is located at the following coordinates:

25°56'41.66" S

27°59'43.84" E

PS 1.4. Temporary Works

No equipment intended for permanent installation shall be operated for temporary purpose without the written permission of and in complete agreement with stipulations as set forth by the Employer's Agent.

The Contractor shall provide all necessary temporary works and power during construction.

Employer:		Contractor:	
Witness:		Witness:	

PS 2. ENGINEERING

PS 2.1. Employer's Design

When and where specific reference is made or preference given to specified equipment, should the Contractor fail to comply with these requirements, this may lead to the disqualification of the tender submitted.

Contractors are free to propose alternative equipment (provided a main offer is submitted to specification) to that proposed by the Employer's Agent and, provided that drawings with details of each alternative proposal are submitted with the Tender, such alternative proposals will be considered in the adjudication of each Tender.

Any alternative equipment offered shall include all the necessary civil, mechanical, electrical and instrumentation costs necessary for a complete working system.

The cost of any changes to the Engineer's design will be for the Contractor's account where full details of the changes were not submitted with the tender.

Contractors shall satisfy themselves that the layouts as proposed by the Employer's Agent suit in all respects the equipment proposed by the Employer's Agent or by the Contractor as the case may be. Where equipment other than that proposed by the Employer's Agent is accepted, it will be the sole responsibility of the Contractor to ensure that the associated equipment including pipe work is compatible with the accepted material and proposed structures.

In the case of the Employer's Agent's acceptance of an alternative proposal, the Contractor shall submit in triplicate to the Employer's Agent for his approval, detailed working drawings of the Contractor's alternative design proposal before any related work is executed.

An extension of Time for Completion of the Contract due to time spent on the alteration of the tender drawings to suit the Contractor's alternative proposals or, due to time spent in obtaining the Employer's Agent's approval of such alternatives, shall not be considered.

Acceptance of an alternative proposal or offer shall not relieve the Contractor of any of his obligations in terms of the Contract. The Contractor's cost of preparation and submission of an alternative proposal shall be deemed to be included in the rates tendered for the execution of the Work.

PS 2.2. Drawings

PS 2.2.1 Tender Drawings in Volume 4

With reference to PS 2.1 above, the drawings submitted will comprise a component of the Employer's proposed design. Drawings shall be read and understood in sufficient detail to understand the scope of the works required to be performed. If there are areas that appear unclear or if the Contractor deems there to be material errors in the design, he shall bring it to the immediate attention of the employer prior to the close of tenders. The Contractor is

Employer:		Contractor:	
Witness:		Witness:	

expected to address by letter any clarifications he may require in understanding the tender document and drawings, such that he may sufficiently price the document to complete all of the specified works.

The drawings, forming part of this Tender, are bound into Volume 4 of this document, and are listed below. All tender Drawings must be returned at the time of tendering together with the tender documents. If the Contractor deems there to be drawings missing, he shall inform the Employer immediately for clarification.

The drawings included in these tender documents are intended for tender purposes only and shall not be used for construction purposes.

Only working Drawings which have been approved by the Employer's Agent and marked accordingly as follows: "This Drawing approved for construction by": and which have been signed and dated by him and officially issued to the Contractor for construction, shall be used on the Works.

The drawings that are issued for tender purposes are listed below:

NO.	DESCRIPTION	REV	SHEET	DRAWING NO.
A	GENERAL (GEN) DRAWINGS			
A.1	Drawing List	T02	1 of 1	JW14060R-GEN-001
A.2	Locality Plan	T02	1 of 1	JW14060R-GEN-002
A.3	Site Layout	T02	1 of 1	JW14060R-GEN-003
A.4	Typical Name Boarder	T02	1 of 1	JW14060R-GEN-004
B	CIVIL AND STRUCTURAL (CE) ENGINEERING DRAWINGS			
B.1	MCC Building for Belt Press Set A - Foundation, Surface bed Layout and Details	T02	1 of 2	JW14060R-CE-001
B.2	MCC Building for Belt Press Set A - Sections and Details	T02	2 of 2	JW14060R-CE-002
B.3	MCC Building for Belt Press Set C - Foundation, Surface bed Layout and Details	T02	1 of 2	JW14060R-CE-003
B.4	MCC Building for Belt Press Set C - Sections and Details	T02	2 of 2	JW14060R-CE-004
B.5	Pump, Sludge Valve Bank and Polyelectrolyte Tank Concrete Bund Walls and Plinths Details - Sections and Details	T02	1 of 2	JW14060R-CE-005
B.6	Pump, Sludge Valve Bank and Polyelectrolyte Tank Concrete Bund Walls and Plinths Details - Sections and Details	T02	2 of 2	JW14060R-CE-006
B.7	Polyelectrolyte Silo Concrete Bund Wall - Sections and Details	T02	1 of 1	JW14060R-CE-007
B.8	Crawl Beam - BP1C-BP4C Sections and Details	T02	1 of 2	JW14060R-CE-008
B.9	Crawl Beam - BP1A-BP6A Sections and Details	T02	2 of 2	JW14060R-CE-009
C	MECHANICAL AND ELECTRICAL ENGINEERING (ME) DRAWINGS			
C.1	General Arrangement - Dewatering Building North-East Floor Plan	T02	1 of 2	JW14060R-ME-001

Employer:		Contractor:	
Witness:		Witness:	

NO.	DESCRIPTION	REV	SHEET	DRAWING NO.
C.2	General Arrangement - Dewatering Building North-West Floor Plan	T02	2 of 2	JW14060R-ME-002
C.3	General Arrangement - Sludge Valve Bank for BP1A-6A Sections and Details	T02	1 of 1	JW14060R-ME-003
C.4	General Arrangement - Sludge Valve Bank for BP1C-4C Sections and Details	T02	1 of 1	JW14060R-ME-004
C.5	General Arrangement - New Polyelectrolyte Holding Tank for BP1C-4C Sections and Details	T02	1 of 1	JW14060R-ME-005
C.6	General Arrangement - Belt Press for BP1A-6A Sections and Details	T02	1 of 1	JW14060R-ME-006
C.7	General Arrangement - Belt Press for BP1C-4C Sections and Details	T02	1 of 1	JW14060R-ME-007
C.8	General Arrangement - Wash Water Strainer for BP1A-s6A Sections and Details	T02	1 of 1	JW14060R-ME-008
C.9	General Arrangement - Wash Water Supply Pumps and Strainer for BP1C-4C Sections and Details	T02	1 of 1	JW14060R-ME-009
C.10	General Arrangement - Sludge Supply Pumps Sections and Details	T02	1 of 1	JW14060R-ME-010
C.11	New Low Voltage Switchboard - Single Line Diagram	T02	1 of 1	JW14060R-ME-011
C.12	New Belt Presses MCC "C" - Single Line Diagram	T02	1 of 2	JW14060R-ME-012
C.13	New Belt Presses MCC "A" - Single Line Diagram	T02	1 of 2	JW14060R-ME-013
C.14	New Belt Presses Cables Racking Layout - Area 1	T02	1 of 1	JW14060R-ME-014
C.15	New Belt Presses Cables Racking Layout - Area 2	T02	1 of 1	JW14060R-ME-015
C.16	Building Lighting and Small Power Layout - Area 1	T02	1 of 1	JW14060R-ME-016
C.17	Building Lighting and Small Power Layout - Area 2	T02	1 of 1	JW14060R-ME-017
C.18	Typical D.O.L Schematic Diagram	T02	1 of 1	JW14060R-ME-018
C.19	Typical D.O.L Forward / Reverse Schematic Diagram	T02	1 of 1	JW14060R-ME-019
C.20	Typical VSD Schematic Diagram	T02	1 of 1	JW14060R-ME-020
C.21	Typical VSD Belt Drives Schematic Diagram	T02	1 of 1	JW14060R-ME-021
C.22	Typical Conveyor Belt Schematic Diagram	T02	1 of 1	JW14060R-ME-022
C.23	Typical Soft Starter Schematic Diagram	T02	1 of 1	JW14060R-ME-023
C.24	Typical PLC DB - Single Line Diagram	T02	1 of 1	JW14060R-ME-024
C.25	Typical Lighting and Small Power DB - Single Line Diagram	T02	1 of 1	JW14060R-ME-025
C.26	Typical Small Power DB - Single Line Diagram	T02	1 of 1	JW14060R-ME-026
C.27	New Belt Presses MCC "C" - Single Line Diagram	T02	2 of 2	JW14060R-ME-027
C.28	New Belt Presses MCC "A" - Single Line Diagram	T02	2 of 2	JW14060R-ME-028
C.29	New Belt Presses Earthing and Lighting Protection - Schematic Diagram for North-East "Area 1" Section	T02	1 of 2	JW14060R-ME-029

Employer:		Contractor:	
Witness:		Witness:	

NO.	DESCRIPTION	REV	SHEET	DRAWING NO.
C.30	New Belt Presses Earthing and Lighting Protection - Schematic Diagram for North-West "Area 2" Section	T02	1 of 2	JW14060R-ME-030
C.31	New Belt Presses Earthing and Lighting Protection - Schematic Diagram	T02	1 of 1	JW14060R-ME-031
C.32	General Arrangement of the Unit 3 Chlorine Contact Chamber Wash Water Transfer Pumps	T02	1 of 1	JW14060R-ME-032
D	CONTROL AND INSTRUMENTATION (CI) ENGINEERING DRAWINGS			
D.1	Legend Sheet - Asset Tagging Piping & Instrumentation Diagram	T02	1 of 3	JW14060R-CI-001
D.2	Legend Sheet - Asset Tagging Piping & Instrumentation Diagram	T02	2 of 3	JW14060R-CI-002
D.3	Legend Sheet - Asset Tagging Piping & Instrumentation Diagram	T02	3 of 3	JW14060R-CI-003
D.4	Dewatering Plant Process Flow Diagram	T02	1 of 2	JW14060R-CI-004
D.5	Dewatering Plant Process Flow Diagram	T02	2 of 2	JW14060R-CI-005
D.6	Piping and Instrumentation Diagram - Belt Press Plant BP1A-4A	T02	1 of 2	JW14060R-CI-006
D.7	Piping and Instrumentation Diagram - Belt Press Plant Bp5a-6a	T02	2 of 2	JW14060R-CI-007
D.8	Piping and Instrumentation Diagram - Belt Press Plant BP1C-4C	T02	1 of 1	JW14060R-CI-008
D.9	Piping and Instrumentation Diagram - Poly Dosing Make-Up and Holding Tanks	T02	1 of 1	JW14060R-CI-009
D.10	Piping and Instrumentation Diagram - Poly Dosing Supply to BP1A-6A	T02	1 of 1	JW14060R-CI-010
D.11	Piping and Instrumentation Diagram - Poly Dosing Supply to Bp1C-4C	T02	1 of 1	JW14060R-CI-011
D.12	Piping and Instrumentation Diagram - Main Wash Water Supply to Dewatering Building	T02	1 of 1	JW14060R-CI-012
D.13	Piping and Instrumentation Diagram - Main Sludge Supply to Dewatering Building	T02	1 of 1	JW14060R-CI-013
E	STANDARD (STD) DRAWINGS			
E.1	Dewatering and MCC Access Door Schedule and Details	T02	1 of 1	JW14060R-STD-001
E.2	Typical Equipment Access Steel Stairs, Handrails Details and Grating Details	T02	1 of 1	JW14060R-STD-002
E.3	Typical Fencing and Access Gate Details	T02	1 of 1	JW14060R-STD-003

PS 2.2.2 Civil, Building and Structural Drawings

The drawings with sufficient construction detail will be issued during the construction period to enable the Contractor to commence with work. The drawings will be issued to the Contractor with due consideration of the programme of manufacture and construction after co-ordination with the Contractor. In particular, the Contractor shall indicate in the Construction Schedule the lead times for critical Drawings.

The original Contract Documents and Drawings shall remain in the custody of Employer's Agent or Representative. The Employer's Agent or

Employer:		Contractor:	
Witness:		Witness:	

Representatives shall produce copies as and when required by JW and the Contractor.

Three complete copies of all the contract document (volume 1 to 4) which includes tender drawings and the Specifications (excluding SANS 1200 and the Standardised Specifications) shall be furnished free of cost to the Contractor for their own use. The Employer's Agent shall within fourteen days after receipt by them of a request for the same, furnish the Contractor with any details that, in the opinion of the Employer's Agent, are necessary for the execution of any part of the work. Such copies and details shall be properly preserved and kept in good condition to the satisfaction of the Employer's Agent or Representative and kept at the Works in the Contractor's charge until completion thereof. The Employer's Agent or Representative shall always have reasonable access thereto and all drawings shall be returned to the Employer's Agent by the Contractor on the completion of the Contract.

PS 2.2.3 Mechanical, Piping, Electrical and Control & Instrumentation Drawings

The Drawings that were issued as part of the Tender Documentation are not manufacturing drawings and the dimensions given are only sufficient for tendering purposes or to enable the Contractor to complete his working drawings.

The drawings show the general plan and sectional dimensions of some Civil, Structural and Mechanical structures where the New Civil, Structural, Mechanical, Electrical, Control and Instrumentation equipment is to be installed.

The Contractor shall submit Concept Design drawings for review by the Employer's Agent before commencing with any manufacturing process. Concept drawings submitted by the Contractor shall give sufficient information to make a proper assessment of the Plant offered together with sufficient detail to enable the dimensions and general arrangement of the Plant to be determined. All the important parts shall be shown in detail, i.e. Filter Belt Press body, scaling arrangements, bearing arrangements, guides, wheels, etc.

On completion of the Works, the Contractor shall deliver to the Employer's Agent's office one complete set of as-built drawings in high quality paper copies together with an electronically saved version on a USB memory stick of the Contractor's Drawings, updated to reflect the as-built information. These Drawings must be clearly marked as "As-built".

All As-built drawings shall contain general arrangements, assemblies, parts lists (including part numbers) and complete component details as well as wiring and hydraulic diagrams. These items are required in draft form before the Tests on Completion are commenced and in final form before the "Taking Over" period in terms of the General Conditions of Contract.

The Contractor shall keep and maintain a Drawing Register on site which shall be made available to the Employer and the Employer's Agent. The register shall reflect the drawing number, title, revision number and for what purpose the drawing was issued, e.g. construction or "As-built".

Employer:		Contractor:	
Witness:		Witness:	

Notwithstanding anything provided for in the GCC, the Contractor shall provide fully dimensioned detailed drawings as well as details of imposed loads by the equipment which will enable the Employer's Agent to finalise the civil drawings and details for Construction. Co-operation between the Contractor and the Employer's Agent is essential.

The Contractor shall allow a period of four weeks for the Employer's Agent to finalise the Construction Drawings if necessary.

PS 2.2.4 Construction Drawings

Upon receiving the instruction to commence with construction, the Contractor shall receive 3 sets of construction drawings, of which 1 set shall be designated for as-built records and updated by the Contractor on a daily basis. The drawings shall be submitted to the Employer's Agent with the Contractor's request for issue of the Practical Completion Certificate.

PS 2.2.5 Shop Drawings

Where an item to be supplied in conformance with this Contract Specification has not been designed by the Employer's Agent or Employer, the Contractor shall be required to supply the Employer's Agent with 3 copies of detailed shop drawings prior to delivery of materials, including an electronic copy in drawing format that is compatible with the software packages (AutoCAD or .dxf) used by the Employer's Agent and/or Employer. Only on approval of such shop drawings or an amended version thereof, shall the Contractor proceed with the manufacturing, supply and installation of the designed item.

PS 3. PROCUREMENT

PS 3.1 Preferential Procurement Procedures

The Contractor's attention is drawn to the following returnable schedules contained in Part T2:

- a. Empowerment and Preferential Procurement (JW10); and
- b. Enterprise Declaration Affidavit (to be endorsed by a Commissioner of Oaths) (JW11).

These schedules contain all requirements about preferential procurement.

PS 3.2 Sub-Contracting

PS 3.2.1 Definitions

a. Start-up Enterprises

An enterprise that has been in existence and operating for less than two years.

b. Small Enterprises

An enterprise that has a CIDB grading designation of 1 or 2.

c. Micro Enterprises

Employer:		Contractor:	
Witness:		Witness:	

An enterprise that has a CIDB grading designation of 3.

d. Locally based SMMEs

Enterprises that have their operational base in the ward in which the project is to be executed or, alternatively, the members of the enterprise are resident in the particular ward. Should a suitable locally based SMME as defined above not be available in the particular ward, then they shall be sourced from adjacent wards.

e. Contract Participation

Contract Participation in terms of this contract is a process by which the Employer implements Government's objectives by setting a target relating to small Contractor development which the Contractor shall achieve as a minimum.

f. Contract Participation Goal (CPG)

Contract Participation Goal is the monetary value of the target set by the Employer in the Contract Participation process.

g. Contract Participation Performance (CPP)

Contract Participation Performance is the measure of the Contractor's progress in achieving the CPG.

The commitment of the Employer to Government Policy concerning the empowerment of the SMMEs shall be noted and adhered to by the Contractor. It is against this background that Johannesburg Water has made provisions under this contract to ensure that the Contractor impart skills to the SMME within the project area during the project implementation.

The onus is upon the Contractor to handle and manage the procurement process of the Sub-Contractors and once appointed, should be dealt with in accordance with the provisions of Clause 4.4 of the General Conditions of Contract 2015.

The Contractor shall not cede or assign the Contract or any part thereof without the prior written approval of the Employer's Agent.

The Contractor shall obtain the written approval of the Employer's Agent before appointing any Sub-Contractor. The Contractor shall be solely responsible for the supervision of and payments to such a Sub-Contractor(s) and the approval of a Sub-Contractor by the Employer's Agent shall not indemnify the Contractor from any of his liabilities in terms of the Contract.

Employer:		Contractor:	
Witness:		Witness:	

Approval given in terms of subcontracting shall not relieve the Contractor of any responsibility, duty or obligation imposed upon him by the Contract, and the Contractor shall in particular be and remain solely liable and responsible for all acts, omissions, negligence or breaches of contract on the part of the assignee or any of his employees, and for all acts, omissions or negligence of any sub-Contractor or any of his employees.

PS 3.2.2 Applicable Legislation

The following Acts, as amended from time to time, are predominant amongst those which apply to the construction industry and are listed here for reference purposes only:

- The Constitution of South Africa.
- Preferential Procurement Policy Framework Act No. 5 of 2000.
- Construction Industry Development Board Act No. 38 of 2000.
- Broad-Based Black Economic Empowerment Act No. 53 of 2003.

PS 3.2.3 Scope

The City of Johannesburg has identified job creation and access to procurement opportunities by Start-ups, Small and Micro enterprises (SMMEs) as an essential requirement towards building an economically viable City.

This tender is subject to the sub-contracting conditions as described in the Contract Data, and must be adhered to by the main contractor.

NB: all sub-contractors appointed on this contract must comply with the Central Supplier Database (CSD) requirements, i.e. they must be registered on the CSD.

It is a condition of this contract that the Contractor is required to sub-contract a minimum value of work to SMME equal to 15% of the Contract Sum.

The Contractor is to allow for fortnightly certificates from the SMMEs and for payment to the SMMEs to be affected within 7 days of certification. To achieve the goals of this policy and to ensure that the SMMEs are treated fairly and given every opportunity to advance their business whilst delivering a successful project, the Contractor is to note the following and provide for any cost that may be associated therewith:

- a. The Contractor will be expected to have clearly specified the programme dates to the SMME and these dates are to be included in the contractual agreement between the two parties. The Contractor is to monitor the SMME's progress against the programme and hold progress meetings with the SMME contractors where minutes are to be kept and signed off by both parties.
- b. Before site establishment, the Contractor will provide each appointment letter and contractual agreement that the Contractor engages with for each SMME on this

Employer:		Contractor:	
Witness:		Witness:	

Project. The Agreement must include agreed work values agreed upon with the Contractor and SMME.

- c. Before site establishment, the Contractor will provide the following for all SMMEs:
- SMME company registration
 - SMME CIDB proof of registration.
- d. The Contractor is to assess the skills of the SMME and provide the relevant support and training for the SMME to complete the works to programme, budget and specification. The Contractor will be expected to provide training to the SMME that will ensure that the SMME's staff is suitably trained to execute the works and that they receive sufficient relevant experience on the project.
- e. The Contractor is responsible for safety compliance on the project and will assist the SMME Contractors in all aspects to achieve safety compliance, that will include:
- Assisting the SMME with developing their safety files, legal appointments, etc.
 - Assisting the SMME with achieving safety on site.
 - Having toolbox talks with the SMME Contractor's employees on a daily basis.
 - Providing all safety equipment and signage.
 - Providing safety training where necessary.
- f. The Contractor is to provide all the necessary equipment for the timeous monitoring and the checking of the quality of works as carried out by the SMME. The Contractor will be expected to monitor the SMME's works for quality compliance and provide all the necessary support to the SMME in order to achieve quality requirements. The Contractor is to ensure that if the SMME's quality of works does not achieve specification, the Contractor will assist the SMME to achieve specification and not allow the works to continue until the quality requirements are achieved.
- g. The Contractor is to generate monthly reports for the Johannesburg Water SOC. which includes the following:
- Per SMME: resources on the site, i.e. supervisors, labour, plant tools and equipment
 - Per SMME: progress of works on site.
 - Per SMME: quality control on site.
 - SMME expenditure on the project versus target expenditure including payment progress

Employer:		Contractor:	
Witness:		Witness:	

- Copies of minutes of the SMME and Contractor progress meetings.
 - Concerns and improvements to be made.
 - Items listed in PS 5.10
- h. In the execution of the Subcontract Work, the Contractor shall ensure that the Sub-Contractor(s) comply with all relevant legislation and regulations including, but not confined to, the Occupational Health and Safety Act. The Contractor hereby indemnifies the Employer against any loss, damage, or claim for Subcontract Works set out for the construction of the Carlswald Reservoir as well as the new pump station arising out of the former's failure to comply with instructions issued to him in regard to these requirements.
- i. The Contractor shall be required to adopt labour intensive construction techniques through the allocated work in the Bill of Quantities, with the proviso that the Employer's specific objectives regarding time and quality are not compromised. Maximisation of employment shall be the aim on this contract.
- j. Together with their tenders, all Contractors are required to submit a comprehensive implementation plan clearly stating the labour content and number of jobs that shall be created. The employment of labour shall be reflected in a programme in sufficient details to enable the Project Manager to monitor and compare it with the implementation plan.
- k. The Contractor shall be required to submit employment data on a monthly basis to the Employer's Agent.
- l. Contractors are to also note that it is an explicit condition of this Contract that all unskilled labourers on the project are to be employed from the local community. The Contractor shall, in general, maximise the involvement of the local community.
- m. TRAINING OF SMMEs: The sum shall be in full compensation for the provision of training to SMMEs, to complete the works as per specification **Unit: Sum**

PS 3.2.4 Supply and Delivery of Equipment

The Contractor shall be responsible for the delivery of all equipment to the Site and shall make their own arrangements for handling (incl. double handling) and transporting all material. All items transported shall be effectively supported and secured by appropriate restraints to prevent damage. The type and positioning of the restraints shall be such that items will not be damaged by touching each other or by the restraints itself.

All items shall be handled throughout the process of delivery with all necessary care to prevent damage and or overstressing of components. Containers for lubricants and paint shall not be stacked on top of fabricated items while being transported but shall be placed completely separated from the fabricated items.

Employer:		Contractor:	
Witness:		Witness:	

The equipment delivery period is estimated to be approximately 35 weeks for the filter Belt Presses and approximately 24 weeks for all other equipment. If the Tenderer considers the delivery time of 35 or 24 weeks inadequate for particular items, they must specify the delivery period required for each item in the covering letter to this Contract Document.

The term "supply and deliver" of materials and equipment includes the purchase thereof from commercial sources, manufacturing thereof, factory corrosion protection, factory testing, provision of test certificates certifying compliance of the goods in accordance the Specifications, provision of drawings and details, provision of special tools and keys, the handling thereof, transport and delivery to Site.

Tender rates must provide for all the costs by the Contractor to "supply and deliver".

No other payment for materials and equipment shall be considered other than that under the "supply and deliver" items in the Bill of Quantities.

PS 3.2.5 Purchasing of Equipment

The Contractor is required to purchase the materials and equipment necessary for the Contract at the earliest possible date thus limiting the effect of inflation and delay to project completion. The Contractor must strive to keep the number of suppliers to a minimum.

Payment for materials and equipment shall only be affected if the Contractor can prove ownership of the items and has delivered the items to site but not necessarily built them permanently to the specified location on the works.

In the case that off-site storage is agreed by the Employer's Agent and approved by Employer, then payment shall only be affected if the Contractor can prove ownership and that Cession of Ownership from the Contractor to the Employer takes place.

NOTE - It will be the Contractor's responsibility to ensure that the necessary warranties from the equipment suppliers is negotiated such that it only comes into effect on commissioning of the equipment.

PS 3.2.6 Guarantee of Equipment

It is an express condition of this Contract that the guarantee period on all equipment given by the suppliers to the Contractor shall only commence once the works is in operation. This stage shall be reached once the Certificate of Completion has been issued.

PS 3.2.7 Particulars of Equipment Offered

The Tenderer shall include Technical and comprehensive information covering every item of equipment offered with his Tender. The Employer's Agent must be able to determine, without reference to the suppliers, any information regarding delivery, power consumption, efficiency, accuracy, etc, applicable under the specified range of operation conditions.

Employer:		Contractor:	
Witness:		Witness:	

Technical information regarding the filter Belt Presses, pumps, motor, pressure reducing valves, self- cleaning strainers, motor control centres, busbar trunking, transformers, flow meters, valves, dimensions, etc. shall also be supplied.

Failure to comply with the above requirement may lead to the disqualification of the Tender submitted.

PS 3.2.8 Bill of Quantities

The prices quoted in the Bill of Quantities shall cover the cost of all work required for the execution of the Contract and each price shall be considered as the full value of the work described in each item and as covering all contingent expenses.

PS 3.2.9 Bonds & Guarantees

Security in the amount equal to ten (10) per cent of the contract price shall be provided by the Contractor for the due and faithful performance by him of all the duties and obligations resting upon and assumed by him in terms of the Contract.

Such security shall be in the form of a deed through lodging a bond of suretyship furnished by an approved bank, insurance or guarantee corporation in such form as may be prescribed by Johannesburg Water, provided however that the Employer's Agent may, upon written application by the Contractor, return to the Contractor the whole or part of such security held by Johannesburg Water. The Employer's Agent will, subject to his sole discretion, consider what he deems sufficient for the protection of Johannesburg Water, and is entitled to hold all or a portion of the security until the completion of the Contract and the expiry of the defects liability and Defects Liability Period.

PS 4. Practical Completion of the Works

The Time for Practical Completion as stated in the Contract Data is 24 months. If the Contractor considers the completion time of 24 months inadequate, he must specify the completion period required in his covering letter to his Tender.

Employer:		Contractor:	
Witness:		Witness:	

PS 5. CONSTRUCTION

PS 5.1 APPLICABLE STANDARDS

PS 5.1.1 National Standards (Civil)

The Standard Specifications, including the latest updates, for all associated civil work applicable to this Contract shall be:

Civil Works	
SANS 1200 A	General
SANS 1200 AB	Employer's Agent's office
SANS 1200 C	Site clearance
SANS 1200 D	Earthworks
SANS 1200 G	Concrete (Structural)
SANS 1200 H	Structural steel work
SANS 1200 HB	Cladding and Sheeting
SANS 1200 HC	Corrosion Protection of Structural Steelwork
SANS 1200 L	Medium Pressure Pipelines
SANS 1200 LC	Cable Ducts
SANS 1200 LE	Stormwater Drainage

The Standard Specifications for any associated civil work applicable to this Contract are not issued with this volume but are available at the Contractor's expense from: Standards South Africa,

PS 5.1.2 National Standards (Mechanical, Electrical and C&I)

The Standard Specifications for all associated equipment for the installation of fibre-based cabling applicable to this Contract shall be SANS 10340-1:2006 and SANS 10340-2:2006.

The Standard Specifications for all associated electrical and electronic work applicable to this Contract shall be SANS 10142-1:2003.

These Specifications are not issued with this volume but are available at the Contractor's expense from: South African National Standards. The Contractor shall be in possession of these Technical Specifications and shall keep a hard copy of the specifications on site for reference by him and the Employer's Agent for the duration of the Contract.

Employer:		Contractor:	
Witness:		Witness:	

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PS 5.1.3 Particular Generic Specification

The following Particular Generic Specifications forming part of the Contract have been written to cover phases or items of work involving a specialist type of operations or material to be encountered on this Contract and that are specific to the Employer's installation, but not adequately covered by the standard requirements.

General	
Spec. No.	Description
G01	Colour Coding of Equipment
G02	Corrosion Specification
Civil	
Spec. No.	Description
PQC	Carpentry, Joinery and Ironmongery
PQD	Steel Doors and Windows
PQH	Painting
PWB	Building Work
PWC	Subsurface Drains
Mechanical Works	
Spec. No.	Description
M05	Mechanical Mixing Equipment
M08	Gearboxes
M15	Filter Belt Press
M16	Belt Conveyor Equipment
M17	Mechanical Actuator Equipment
M18	Centrifugal pumps
M20	Mechanical Valves
M21	Pressure pipework
M26	Chemical Dosing and Transfer pumps
M30	Polyelectrolyte handling, Storage, Make-up and Dosing Equipment
Electrical Works	
Spec. No.	Description
E01	Electrical Motors
E02	Electrical Cable Racking
E04	Electrical Low Voltage Switchboards and Motor Control Centres
E05	Electrical Low Voltage Power & Control Cables
E06	Electrical Medium and Low Voltage Cable Installation
E08	Electrical Wiring
E09	Electrical Building Installation

Employer:		Contractor:	
Witness:		Witness:	

E10	Electrical Busbar Trunking
E11	General Electrical Earthing and Lightning Protection
E12	Electrical Medium Voltage Cables
E13	Electrical Medium Voltage Switchgear
E14	Standby Generators
E15	Electrical Transformers
E16	Uninterruptible Power Supplies (UPS)
E18	Electrical Miniature Substations
E19	11kV Ring Main Units
Automation and Control	
Spec. No.	Description
Volume 3	PLC Panels
Volume 4	PLC Software
Volume 5	Clean Power and Surge Protection
Volume 6	Cabling
Volume 7	Networking

PS 5.2 Plant and Materials

All materials intended for the purpose of this Contract shall bear the approval of the relevant SANS specifications. Any deviations there from shall be recorded and reported by the Contractor for approval by the Employer's Agent.

Johannesburg Water shall have the right to refuse acceptance of any material or workmanship which is found to be unsound, damaged or contrary to the specification, or which is found during the Period of Maintenance or during tests in situ to be defective or in any way contrary to the specification due to causes within the Contractor's control or responsibility. All material or construction rejected by the Employer's Agent shall be replaced or repaired by the Contractor at their own expense to the satisfaction of the Employer's Agent, whose decision with regard to this matter shall be binding on the Contractor.

All materials used shall be the best of their respective kinds and shall be suitable for working at the pressures and temperatures involved under all working conditions, without distortion or deterioration or the setting up of undue stresses in any part and without impairing the efficiency or reliability of the plant and the strength of its component parts. No welding, burning, filling, or plugging of defective castings shall be permitted without the Employer's Agent's approval in writing.

Materials to be supplied "Free Issue" to the Contractor will be indicated as such in the Bill of Quantities.

PS 5.3 Construction Equipment

In addition to GCC (2015) Clause 7, no plant will be supplied by the Employer, however the Employer does reserve the opportunity to negotiate with the Contractor that different plant be used of another origin for whatever purpose that may become apparent at the time.

Employer:		Contractor:	
Witness:		Witness:	

In so doing the Contractor shall supply and use suitable and sufficient construction plant, tools, equipment, and material as may be required to carry out the Works efficiently. Only the construction plant, tools, equipment, and material which are required for this purpose shall be brought onto the Site and shall be stored, stacked, or erected in such a way as not to interfere with other work or traffic. The Contractor shall furnish statements showing details of construction plant, tools, equipment, and material employed or used on the Works on a day-to-day basis, the Daily Site Diary indicating types, numbers, quantities, hours worked, idle time, etc. all as stipulated in the Project Specification or as directed by the Employer's Agent.

Construction equipment shall be suited for the onsite intended use and shall conform to all relevant safety aspects required by the OHS Act Purchasing of Equipment.

PS 5.4 Existing Services

The Contractor shall make himself acquainted with all existing works. Under no circumstances shall the Contractor alter or in any way interfere with existing works or underground services unless authorised by the Employer's Agent.

Where existing works are of such a nature that the Employer's Agent may require them to be moved by the Contractor, the cost of such work will be paid for at scheduled rates or on dayworks, plant and materials basis. The Contractor will be held responsible for damages to any existing works and any damages caused shall be made good at his own cost without delay.

The Contractor is to exercise care when the proposed work is to cross an existing service, or work is to be performed close to an existing service. Prior to commencement of the relevant portion of the proposed works the Contractor with the Employer's Agent or his duly appointed representative shall also perform a visual inspection of the area in question. This inspection will not waive the Contractor of his obligations with respect care of the works referenced in GCC (2015), Clause 8.2.

PS 5.4.1 Service Providers

Organizations, which have special conditions for crossing of services, are:

- a. Johannesburg Water
- b. Eskom
- c. Telkom
- d. Fibre Providers
- e. Johannesburg Roads Agency

For crossing or working in close vicinity of a service under the control of any of the above organisations, the organisation shall be notified and its general and specific requirements for each crossing or operation shall be carefully observed.

Employer:		Contractor:	
Witness:		Witness:	

PS 5.4.2 Priorities

Services are labelled Priority 1 (P1), Priority 2 (P2) or Priority 3 (P3) on construction Drawings according to the procedure to be observed.

- Priority 1. Indicates an extremely important service.
- Priority 2. Indicates a less important main service.
- Priority 3. Indicates minor services and leadings.

PS 5.4.3 Procedures

Procedure for Priority 1 Services

These services are extremely important.

Once the Contractor is appointed for the Contract, he shall immediately inform the respective service providers of his appointment in writing. He shall also obtain current copies of the Drawings with details of each of the services from the service providers.

The Contractor shall then arrange a meeting with the service provider and the Employer's Agent, to discuss the proposed work. Immediately after the meeting, the Contractor shall confirm in writing the content of this meeting.

At least seven days prior to the anticipated service crossing, the Contractor shall request the service provider to either expose the service or to supervise the exposure of the service. The service provider will nominate a representative, who will remain on site for the duration of all works in the vicinity of the service. No work whatsoever closer than 1,5 meters from the outer extremities of the service shall be carried out in the absence of this service representative. This representative shall have full authority to protect the safety of the service being crossed, including the power to halt and revise the Contractors work methods should he feel his service is in danger of being damaged.

Backfilling around and above the service will either be done by the service provider or under his supervision to the contract specification.

All instructions shall be in writing, acknowledged by signature of the party receiving the instruction. On completion of the work at a service crossing, the service provider will confirm in writing that his service is undamaged.

Procedure for Priority 2 Services

These are less important main services.

Once the Contractor is appointed for the project, he shall immediately inform the respective service providers of his appointment in writing. He shall also obtain current copies of the drawings with details of each of the services from the service providers.

Prior to working close to a service marked P2, the Contractor must discuss the service crossing with the Employer's Agent.

It is the responsibility of the Contractor to locate the existing service before the anticipated crossing by hand excavation. Excavation must be done by shovel

Employer:		Contractor:	
Witness:		Witness:	

only. If this is impossible, work must be discontinued and the problem reported to the Employer's Agent for further instructions. Any damage, however small, must be reported immediately.

On exposing the services, the Contractor must notify the Employer's Agent that such service has been exposed and must arrange for a site visit by the Employer's Agent to inspect the service for any possible damage. When services have been located, no machine excavation may be done within one metre on either side of such service.

In the event of the indicated service not being located, the Contractor shall inform the Employer's Agent, who will in turn request the service provider for assistance.

Backfilling may only be carried out in the presence of the representative of the service owner who will provide a written clearance indicating that the work has been completed without damage to the original service.

Procedure for Priority 3 Services

These are minor services.

It is seldom possible to indicate the position of these minor services and leadings on a drawing and the initiative of the Contractor is relied upon to locate it.

Exposure of these services is the responsibility of the Contractor, and must be done with caution, by hand. Any damage shall be reported to the Employer's Agent immediately. No machine excavation is to take place within one meter on either side of the exposed service.

Before backfilling is done, the service shall be inspected by the Employer's Agent's Representative who will give the service provider the option of inspecting his service.

PS 5.4.4 Damage to Existing Services

In addition to GCC (2015), Clause 8.2, should an existing service be damaged, the procedure as set out below is to be followed. The Contractor must:

1. Take immediate steps to minimize:
 - Damage and loss to property of the service provider and the public e.g. arrange to close down valves, shut off pumps etc.
 - Inconvenience to the public.
 - Further damage to the already damaged service.
 - Damage to other services.
2. Ascertain if an important service is in the vicinity of the problem by carrying out the following checks on available drawings:
 - Eskom power line.
 - Johannesburg Water potable water lines
 - Johannesburg Road Agency stormwater lines
 - Fibre Providers

Employer:		Contractor:	
Witness:		Witness:	

If any of the above are present, the Employer's Agent must be informed.

3. The Contractor must contact the Works Manager and inform him/her of the problem.
4. The Contractor shall then contact the relevant organisation and arrange for site or other suitable representation by the organisation whose service may be affected. Failing co-operation, he should refer the matter to the Employer's Agent, who must repeat the request for co-operation and record the reaction.
5. The Contractor shall not allow any machine excavation at the site of the problem unless:
 - No other services are in the vicinity.
 - All affected organizations are represented on site.
 - Any organization not represented has given written permission for machine excavation.
 - All other services are made visible and adequately protected.
6. The machine shall not work closer than one metre from any undamaged service.
7. All excavation work shall preferably be done by hand using shovels only.
8. On completion of repair work, all representatives of other organizations must be requested to inspect their respective services and give written confirmation that their service is undamaged before backfilling takes place.

PS 5.4.5 Procedures When Dealing with Existing Electrical Services

The following procedures are to be followed when a proposed service is to cross an existing electrical service or work is to be performed in close proximity to an existing service.

Procedure for P1 Service

These are highly important services.

Once the Contractor is appointed for the project, he shall immediately inform the respective service providers of his appointment in writing. He shall also obtain current copies of the drawings with details of each of the services from the service providers.

The Contractor shall then arrange a meeting with the service provider and the Employer's Agent to discuss the proposed work. Immediately after the meeting, the Contractor shall confirm in writing the content of this meeting.

1. The Electrical Engineer must be informed in writing, a minimum of seven (7) working days before work commences at or near the site in question and work shall not commence until this has been acknowledged.

The following special conditions shall be complied with:

- No excavation work is done within three (3) metres of the centre line of the cable/s or any of its ancillary equipment, other than for the purpose of crossing the service.

Employer:		Contractor:	
Witness:		Witness:	

- Should it be necessary to cross the cable/s at any point, no excavation work by means of earthmoving machinery may be done. The necessary material to support the cable or to protect it from any damage whatsoever shall be supplied free of charge or supplied by the Electrical Engineer and the costs recovered from, the Contractor. Should the Electrical Engineer decide that the Contractor may do the work it shall be under the constant supervision of the Electrical Engineer.
 - The crossings are so designed as to ensure a minimum distance of one (1) metre between the cable/s and any object. If the said minimum distance cannot be maintained an approved reinforced type concrete culvert shall be installed over the service by the Works at the cost of the Contractor.
 - The necessary liaison is arranged with the Electrical Engineer during installation of any object in order to ensure that the equipment of the Works is not damaged in any way.
 - The crossing of the service is made only under the strict supervision of the Electrical Engineer.
 - No blasting work is done in close proximity to the service and that all blasting work required is approved by the Electrical Engineer.
 - Full details of the exact location of the service and its ancillary equipment, as well as any other information required must be obtained from the Electrical Engineer.
 - The accompanying form acknowledging all of the above shall be signed.
2. During the duration of the operation the Works Manager will make certain that the service is protected and reserves the right to stop work should he feel that the work being performed could endanger the service. The matter will then be referred to the Electrical Engineer.
 3. Should any damage be caused to the Works service the costs of repairs will be for the Contractor's account.
 4. The Electrical Engineer will close and make good the excavations.
 5. The written agreement mentioned above will be signed off by both parties.
 6. The costs incurred in all of the above will be to the account of the Contractor.
 7. Should the Cable Surface Right be affected the following additional procedures shall apply:
 - No excavation work, storage and parking of motor vehicle is done within two (2) metres of the cable or any of its ancillary equipment such as oil pressure tanks, joint bays and link boxes, other than for the purpose of crossing the cable.
 - Should it be necessary to cross the cable at any point, no excavation work by means of earthmoving machinery is done, proper cable supports to the satisfaction of the Electrical Engineer are installed and the crossings are so designed as to ensure a minimum distance of one (1)

Employer:		Contractor:	
Witness:		Witness:	

metre between the cable and any object. For this purpose it must be noted that the cable has been laid at an average depth of 1 m.

- No crossing, structure, fence or any other object shall be constructed over any of the existing cable joints.
- Cable crossing be made only under the strict supervision of the Electrical Engineer.
- No blasting work is done in close proximity to the cable and that all blasting work required is approved by the Electrical Engineer.
- Access be provided at all times (24 hours a day 7 days a week) where the Employer's surface right permit is to be crossed during and after construction.
- No trees and/or shrubs may be removed or planted except by or with permission from the Employer's Agent.
- Where vehicular crossing is required such crossing shall conform to the requirements of the Electrical Engineer.
- Before work in the vicinity of the Employer's surface right commences the Electrical Engineer shall be informed and his permission obtained to proceed.

Procedure P2

These are services of secondary importance.

Once the Contractor is appointed for the project, he shall immediately inform the respective service providers of his appointment in writing. He shall also obtain current copies of the drawings with details of each of the services from the service providers. Prior to working close to a service marked P2, the Contractor must discuss the service crossing with the Employer's Agent.

1. The Electrical Engineer must be informed in writing two (2) working days before work commences and such work shall not commence until this has been acknowledged.
 - The top 300 mm of soil above the service may be removed by pick and shovel.
 - The remainder of the cover shall be removed carefully by shovel only. If any damage, however small, is caused to the cable it must be reported immediately. The costs of repairs will be for the Contractor's account.
 - When the cable is exposed, the Electrical Engineer or his representative must be informed in order that it may be inspected. No machine excavation within a one-meter radius of the exposed cable is permitted.
2. When the work is completed the excavations may be backfilled until the cable is just exposed when the Electrical Engineer's representative shall inspect once again for possible damage.

Backfilling will then proceed in the presence of the Electrical Engineer's representative who will provide a written clearance when the job is completed.

Employer:		Contractor:	
Witness:		Witness:	

PS 5.5 Site Establishment, Facilities Available and Required

PS 5.5.1 Water Supply for Construction Purposes

The Contractor shall make a connection to the existing potable water pipeline within approximately 200 meters from the area available for the erection of site offices and stores. Any use of this connection shall be measured, and the Contractor shall be held responsible for payment of the water used at the current municipal rates. The connection to the existing network shall include an approved water meter (supplied by the Contractor), that will be used to measure the quantity of the water used by the Contractor. The Contractor shall also provide, at their own cost, all connections fittings, pipework, temporary plumbing and pumps necessary to distribute the water on site.

Delivery pressures at the take-off points on the water main cannot be guaranteed.

The Employer does not guarantee continuity of supply and in such cases the Contractor shall make their own provision for standby supplies to maintain continuity. The variation of pressure in the water supply and/or breakdown in the supply shall not be grounds for an extension of time or compensation.

PS 5.5.2 Power Supply for Construction Purposes

Supply of Electricity

The Contractor shall make a connection to an existing power distribution point within approximately 200 meters from the area available for the erection of site offices and stores. Any use of this connection shall be measured, and the Contractor shall be held responsible for payment of the amount measured at the current municipal rates. The connection to the existing network shall include an approved meter (supplied by the Contractor), that will be used to measure the power used by the Contractor. The Contractor shall also provide, at their own cost, all transformers, HT and LT cables required to distribute the power on site.

Conditions of Supply

All installations connected to a supply of electricity provided by JW shall comply with the regulations. Failure to comply with the Safety requirements may lead to immediate disconnection.

No connection shall be made to the permanent installation without the prior approval of the Employer's Agent, Regional Maintenance Managers and the Works Manager.

No guarantees of power supply quality are given, and power supply breaks of some duration may occur without warning. The Contractor shall make arrangements at their own expense to maintain continuity and quality of power. Any breakdown in power supply or reduction of power supply shall not be grounds for an extension of time or compensation.

Employer:		Contractor:	
Witness:		Witness:	

Application for Supply

A request for power shall be submitted to the Works Manager via the Employer's Agent at least 14 working days before a power supply is required.

PS 5.5.3 Site Office, Store and Housing

The Employer shall make available a suitable area for the Contractor's site offices, workshops and stores. The area available may be shown on the Construction drawings. The Contractor shall advise in their tender the area required for site establishment.

The Contractor will be permitted to establish a stores yard and to erect presentable temporary buildings for the storage of materials and for offices and latrines, all of which shall be neatly fenced. The fence must be sturdy, as indicated on the drawings, and must be fitted with a lockable vehicle entrance gate and shall be at least 2 m in height.

The Contractor shall employ security staff to provide security services to his site camp and other storage areas. The Contractor will not be allowed to cut down any trees or to make any excavations on the sites for the storage yard and temporary buildings without the written permission of the Employer's Agent.

No housing for the Contractor's employees on site is permitted under any circumstances. The Contractor shall make his own arrangements to house and transport contracting staff.

Upon completion of the work in terms of this contract, or when ordered by the Employer's Agent, the site must be cleared of all structures, concrete slabs and waste and excavations must be backfilled and restore the Site to a clean and sanitary condition to the satisfaction of the Employer's Agent. He shall rehabilitate the area in accordance with the EMP.

The tendered sums for as scheduled by the Employer's Agent, whether grouped or individually, shall include all costs for the installation, maintenance and removal of the fencing as specified, in addition to all other facilities specified and as required by the Contractor for his own purposes.

The Contractor shall make the necessary arrangements with Johannesburg Water to obtain access for the vehicles and personnel he intends to employ on site.

PS 5.5.4 Crane and Lifting Equipment

Lifting equipment is not available on the site. The Contractor shall supply **suitably sized lifting equipment.**

PS 5.5.5 Security

Northern Wastewater Treatment Works has 24 hours security guards for the complete Works, which is appointed by Johannesburg Water (SOC), but the Contractor shall make their own security arrangements to secure the new facilities under this Project.

Employer:		Contractor:	
Witness:		Witness:	

The Contractor shall be responsible for providing, operating and maintaining the security system including personnel, vehicles, equipment, access control buildings, guard shelters, barriers/booms, identification systems, administration, management and the like.

The Contractor shall submit within 21 days of the Commencement Date to the Employer's Agent for approval a Method Statement containing a full description of the security policies and systems they propose to adopt on the Site.

The Security shall operate on a continuous 24 hour per day 7 days per week basis for the duration of the Contract. The Method Statement shall include full and effective security control of all accesses to the site including appropriate identification procedures for all persons and vehicles entering and leaving the Site.

The Contractor shall co-operate with the South African Police Services (SAPS) and comply with the Employer's requirements on all matters relating to security of the Works and persons entering the Site.

The Contractor shall prevent firearms from being brought on to the Site. They shall include, in all Employees' Contracts, the right to search Employees for firearms or other weapons as well as the right to remove the firearm or weapon and store it in a place of safety, until it can be handed back to the employee. The Contractor shall make the right to search vehicles and visitors for firearms upon entry to the Site, a condition for entry. Applicable signs shall be erected at the entrances to the Site.

The Contractor shall employ a security firm approved by the Employer's Agent. Notwithstanding the Employer's Agent's approval, compliance with the requirements of the Specification shall remain the responsibility of the Contractor.

No Employees, apart from a Security Guard, shall be allowed to remain overnight at the site camp unless overnight work is approved detailing the activities to be performed by the Employer's Agent or Representative.

PS 5.5.6 Telephone Facilities

The Contractor shall be responsible for arranging their own telephone facilities and shall be responsible for all costs relating thereto.

PS 5.5.7 Ablution Facilities

Ablution facilities are not available on site. The Contractor shall therefore make the necessary arrangement to provide these facilities. Chemical serviced toilets shall be in accordance the minimum acceptable standard. These must be placed in a position as approved by the Employer's Agent. The facilities shall be submitted to the Employer's Agent's approval and shall be kept in a clean and sanitary condition.

PS 5.5.8 Storage Facilities

Johannesburg Water has no storage facilities available for use by the Contractor. The Contractor shall provide their own storage facilities.

Employer:		Contractor:	
Witness:		Witness:	

The facilities shall be subject to the approval of the Employer's Agent, who shall have full access to them at all reasonable times. Site storage buildings shall be maintained in good condition and appearance. Fuel shall be stored in properly constructed storage tanks and banded in accordance to relevant fire and safety regulations. Fuel installations shall be secured against access by unauthorized persons. The Contractor shall make his own arrangements to secure the facilities.

PS 5.6 Site Facilities Required

PS 5.6.1 Facilities for the Employer's Agent

Office Building

Three offices, complete with furnishings and amenities as specified in section PSAB 3.2 of this document, must be provided by the Contractor for the exclusive use by the Employer's Agent.

The Contractor shall consult with the Employer's Agent prior to the supply and erection of these office.

Carports

Carport for total of four motor vehicles shall be provided adjacent to the Employer's Agent's office. The carport shall each be at least 15 m² in area and have side cladding and shall be constructed in such a way as to shelter the parked vehicles from the prevailing winds and rain.

Ablution and Latrine Facilities

The Contractor shall, in addition to catering for their own staff, provide ablution and latrine facilities adjacent to the Employer's Agent's office for the exclusive use of the Employer's Agent and their staff. The facilities shall consist of a hand washbasin and a latrine. Serviced Chemical toilets shall be the minimum type of ablution acceptable to the Employer.

The facility shall be maintained in a clean and hygienic condition.

First-aid Kit and Protective Clothing

The Contractor shall provide on the Site of Works two first-aid kits to deal with accidents, illnesses and snakebite which may occur during the normal course of Site operations.

The Contractor is not obligated to provide Personal Protective Equipment for the Employer's Agent.

Services for Office and Ablutions

The Contractor shall provide, at their own cost, a constant supply of potable water and electric power to the Employer's Agent's office and ablutions.

PS 5.6.2 Name boards

Two name boards (Provisional Quantity) shall be erected and the boards shall comply with the format and size shown on Drawing No. JW14060R-GEN-004 bound in Volume 4, as a reduced drawing. The Contractor shall, within 21 days

Employer:		Contractor:	
Witness:		Witness:	

after the Commencement Date provide, erect and maintain the project name boards. The name boards shall be erected at locations indicated by the Employer's Agent.

No other name board other than stated above shall be allowed and on completion of the works, the Contractor shall remove the board from the site on completion of the Contract.

PS 5.6.3 Measurement and Payment

The site facilities described in PS 5.6.1 and PS 5.6.2. above **Error! Reference source not found.** for the Employer's Agent should be allowed for in the Preliminary and General Items.

PS 5.6.4 Facilities for the Contractor

The Contractor shall provide, maintain and remove their own facilities to the satisfaction of the Employer's Agent. The Contractor shall provide the area around their office, stores and sheds (i.e. the "Camp") with adequate security fences to ensure that unauthorised persons do not enter the camp area and security personnel should be deemed necessary.

The Contractor shall provide on-site laboratory facilities necessary to satisfactorily perform all the site control and testing requirements called for in the Contract.

The Contractor will not be allowed to cut down any trees or to make any excavations on the sites for the storage yard and temporary buildings without the written permission of the Employer's Agent.

Upon completion of the work in terms of this Contract, the site must be cleared of all structures, concrete slabs and waste. The area is to be rehabilitated according to the Specification.

The tendered sums for as scheduled by the Employer's Agent, whether grouped or individually, shall include all costs for the installation, maintenance and removal of the fencing as specified, in addition to all other facilities specified and as required by the Contractor for their own purposes.

PS 5.6.5 Waste Disposal Sites

The Contractor shall make his own arrangements for solid and liquid waste disposal. Disposal shall take place at an approved site.

PS 5.7 Site Usage

Access to the Site is by means of existing gravel / tarred roads from the North (R114) or through the Works main access gate through school road which connect with the R511- (Winnie Mandela Drive).

Both accesses have lockable gate and access is controlled by means of security guards appointed by Johannesburg Water (SOC) LTD. The Contractor shall implement his own access control for the project site establishment.

Employer:		Contractor:	
Witness:		Witness:	

Vehicle speed within the Works shall be restricted to the maximum speed of 30 km/h and vehicles shall be driven by licensed drivers with extreme caution. The Contractor shall only make use of the site area as indicated on the drawings or as directed by the Employer's Agent.

The Contractor shall be required to report daily to Management personnel of the Works.

The Contractor's staff shall be identified by clothing and an identification tag, which shall be displayed when entering the Site of Works.

Access is to be made available to Johannesburg Water's employees to any portion of the Site whenever required.

The Contractor shall be responsible for the closing of all gates on roads and tracks used by him or his employees.

PS 5.8 Permits and Wayleaves

Work permits shall be completed and shall be area specific.

As the Contract shall require the removal of equipment from Site, the Contractor shall acquire permits as required by the Employer.

No wayleaves are envisaged under the Contract. The Works called for under this Contract shall be executed within the works site boundaries.

PS 5.9 Alterations, Additions, Extensions and Modifications to Existing Works

The Contractor must ensure necessary resources and equipment and safety procedures are included in the tender price to carry out this work under the above limitations and shall include the provision of temporary works.

All proposed interruptions and tie-ins to the existing treatment process shall be discussed and agreed with the Employer's Agent and the Works Operational staff. Where necessary, detailed method statements will be required to be provided. Allow 14 working days for approval of method statements.

PS 5.10 Water and Electricity for Construction Purposes

The responsibility lies with the Contractor to negotiate all costs and necessary connections that might be required during the execution of the works as set out in **Clause PSA 4.2 of Portion 2**. All connections will conform to the requirements of Johannesburg Water and costs applicable will be paid by the Contractor.

PS 5.11 Survey Control and Setting out of the Works

The Contractor shall provide permanent beacons marking the main setting out grid lines for all construction works and permanent level benchmarks. An item for this work has been provided in the Bill of Quantities. The Employer shall not be held responsible if any of the beacons are removed as long as there are other beacons existing.

The Contractor shall take reasonable steps to preserve beacons and benchmarks he has provided.

Employer:		Contractor:	
Witness:		Witness:	

All necessary pegs, profiles, site rails and other devices required for the setting out of works from the main beacons shall also be supplied and erected by the Contractor to the satisfaction of the Employer's Agent. The cost of these secondary setting out points shall be borne by the Contractor and shall be deemed to be included in their rates and prices.

The Contractor shall be responsible for the setting up, marking and core drilling of holes for the new position of the holding down bolts.

PS 5.12 Accommodation and Care of Employees

No employees, apart from a security guard, may be housed on the Site of Works. The Contractor shall make his own arrangements to secure the facilities provided for under the Contract.

PS 5.13 Marking

All plant including steel piping and specials delivered under this Contract shall have painted or marked thereon or on the container the relative item number given in the Bill of Quantities.

PS 5.14 Off-Loading, Stacking and Liability for Breakages

The Contractor will be required at his own expense to make all arrangements for off-loading and carefully stacking all plant delivered under this Contract at the Site of the Works. The off-loading and stacking shall be carried out strictly in accordance with the requirements of the Employer's Agent so as to permit a thorough and careful examination and testing of all items for breakages, fractures, etc. and any routine maintenance during storage.

The Contractor shall be fully responsible for the protection of all plant delivered by him to Site but still in storage, against damage by water, weather, fire and any other interference until such time as it is erected and installed, put into satisfactory operation and accepted by the Employer as complete.

PS 5.15 Storage

Johannesburg Water has no storage facilities available for use by the Contractor who must make his own arrangements in this regard.

The Contractor will be permitted to establish a stores yard and to erect presentable temporary buildings for the storage of materials and for offices and latrines, all of which shall be neatly fenced. The fence must be sturdy, covered with diamond mesh wire and fitted with a lockable vehicle entrance gate and shall be at least 2 m in height.

The Contractor shall make his own arrangements to secure the facilities provided.

The Contractor will not be allowed to cut down any trees or to make any excavations on the sites for the storage yard and temporary buildings without the written permission of the Employer's Agent.

Employer:		Contractor:	
Witness:		Witness:	

Upon completion of the work in terms of this Contract, the site must be cleared of all structures, concrete slabs and waste. The area is to be rehabilitated according to the Specification.

The tendered sums for as scheduled by the Employer's Agent, whether grouped or individually, shall include all costs for the installation, maintenance and removal of the fencing as specified, in addition to all other facilities specified and as required by the Contractor for his own purposes.

PS 5.16 Inspection at Site

All plant will be carefully examined upon delivery at the Site by the Employer's Agent's representative and all items showing defects or damage of any description shall be laid aside as not being in accordance with the requirements of the Contract and these shall be removed and replaced by the Contractor at his own cost.

PS 5.17 Temporary Housing, Stores, etc.

The Contractor shall provide and maintain at his own cost all sheds of a temporary nature necessary for the accommodation and proper protection of plant from damage or loss. These are to be erected only on sites which shall have been approved by the Employer's Agent and they shall be removed as soon as their necessity ceases and the site thereof restored to its original condition and the ground left clean and sanitary.

PS 5.18 Management Meetings

Meetings will be held every month with the first meeting called the site handover meeting. The Contractor will be supplied with an appropriate agenda for the management meetings and meetings will be chaired by the Employer's Agent or his duly appointed representative. The Employer's Agent or his duly appointed representative will be responsible for issuing of the minutes.

Employer:		Contractor:	
Witness:		Witness:	

PS 6. MANAGEMENT OF THE WORKS

PS 6.1 Applicable SANS 1921 Standards

Although not bound in or issued with this document, the following SANS 1921 Construction and Management Requirements for Works Contracts as approved by the Council of the South African Bureau of Standards shall apply to this Contract. The Contractor shall be in possession of these Standards and shall keep a copy of it on site for reference by him and the Employer's Agent for the duration of the Contract.

PS 6.2 Planning and Programming

An initial programme in terms of the Clause 5.6 of the GCC (2015), complete with a cash flow budget for the execution of the works must be made available to the Employer's Agent for approval within 21 days after the receipt of the Letter of Award. Aspects that will require co-ordination with the Employer must be indicated clearly and provision must be made for it in the programme.

The programme shall be in the form of a gant chart and shall clearly show the anticipated quantities of work to be performed each month, together with the manner in which the listed plant is to be used, as well as the cash flow for the various sections of work. The Contractor must take cognisance of the following when developing the programme:

1. Sequence of the works for the relevant works area.
2. Target dates for the tasks identified in sequence of the works for the relevant working areas.
3. Materials requirements.
4. Construction Plant to be used.
5. Services affecting construction.
6. Any factors that could affect construction progress after commencement.

No deviation from the approved sequence of construction shall be accepted without prior written approval.

No work of a permanent nature may be executed before the programme has been approved by the Employer's Agent.

All method statements shall be approved by the Employer's Agent before commencement of construction. In order to minimize the impact on traffic, pedestrians and business the Contractor will be required to segment the works in such a manner that no portion of the works is more than one day ahead of the following position i.e. trenches cannot be excavated more than one day ahead of pipe laying, pipes more than one day in advance of manhole construction and finishing off etc. These segments of the works shall be clearly defined in the Contractor's method statement for each work area.

If, during the progress of the work, the quantities of work performed per month fall below those shown on the programme, or if the sequence of operations is altered, or if the program is deviated from in any other way, the Contractor shall,

Employer:		Contractor:	
Witness:		Witness:	

within one week after being notified by the Employer's Agent, submit a revised programme.

If the programme is to be revised by reason of the Contractor falling behind his programme, he shall produce a revised programme showing the modifications to the original programme that are necessary to ensure completion of the Works or any part thereof within the time for completion. Any proposal to increase the rate of work shall be accompanied by positive steps to increase production by providing more labour and plant on the Site, or by using the available labour and plant in a more efficient manner.

Failure on the part of the Contractor to submit or to work according to the programme or revised programme shall be sufficient reason for the Employer to take steps as provided for in the GCC (2015).

The approval by the Employer's Agent of any programme shall have no contractual significance other than that the Employer's Agent would be satisfied if the work is carried out in accordance to such programme and that the Contractor undertakes to carry out the work in accordance with the programme. It shall not limit the right of the Employer's Agent to instruct the Contractor to vary the programme should circumstances make this necessary.

Where the Contractor's programme indicates completion beyond the official contract completion date, and the programme is accepted by the Employer's Agent, such acceptance shall in no way whatsoever indicate the Employer's Agent's acceptance of an extension to the contract period. Nor shall it be acceptable in terms of Clause 5.6.5 of the GCC (2015) as notification of an intention to claim. It shall, however, indicate that the Contractor has taken due cognizance of the completion date and of the consequent possible application of penalties.

PS 6.3 Planning

The Contractor shall ensure that he delivers goods and services timeously, to not unnecessarily delay other contractors, service providers and suppliers.

PS 6.4 Programming

It will be an explicit requirement of the contract that this programme is updated monthly and submitted to the Employer's Agent at least two working days prior to the monthly site progress meeting. The programme shall at minimum contain:

PS 6.4.1 Time Scale Minimum

1. Days, where the period does not exceed three months.
2. Weeks, where the project period exceeds three months.
3. Months, where the period does not exceed one year.
4. Years, where the project period exceeds one year.

Employer:		Contractor:	
Witness:		Witness:	

PS 6.4.2 Tasks

Where phases or stages are anticipated, this shall be the highest level of division and all tasks related to the successful accomplishment of that phase of the area shall be grouped. Resources allocation and task dependency shall be indicated.

PS 6.4.3 Start and Finish Dates

All tasks shall have specific start and finish dates.

PS 6.4.4 Critical Path

All tasks forming the programme line that will establish any delays in the overall Contract Period shall be clearly indicated and an indication of their sensitivity characteristics shall be provided.

PS 6.4.5 Progress Tracking

The Contractor shall be required to periodically indicate progress per task graphically and on a percentage basis.

PS 6.4.6 Non-working Time

South African public holidays, weekends and the local traditional annual builder's break shall be incorporated in the programme.

PS 6.4.7 Sequence of the works

The Contractor shall supply his proposed sequence of work together with the initial programme & the sequence of works to be executed shall be agreed between the Employer's Agent and the Contractor.

PS 6.4.8 Software Application for Programming

The construction programme shall be completed in Microsoft Office Project Professional 2010 or compatible software. It shall show the activities planned start dates, planned end dates and planned durations. The construction programme and updated versions thereof shall be made electronically available to the Employer's Agent.

The programme shall be costed in accordance with the Bill of Quantities and resourced accordingly.

PS 6.5 Methods and Procedures

The methods and procedures for the execution of the works shall be in accordance with the standard specifications and the variations and additions thereto.

The Contractor will advise in his tender the methods and procedures that he proposes in performing the Works. These methods and procedures shall not be deemed as terms of the Contract. The Contractor is also allowed to change his methods and procedures as he sees fit subject to the change being

Employer:		Contractor:	
Witness:		Witness:	

approved by the Employer's Agent. Methods and procedures will not vary the specification and cannot be used to provide qualifications to the proposed agreement. The intention of the method statement is to provide the Employer's Agent and the Employer with information as how he proposes to perform the said works.

PS 6.6 Quality Plans and Control

In addition to guidelines set out in GCC 2015 Clause 7, the Contractor will furnish the Employer's Agent with a Quality Assurance and Control Plan that incorporates all of the requirements of this specification within three weeks of the Letter of Award of the contract. The onus to produce work that conforms in quality and accuracy of detail to the requirements of the specifications and drawings rests with the Contractor, and the Contractor shall, at his own expense, institute a quality-control system and provide experienced personnel, together with all transport, instruments and equipment to ensure adequate supervision and positive control of the works at all times.

All material, plant and equipment shall be of the best quality available and shall, where applicable, comply with the relevant standard specifications of the SANS. In cases where no specification of the SANS exists, the relevant British, German or American specifications will be applicable as determined by the Employer's Agent. The latest amendments of these specifications shall apply.

The Contractor shall submit for the approval of the Employer's Agent and before any orders are placed, the names of the firms from which he proposed to obtain his supplies of materials and manufactured articles.

He shall also supply samples as and when required by the Employer's Agent.

The Employer's Agent may also, in exercising the powers vested in him, order the Contractor to remove all or any of the material and equipment which, in his opinion, is of an inferior quality and to replace them with proper materials or equipment at his own expense.

The cost of supervision and process control will be deemed to be included in the rates tendered for the related items of work.

On completion and submission of every part of the Works to the Employer's Agent for examination, the Contractor shall furnish the Employer's Agent with proof of quality in the form of a data pack containing measurements and levels to indicate compliance with the scope of work.

Notwithstanding anything contained in this document, nor any examination of the Works by the Employer's Agent, nor any tests carried out, nor any approvals granted (verbally or in writing), nor any consent that may have been given, either directly or implied, nor anything that may be construed to the contrary, the Contractor shall remain fully and solely accountable for correctly setting out, founding and constructing the Works, and for compliance with the specifications and the drawings.

Employer:		Contractor:	
Witness:		Witness:	

PS 6.7 Accommodation of Traffic on Public Roads Occupied by the Contractor

The Contractor is responsible for pricing traffic accommodation in his tender if applicable. The Contractor, in understanding his site operations, may require traffic accommodation and therefore will have to comply with prevailing local and /or national guidelines in this regard. The Contractor shall make applications to the relevant authorities for such permissions. The timing and contractual risk of such applications shall be for the Contractors account. The Employer's Agent, without prejudice, may assist in this regard.

PS 6.8 Other Contractors on Site

During the course of the contract, other contractors may be involved in construction projects within and in the vicinity of the site, which may be inter-related to the work being undertaken on this contract.

The Contractor shall cooperate with other such contractors and shall provide them with all reasonable access to enable them to carry out their work. Access may be required, from time to time, by these contractors and the Contractor shall take all reasonable steps to accommodate such requirements.

No claims, related to works being carried out by other contractors, will be entertained by the Employer.

PS 6.9 Testing, Completion, Commissioning and Correction of Defects

PS 6.9.1 General

The onus is on the Contractor to produce work that will conform in quality and in accuracy of detail to the requirements hereinafter specified. The Contractor shall clearly understand that it is not a duty of the Employer's Agent or his representative to act as foreman or surveyor on the Works.

The Contractor shall, at his own expense, provide an experienced Site Agent, foremen and surveyors together with all transport, instruments, and equipment for supervising, checking and controlling the work.

The act of passing any completed work for payment by the Employer's Agent shall not be construed as signifying approval or acceptance thereof. Failure on the part of the Employer's Agent to reject any defective work or material shall not in any way relieve the Contractor of his obligations under the Contract, nor prevent later rejection when such work or material is discovered. In this regard, it is emphasised that notwithstanding anything contained in this document, any tests that may have been carried out, any consent that may have been given, either directly or implied, and anything that may be construed to the contrary, the Contractor shall remain fully and solely accountable for the Works and for compliance with the specifications and the drawings.

The Contractor shall, when submitting any work to the Employer's Agent for examination, satisfy himself by testing, measurement and otherwise as may be necessary that the work does in fact meet the requirements of the Specifications. This information shall be submitted with the Contractor's request for examination and the Employer's Agent shall decide on the number and type of tests, measurements, etc. required to enable him to judge the

Employer:		Contractor:	
Witness:		Witness:	

quality of the work. The submission of this information shall in no way diminish the authority of the Employer's Agent to conduct such tests as he may consider necessary in order to determine the quality of the work performed by the Contractor, nor will he be bound to take account of the Contractor's tests, measurements, etc. should he consider these to be either incorrect or not representative.

Quality control and completion tests shall be in accordance with the relevant standard and amended specifications and additional specifications.

The tendered rates shall include the cost of all control testing, and no additional claims shall be entertained in this respect. This includes the supply of all necessary equipment required for these tests and/or inspections by the Employer's Agent.

Should the control testing performed or arranged by the Contractor not meet the requirements of the specification, the Employer's Agent shall have the right to conduct all such testing at the Contractor's expense.

In such a case, the Employer's Agent shall be given at least 72 hours' notice when testing is required. No claims, however, shall be considered in respect of delays resulting from such testing.

Whenever the Employer's Agent conducts control testing on behalf of the Contractor, charges shall be levied. The Employer's Agent may, from time to time, carry out his own check tests on the work performed by the Contractor. Should such check tests show the Contractor's control testing to be such that the quality of the Contractor's work can be called into question, then the Employer's Agent may order further check tests to be carried out on work already completed by the Contractor.

All costs associated with such check tests shall be for the Contractor's account as shall the costs of any other check test whose results do not comply with the specification.

Where the Employer's Agent is required to witness certain control tests, such as the pressure testing of pipelines, and the results of such tests do not comply with the specifications, then charges will be levied against payments to the Contractor in order to recover the costs of the Employer's Agent's presence at the test.

The requirements of the Local Authority, insofar as their witnessing of tests, shall be adhered to.

PS 6.9.2 Performance Tests

General

The Contractor shall carry out all tests required to satisfy the Employer's Agent that the plant is capable of performing the duties prescribed in the Specification, and shall allow for this in his Tender. Any defects detected during the testing operation shall be made good by and at the expense of the Contractor, including all additional costs incurred by the Employer and his representatives and the Employer's Agent. These tests shall be carried out to certify that the

Employer:		Contractor:	
Witness:		Witness:	

plant, as installed on Site is operating in accordance with the specified and guaranteed hydraulic, mechanical and electrical performance of the equipment and must be witnessed by the Employer's Agent. Three copies of reports on all tests shall be submitted within one week after the tests have been carried out.

The Employer's Agent will be entitled to be present at such test and the Contractor shall give the Employer's Agent reasonable notice of the dates of the test.

PS 6.9.3 Factory Tests

The Contractor shall carry out tests in accordance with the requirements of the recognised SANS, IEC or BS standards. Comprehensive details of the standards used and to which equipment the tests will be applicable shall be supplied. Such additional tests in the manufacturer's "Works", which in the opinion of the Employer's Agent are necessary to determine that the Contract work complies with the requirements of the Specification, whether under test conditions or in normal service, may be called for at no additional cost to the Employer.

PS 6.9.4 Tests on Site

All Site tests shall normally be carried out in the presence of, but always to the satisfaction of the Employer's Agent and at such times as he may reasonably require. The Contractor shall provide all the relevant test equipment and bear the costs of all testing to be done. All equipment must be tested to ascertain whether it performs its intended duties in a manner as specified.

PS 6.9.5 Accepted Laboratories

Unless otherwise stated in a specification that forms part of this Contract, only the testing laboratories of the South African Bureau of Standards, the Council of Scientific and Industrial Research, the relevant Government Departments and Local Authorities will be accepted as approved laboratories in which tests or design work required in terms of a specification may be carried out.

PS 6.9.6 Methods of Testing

Unless otherwise prescribed in a specification that forms part of this Contract, all testing shall be carried out and interpreted in strict accordance with the methods specified in relevant SANS, IE or BS Specification(s).

PS 6.9.7 Inspection of Works by Local Authority

The Contractor shall afford inspectors from the Local Authority reasonable access to all parts of the site. The Employer's Agent in the presence of representatives of the Local Authority will generally undertake testing of the works. Accordingly, the Contractor shall notify the Employer's Agent at least 24 hours in advance as to when the various sections of work will be available for testing. The Employer's Agent may require the Contractor to submit a weekly schedule of times, based on his programme, that he envisages work to be available for testing.

Employer:		Contractor:	
Witness:		Witness:	

PS 6.9.8 Commissioning of Equipment

Before starting up any section of the mechanical plant or filling tanks and sumps with liquid, the Contractor shall clean out the tanks or structures or, if necessary, arrange with the Main Contractor to remove any building rubble from the structures, check that all nuts are tightened correctly, that all equipment is complete and ready for start-up, that the plant has been installed correctly and that three copies of the operating manuals have been handed over.

With regards to the commissioning of the Belt Presses the Contractor shall as part of his Tendered Rates for Commissioning of the Belt Presses arrange an OEM specialist to be present on site for the full duration of the Belt Press Commissioning Period.

PS 6.9.9 Servicing and Defects Liability Period

Without limiting in any way, the obligations or responsibilities of the Contractor for maintenance, the Contractor shall make regular quarterly visits to the reservoir during the Defects Liability Period to supervise the maintenance of the equipment. During these visits, he shall make all adjustments and do everything necessary to ensure the proper running of the plant. After each supervising visit to the Site, the Contractor shall submit to the Employer's Agent a report on:

- a. The condition of the equipment and the servicing work carried out, and
- b. Any adjustments which may have been made.

The last servicing visit shall be carried out during the last week of the Defects Liability Period during which visit the Contractor's representative shall carry out full checks on the equipment to ensure that the alignment, clearances and any other setting are correct, and he shall carry out any adjustments necessary. The Defects Liability Period will not terminate until the Employer's Agent is satisfied that the Contractor has finally checked the adjusted equipment.

Servicing will be measured as scheduled by the number of visits.

The dates for the service visits shall be agreed with the Employer's Agent during the final inspection prior to issue of the certificate of completion.

PS 6.9.10 Operating and Maintenance Instructions

Before completion of the testing of the plant, the Contractor shall provide the Employer with adequate and complete working, operating and maintenance instructions in triplicate, with the necessary drawings and diagrams clarifying the instructions.

The Contractor must compile and provide three copies of a complete operation manual for the equipment provided. This manual shall contain comprehensive information as set out hereafter.

- a. Drawings of the equipment detailing all part numbers and materials.

Employer:		Contractor:	
Witness:		Witness:	

- b. A complete spare list.
- c. A lubrication and maintenance schedule showing all maintenance and lubrication operations, their recommended frequency and the grades of lubricant required.
- d. A maintenance brochure describing all maintenance, adjustment and replacement procedures.
- e. Operating manual describing the operation of the equipment with performance curves where applicable.
- f. A manual detailing all dismantling and reassembly procedures.
- g. Maintenance procedure for corrosion protection painting systems.
- h. Complete Data book of the equipment on completion of the Contract.

The Contractor shall amplify and amend such drafts until the Employer's Agent is satisfied that they will fulfil the purpose of ensuring that the Employer's staff is adequately instructed to operate and maintain the works. Once the drafts have been approved by the Employer's Agent, the Contractor shall prepare three suitably bound copies and deliver them to the Employer's Agent.

The manual must be specific for the plant supplied and all extraneous material not connected with the relevant plant shall be deleted, leaving the manual as a comprehensive coherent document, bound in a professional way such that it may be used frequently without falling apart. Standard pamphlets may be supplied as addenda, bound separately in a good quality file to serve as a reference but will not be allowed as part of the main manual. The Contractor shall allow in his tender price for the supply of these operating and maintenance instructions.

In addition to the above, the Contractor, and where necessary the suppliers of equipment, will be required to instruct the works personnel in the proper and correct operation of the equipment installed for a maximum period of 14 days. The timing of this training will be determined in consultation with the Employer and the Employer's Agent.

The manuals shall be drawn up in English.

PS 6.9.11 Completion, Commissioning and Correction of Defects

The tendered rates shall include the cost of all activities and tests that may be required in ensuring proper completion and commissioning of the Works, and no additional claims shall be entertained in this respect. This includes the supply of all necessary equipment required for such and / or for inspections by the Employer's Agent and any other relevant authority.

Any defect in the Works shall be corrected to the satisfaction of the Employer's Agent.

PS 6.10 Recording of Weather and Abnormal Rainfall

If during the time for completion of the works or any extension thereof, abnormal rainfall or wet conditions shall occur, then an extension of time in

Employer:		Contractor:	
Witness:		Witness:	

accordance with Clause 5.12 in GCC 2015 hereof shall be granted by the Employer calculated in accordance with the formula given below for each calendar month or part thereof.

$$V = (Nw - Nn) + ((Rw - Rn)/X)$$

V	Extension of time in calendar days in respect of the calendar month under consideration.
Nw	Actual number of days during the calendar month on which a rainfall of Y mm or more has been recorded.
Nn	Average number of days, as derived from existing rainfall records, on which a rainfall of Y mm or more has been recorded for the calendar month.
Rw	Actual rainfall in mm recorded for the calendar month under consideration.
Rn	Average rainfall in mm for the calendar month as derived from existing rainfall records.

For purposes of the contract Nn, Rn, X and Y shall have those values assigned to them in the Contract Data and/or the Specification.

The total extension of time shall be the algebraic sum of all monthly totals for the period under consideration, but if the total is negative the time for completion shall not be reduced due to subnormal rainfall. Extensions of time for part of a month to be calculated using pro rata values of Nn and Rn.

This formula does not take account of flood damage that could cause further or concurrent delays and will be treated separately as far as extension of time is concerned.

The factor (Nw - Nn) shall be considered to represent a fair allowance for variations from the average number of days during which rainfall exceeds Y mm. The factor (Rw - Rn)/X shall be considered to represent a fair allowance for variations from the average in the number of days during which the rainfall did not exceed Y mm but wet conditions prevented or disrupted work.

The following average rainfall figures are applicable:

Information Source: South African Weather Service,
Pretoria, Tel.: 012 367 6014

Y = 10 mm/24-hour day

X = 20 mm

Employer:		Contractor:	
Witness:		Witness:	

STATISTICAL INFORMATION: MIDRAND: LATEST		
Month	RAINFALL	
	<u>Nn</u>	<u>Rn</u>
	<i>Actual number of days during the calendar months in which a rainfall of more than Y mm has been received</i>	<i>Average monthly rainfall</i>
January	2.4	140.7
February	1.3	69.4
March	0.9	45.4
April	0.2	32.6
May	0.3	15.9
June	0.0	6.0
July	0.0	0.8
August	0.0	3.2
September	0.1	5.4
October	1.3	48.9
November	1.2	63.7
December	1.9	107.1
TOTAL	9.5	539.1

The Contractor shall be permitted to take his own rainfall measurements on site subject to the Employer's Agent's approval, but access to the measuring gauge(s) shall be under the Employer's Agent's control. The Contractor is to provide and install all the necessary equipment for accurately measuring the rainfall as well as to provide, erect and maintain a security fence plus gate, padlock, and keys at each measuring station, all at his own cost.

PS 6.11 Format of Communications

All communication shall be in writing and any verbal agreements shall only be binding once confirmed and agreed to in writing. Communication by registered post, email or facsimile is acceptable.

The Contractor and the Employer shall follow the correct communication protocol applicable to a normal civil engineering contract. The Contractor shall not put into effect any instructions received by him, other than through such protocol.

Should the Contractor be unclear in this regard, he shall obtain a ruling from the Employer's Agent.

Employer:		Contractor:	
Witness:		Witness:	

Contractor to provide the following reporting on a monthly basis, Local resources reporting shall include but not be limited to;

- a. Number (labourers, SMMEs and suppliers)
- b. Labour:
 - Process of recruitment, selection and appointment
 - Name and surname
 - Gender and age
 - Certified copies of ID not validated older than three months.
 - Proof of Compliance with COID Act, which will be valid for the duration of the Construction period.
 - Contact details (address, telephone numbers and ward number)
 - Contract signed
 - Duration of appointment
 - Commencement date
 - Termination date
 - Activity performed
 - Classification (Skilled, semi-skilled or unskilled (labourer))
 - Time or task rate
 - Allocated Supervisor/foreman
 - Health and Safety induction undergone
 - Training provided:
 - Trainer details
 - Type of training
 - Duration of training
 - Cost of training
 - Attendance register
 - Performance rating (good, fair, poor):
 - For training
 - Work execution
 - Health and safety awareness
 - Additional training or supervision to be provided
 - Proof of Monthly and cumulative payments, including salaries or wages
 - UIF Returns

Employer:		Contractor:	
Witness:		Witness:	

- Certified copy of the contractual agreement not validated older than three months.
- c. SMMEs
 - Process of recruitment, selection and appointment
 - Company name
 - Company contact details (address, telephone numbers and ward number)
 - Company registration (also VAT and TAX)
 - Company age (months or years)
 - Type of company
 - Company size (number of permanent employees)
 - Name and surname of owner
 - Owner contact details (address and telephone numbers and ward number)
 - Gender, age and PDI status
 - Contract signed
 - Certified copies of ID
 - Proof of Compliance with COID Act, which will be valid for the duration of the Construction period.
 - Duration of appointment:
 - Commencement date
 - Termination date
 - Resources provided (labour and/or plant and/or materials)
 - Activity performed
 - Classification
 - Time or task rate
 - Allocated Contractor Supervisor/foreman
 - Health and Safety induction undergone
 - Training provided:
 - Trainer details
 - Type of training
 - Duration of training
 - Cost of training
 - Attendance register

Employer:		Contractor:	
Witness:		Witness:	

- Performance rating (good, fair, poor):
 - For training
 - Work execution
 - Health and safety awareness
 - Additional training or supervision to be provided
 - Proof of Monthly and cumulative payments , including salaries or wages
 - UIF returns
 - Certified copy of the contractual agreement not validated older than three months
- d. Suppliers
- Process of recruitment, selection and appointment
 - Company name
 - Company contact details (address, telephone numbers and ward number)
 - Company registration (also VAT and TAX)
 - Company age (months or years)
 - Type of company
 - Company size (number of permanent employees)
 - Name and surname of owner
 - Owner contact details (address and telephone numbers and ward number)
 - Gender, age and PDI status
 - Contract signed
 - Duration of appointment:
 - Commencement date
 - Termination date
 - Resources provided (plant and/or materials)
 - Activity performed
 - Allocated liaison
 - Health and Safety induction undergone
 - Performance rating (good, fair, poor)
 - Monthly and cumulative payments

Employer:		Contractor:	
Witness:		Witness:	

The report format may be amended from time to time by the Employer's Agent. However, the initial format shall be finalised by the Employer's Agent in association with the Contractor.

A Daily Site Diary shall be used by the Contractor for recording day by day the state of the weather, the work done each day and full details of any circumstance which may affect the progress of the works. One original sheet and two copies shall be used for each day. The original sheet of each set of 3 pages will be retained by the Employer's Agent or his representative. The Contractor may remove the second sheet, but the third sheet shall be retained on the site until completion of the Works, when it shall be handed over to the Employer's Agent.

PS 6.12 Key Personnel

The Contractor is deemed to have in making his offer, all personnel available to perform the works entirely in the contracted time and cost. In addition, he shall comply with the prevailing Act 85 of 1993, Occupational Health and Safety Act.

The Contractor is to provide the Curricula Vitae of key personnel to be employed on the project as well as the person's position and responsibilities within the project team. The Contractor shall provide the following minimum key staff:

- a. Contracts Manager
- b. Site Agent
- c. Quality Manager/Auditor/Controller
- d. Health and Safety Officer/s; and
- e. Foremen
- f. SMME supervisor

PS 6.13 Management Meetings

The Employer's Agent shall hold regular site meetings with representatives of the Contractor, and the Employer. Minutes of such site meetings shall be kept and distributed by the Employer's Agent. Senior Contractor management staff attendance shall be compulsory.

The Contractor shall be required to provide reporting with regard to project progress, resources (human, plant and equipment), community issues, environmental and health and safety aspects.

PS 6.14 Forms for Contract Administration

The Contractor shall maintain a file which shall contain project information related to project progress, resources (human, plant and equipment), community issues, environmental, health and safety aspects, penalties imposed, claims lodged and outcomes, disputes and resolutions, payment and variations.

Employer:		Contractor:	
Witness:		Witness:	

PS 6.15 Daily Records

In addition to records on rainfall and weather, labour, plant, and materials, a site diary, site instruction book (both in triplicate) and safety documents are to be provided and maintained by the Contractor on site and updated daily.

These shall be submitted to the Employer's Agent on completion of the contract.

PS 6.16 Bonds and Guarantees

The Contractor shall within the period stated in the Contract Specific Data, of this document, provide the Employer with a Surety Bond in the form of a Bank Guarantee, Bank Transfer or a Guarantee from an approved Insurance Company to the satisfaction of the Employer in the form included in the Tender Documents. The Bank Guarantee shall be for an amount equal to ten per cent (10%) of the Tender Sum, for the due and punctual fulfilment and completion of all the Contractor's obligations under the Contract. No Extension of Time or any variation of the Contract nor the termination of the Contract by the Employer in terms of GCC 2015 hereof shall in any way impair, diminish or terminate any liability to the Employer under and by virtue of such Surety Bond. The cost of the Surety Bond to be so entered into, shall be at the expense in all respects of the Contractor; the Surety Bond to be released upon issue of the Employer's Agent's Certificate of Completion of the Works, unless otherwise stated in the Contract Data.

Should the Contractor, when notified of the acceptance of his offer, fail to provide an approved Surety Bond within the stated period, then the Employer may, at his sole discretion:

- a. Grant the Contractor a further reasonable period in which to provide the bond; or
- b. Withdraw his acceptance of the tender, in which case the Contract shall be deemed to be void, but without prejudice to the Employer's rights to recover whatever damages he may have suffered by virtue of the Contractor's failure to fulfil his obligations.

PS 6.17 Payment Certificates

Monthly payment certificates shall be submitted by the Contractor in the format approved by the Employer's Agent. Once agreement has been reached with the Employer's Agent on the value of the certificate, the Contractor shall submit an original invoice on which payment will be made. The format will be discussed in the month preceding the first claim and will be resolved before the first payment is made.

Payment for particular items scheduled shall conform to the applicable payment clauses of the Pricing Data, Project Specifications and the Particular Specifications.

Where retention money is applicable to a Contract, the retention money shall be deducted on the invoice from the total amount for work done and then the

Employer:		Contractor:	
Witness:		Witness:	

Value Added Tax (VAT) added to calculate the total amount payable on the invoice.

If penalties are payable, they will be deducted prior to the addition of (VAT) but after the calculation of retention.

Tax invoices shall be submitted for each interim payment claim. The Contractor shall submit a provisional invoice with his payment claim as soon as possible after the date of measurement.

The tendered rates or sums shall cover the cost of drawings and instructions for anything not specially mentioned but obviously required, (e.g. all ancillaries, including all bolts, fastenings and brackets, safety guards and any work or material required for the proper installation of such equipment in complete working order), to enable the equipment as described to be installed and/or function safely and correctly as specified.

If any material on site is claimed, proof of ownership shall be provided, either by means of receipts, or by means of letters from the suppliers, stating that ownership has been transferred to the Contractor.

No claims whatever for extras will be allowed on the grounds that a necessary piece of equipment or a part thereof is not specifically mentioned in the Schedule of Quantities.

Payment for "supply and delivery", "install and commission", "servicing" and "tools and spares" is respectively defined in PS 3.2, PS 5.9.3, and PS 5.9.4.

Before becoming entitled to any of the above payments, the Contractor shall lodge with the Employer's Agent three copies of a detailed invoice showing the amount claimed as well as a claim form in triplicate complete by item as scheduled in a format approved by the Employer's Agent.

Payment Certificates shall be delivered to the Employer's Agent by the 15th of each month.

PS 6.18 Foreign Exchange Risk

The provision of forward cover against foreign exchange fluctuations on the imported content of all equipment required under the contract might be required. In his Tender, the Tenderer must state the value of the imported content of each item and the applicable currencies and the exchange rates on which his tender was based.

The successful Tenderer might be required to take out forward cover on all foreign exchange transactions required in his tender for this contract, the rate applied shall be that ruling at the date of commencement of the Contract that is stated in the Letter of Acceptance.

Amounts tendered will be adjusted for foreign exchange variations up to the date of commencement of the Contract; any fluctuations after this date will be for the Contractor's account.

Employer:		Contractor:	
Witness:		Witness:	

PS 7. FEATURES REQUIRING SPECIAL ATTENTION

PS 7.1 General Conditions of Contract (GCC)

The Contract Document is compiled in accordance with the General Conditions of Contract for Construction Works, Third Edition (2015) and Tenderers are therefore required to price the Tender accordingly.

PS 7.2 Security

Though the security of the Northern Wastewater Treatment Works is outsourced by JW to a security company, the Contractor shall make their own arrangements to secure the on-site facilities provided for the execution of the Contract. The Contractor's required security arrangements shall cover all their works, materials, plant and equipment and personnel. The Employer shall not be held responsible for any loss or damage suffered by the Contractor, his plant, equipment, materials, Sub-Contractor or employees as a result of a security incident of any nature.

PS 7.3 Operation of Valves

Only employees of Johannesburg Water SOC. are permitted to operate existing water valves.

Requests for isolation of any section of such reticulation shall be made to the relevant section of the local authority at least 4 working days in advance of the requirement for isolation. The Employer's Agent shall be advised of the requirement and will monitor the implementation of the request.

PS 7.4 Work Outside Normal Working Hours

The Contractor is permitted to work outside of normal working hours (07:00 to 17:00) only upon obtaining written permission from the Employer's Agent.

Should the Contractor choose to work outside normal working hours without having been ordered to do so by the Employer's Agent, permission will not be unreasonably denied but all additional costs arising out of such work shall be entirely to the Contractor's account.

PS 7.5 Contract Award

The Contract shall be awarded to one main Contractor. It is an explicit requirement of this Contract that the work of the various disciplines be executed by competent staff and/or Sub-contractors. The Contractor will be responsible for the coordination of his own work and that of any sub-contractors.

PS 7.6 Additional Meetings

The cost of all additional meetings or inspections over and above the normal that takes place because of the Contractor not keeping to his program or because of the quality of his work will be for the account of the Contractor and will be deducted from the following payment certificate. An amount of R

Employer:		Contractor:	
Witness:		Witness:	

5 000.00 per meeting will be paid by the Contractor to compensate for the travelling cost, time, etc. of both the Employer's Agent and the Employer.

PS 7.7 Community Liaison and Community Relations

For the purpose of this project, a community liaison officers will be required to inform the community regarding the Contractor's activities on this project.

PS 7.8 Sanitary Facilities

The Contractor shall provide his own sanitary facilities. See Clause 5.19 of the Occupational Health and Safety Specification forming part of Volume 2.

PS 7.9 Control of Manufacturing

The Contractor shall inform the Employer's Agent and the inspection authority timeously of his program and place of manufacturing so that the necessary inspections can be arranged for. Copies of all test records must be delivered to the Employer's Agent before a Certificate of Completion will be issued.

PS 7.10 Waterproofing

Where any work pierces waterproofing, installation shall be as approved. Supply all necessary sleeves, caulking and flashing required to make openings absolutely watertight. The cost of complying with these requirements shall be deemed to be included in the unit rates tendered for the items affecting the waterproofing.

PS 7.11 Local Labour

The Contractor's attention is drawn to Clause 1.4(d) of the Environmental Management Plan (Volume 2) regarding the preferential employment from local communities of labourers and where available skilled artisans.

The Contractor's shall pay Local Labour rates in accordance with the following:

GOVERNMENT GAZETTE, 17 December 2021, No. 45645. DEPARTMENT OF EMPLOYMENT AND LABOUR NO. R. 1605, LABOUR RELATIONS ACT, 1995, BARGAINING COUNCIL FOR THE CIVIL ENGINEERING INDUSTRY (BCCEI): RENEWAL OF PERIOD OF OPERATION OF THE WAGE AND TASK GRADE COLLECTIVE AGREEMENT. (OR SIMILAR BARGAINING COUNCIL THAT MAY BE RELEVANT TO THE SCOPE OF WORKS, FOR E.G. THE METAL AND ENGINEERING INDUSTRIES BARGAINING COUNCIL, OR THE NATIONAL BARGAINING COUNCIL FOR THE ELECTRICAL INDUSTRY SA, etc.)

and any subsequent update to the relevant Collective Bargaining Agreement, that may be gazetted by the Department of Employment and Labour or the Bargaining Council during the execution of this Contract.

It is expressly noted that the rates contained in the aforementioned Gazette or Collective Bargaining Agreement will apply to the Contractor or subcontractor(s) irrespective of whether the Contractor or subcontractor(s) is a member of the employer's organisations listed in the Gazette, or not.

Employer:		Contractor:	
Witness:		Witness:	

It is equally noted that the rates contained in the aforementioned Gazette or Collective Bargaining Agreement will apply to all employees employed for the purposes of executing the Contract (and specifically those defined as local labour) irrespective of whether those employees are members of the trade unions listed in the gazette, or not.

In the absence of a relevant Collective Bargaining Agreement, the labour rates as stipulated by the City of Johannesburg shall apply.

Skilled workers may only be brought in from outside the local communities if such personnel are not available locally.

The Contractor shall pursue a programme of recruitment and training of persons from the local communities. The Contractor shall carry out a training programme for the duration of the construction process for local staff employed or to be employed by him on the site. Apart from satisfying the immediate requirements for unskilled labour, the development of the proficiency of these staff in semi-skilled and skilled categories such as carpenters, drivers, clerks etc. is required.

Employment Contract(s) with persons from local communities shall be structured so that no Employment Contract(s) can be terminated between the period 1 November to 31 January in any year.

The contractor must provide Local Labour information on the required format in the monthly basis.

PS 7.12 Schedule of Quantities for Mechanical, Civil, Electrical & C&I Work

The schedules for the mechanical, civil, electrical, control and instrumentation works differentiate between the supply and delivery of equipment and the installation and commissioning thereof to avoid delays in payment after equipment has been supplied and to improve the Contractor's cash flow. The installation and commissioning items shall therefore not be paid for under materials on site.

It is an explicit requirement of the Contract that specialist contractors are approached for the mechanical, civil, electrical, control and instrumentation works.

PS 7.13 Certificate of Completion

The Certificate of Completion shall be issued after the successful trial operation of all equipment as described in PS 6.9 following the issuing of a Practical Certificate of Completion and the successful completion of any snag items listed in the Practical Certificate of Completion. The twelve months Defects Liability Period shall start on the date stated in the Certificate of Completion.

The retentions monies shall be certified as per Clause 6.10.3 of GCC-2015 and shall be reduced or returned to the Contractor after issuing of the Certificate of Completion and after the Defects Liability Period has elapsed. The Certificate of Completion shall not be issued until the documents required in terms of Contract have been lodged with and accepted as satisfactory by the Employer's Agent.

Employer:		Contractor:	
Witness:		Witness:	

The issuing of the Certificate of Completion could be delayed if the equipment supplied under this contract cannot be successfully trial operated in whole part, a practical completion as defined in Clause 1.1.1.24 of GCC-2015 will be issued conditional to the assessment by the Employer's Agent or Representative, If the issuing of the Certificate of Completion is delayed for reasons beyond the Contractor's control, the Contractor shall be compensated for their expenses because of the time delay between the completion of the works and the commissioning of the equipment. The rate tendered for the payment item for the postponement of the issuing of the Certificate of Completion must include for all the Contractor's expenses.

PS 7.14 Tools and Spares

As part of the equipment supplied, the Contractor shall supply all special tools or keys required for adjustment to any parts of such equipment. The Contractor shall supply such spares ordered by the Employer's Agent.

The cost of special tools and keys shall be covered by the tendered rate or price for the Supply Items of the relevant equipment.

Payment for spares and standard spanners and cabinet(s) shall be made out of the Prime Cost Sum allowed in the Schedule of Quantities for such items. The Contractor's profit, administration and delivery charges shall be paid at the tendered percentage of the actual purchase price of the goods.

PS 7.15 Electrical, C&I, Mechanical and Civil Requirements for as built drawings

All duly signed As-Built Drawings are to be submitted in a transparent plastic format as per the below specification;

Transparent plastic specification for 914 mm x 45 m rolls.

Type: Hydromat 08.

Transparencies may be submitted in size A1 provided they are legible. It is permissible to submit transparencies in size A0 if that is the size of the original. Electronic copies of all duly signed drawings are to be submitted in Auto CAD and PDF formats on a USB flashdrive.

In addition to the above a bound volume in A3 paper prints of all Electrical drawings are to be supplied.

PS 7.16 Abbreviations

Wherever abbreviations for published national Standard Specifications or named Standard Specifications are used, they shall be deemed to refer to the latest edition of the Specification concerned, including all amendments, published 30 days before the closing date for receipt of tenders. Typical abbreviations are: -

ASTM : American Society for Testing Materials
BS : British Standard
BSCP : British Standard Code of Practice
SANS : South African National Standards
SIS : Standards Institute Sweden

Employer:		Contractor:	
Witness:		Witness:	

PS 7.17 IEC : International Electrotechnical Commission
Metric Symbols

Symbols prescribed by the System Internationale (SI) are used in these Specifications.

PS 7.18 **Definitions**

OHS ACT: Occupational Health and Safety Act, 1993 (Act 85 of 1993), as amended and including any regulations made thereunder.

PS 7.19 **SANS Standard**

All materials used and the standards of workmanship employed for the execution of the Works shall comply with the appropriate SANS Standard and or Code and if they do not carry the SANS mark, the Contractor shall obtain a certificate from SANS stating that the items comply with the appropriate SANS standard.

PS 7.20 **Installation of Equipment**

A skilled erector shall be in charge of the work at all times and any instructions and explanations which the Employer's Agent shall give to him, shall be deemed to have given the Contractor.

The work shall be neat and workmanlike true to line and level, plumb and in proper working order.

Where any item of plant is mounted on a frame or bed plate, packers of 10 mm minimum thickness machined to size shall be provided and fitted by the Contractor to ensure accurate alignment.

Where required to correct alignment, all mounted units shall be shimmed with non-corrosive metal shims. Shims shall be the shape and size as the contact area of the parts and slotted so that the shims can be removed without removing the mounted bolts.

All cut edges shall be without burrs. Shims with wrinkles in the material shall not be permitted.

Only small lugs shall protrude after completion.

All equipment shall be properly assembled and mounted to avoid the setting up of initial stresses in the materials and to ensure perfectly free running of all moving parts.

PS 8. HEALTH AND SAFETY SPECIFICATION FOR CONSTRUCTION WORK

Contractors are to prepare Health and Safety Plans in accordance with Johannesburg Water's Health and Safety Specification (refer to Volume 4: Occupational Health and Safety Specification and Environmental Management Plan for Capital Investment Projects). The legal imperatives for this requirement stem from the Construction Regulations (2014), and more specifically the following:

Employer:		Contractor:	
Witness:		Witness:	

- Regulation 4(1)(a):** An Employer shall prepare a documented health and safety specification for the construction work, and provide any principal Contractor who is making a bid or appointed to perform construction work for the Employer with the same.
- Regulation 4(1)(d):** An Employer shall take reasonable steps to ensure that each principal contractor's health and safety plan is implemented and maintained on the construction site.
- Regulation 4(2):** An Employer shall discuss and negotiate with the principal Contractor the contents of the health and safety plan and thereafter finally approve the health and safety plan for implementation.
- Regulation 5(1):** A principal Contractor shall provide and demonstrate to the Employer a suitable and sufficiently documented health and safety plan, based on the Employer's documented health and safety specification.
- Regulation 5(1)(a):** A client shall prepare a baseline risk assessment for an intended construction work project.
- Regulation 5(1)(b):** A client shall prepare a suitable, sufficiently documented and coherent site-specific health and safety specification for the intended construction work based on the baseline risk assessment contemplated in regulation 5(1)(a).
- Regulation 5(1)(l):** A client shall discuss and negotiate with the principle contractor the contents of the principle contractor's health and safety plan contemplated in regulation 7(1), and must thereafter finally approve that plan for implementation.
- Regulation 5(1)(n):** A client shall take reasonable steps to ensure that each contractor's health and safety plan contemplated in regulation 7(1)(a) is implemented and maintained.
- Regulation 7(1)(a):** A principal contractor must provide and demonstrate to the client a suitable, sufficiently documented and coherent site specific health and safety plan, based on the client's documented health and safety specifications contemplated in regulation 5(1)(b), which plan must be applied from the date of commencement of and for the duration of the construction work and which must be reviewed and updated by the principal contractor as work progresses.

PS 8.1 Project-related Occupational Health and Safety Risks

According to the Construction Regulations (2014), a Health and Safety Plan "means a site, activity or project specific documented plan in accordance with the client's health and safety specification". Apart from complying with the Health and Safety Specification (Volume 2), specific attention is drawn to the

Employer:		Contractor:	
Witness:		Witness:	

identification and assessment of risks. The tendering Contractors are required to consider inter alia the following risks (where applicable):

- Excavation and safeguarding of trenches
- Collapse of the excavation walls
- Workers or onlookers falling into the excavations
- Safeguarding of deep excavations
- Working in elevated positions
- Scaffolding
- Traffic control (heavy machinery)
- Plant and machinery operation
- Working around heavy machinery
- Existing services
- Offloading of material
- Electrical Distribution boards
- Electrical Installation
- Making of steel items
- Laying of pipes
- Placing concrete
- Machine operator
- Third party exposures
- Use of portable electrical tools
- Location of site camp
- Storage and handling of material
- Storage of hazardous material
- Fire prevention and protection
- Refuelling vehicles/plant
- Welding
- Handling of compressed gas cylinders

Safe work and emergency procedures need to be prepared to address the abovementioned risks.

PS 8.2 Guide to Risk Assessments

Employer:		Contractor:	
Witness:		Witness:	

PS 8.2.1 Nine steps to Effective Risk Assessments

- Step 1** Identifying the current as well as emerging hazard, risks or exposures.
- Step 2** Aim to identify major hazards, don't waste time on the minor and detail except if such hazard has the potential be repeat itself on a frequent basis.
- Step 3** Involve as many people as possible in the ongoing risk assessment process especially those at risk.
- Step 4** Gather all the information and analyse it.
- Step 5** Look at what actually could or has occurred including non-routine operations.
- Step 6** Use a systematic approach to ensure all hazards are adequately addressed.
- Step 7** Assess the risks identified or the risk has occurred by taking into account the effectiveness of current as well as controls under consideration.
- Step 8** Ensure the process is practical, realistic, cost and business effective.
- Step 9** Always record the assessment in writing including i.e. assumptions, date and why a particular decision has been made.

PS 8.2.2 How serious is it?

Probability		Consequences
A	Common	1 Fatality or permanent disability.
B	Has Happened	2 Major injury.
C	Could Happen	3 Average Lost Time Injury.
D	Not Likely	4 Minor Injury.
E	Practically impossible	5 Medical Treatment or less.

		Probability				
		A	B	C	D	E
Consequence	1	1	2	3	4	5
	2	2	3	4	5	6
	3	3	4	5	6	7
	4	4	5	6	7	8
	5	5	6	7	8	9
Risk rating		Action				
1 - 3 = Serious		Immediate (within 1 week).				

Employer:		Contractor:	
Witness:		Witness:	

4 - 5 =	High	Within 1 month.
6 - 7 =	Moderate	> 4 weeks.
8 - 9 =	Acceptable	No action but will consider from time to time.

Employer:		Contractor:	
Witness:		Witness:	

PS 9. ENVIRONMENTAL MANAGEMENT PLAN

Tendering Contractors are to adhere to the mitigation measures listed in the Environmental Management Plan (EMP) (refer to Volume 3: Occupational Health and Safety Specification and Environmental Management Plan as well as Environmental Management Programme). Environmental mitigation measures are actions needed to align a project implementation phase with environmental control principles, where potential impacts to the natural and social environment are prevented, minimised or remediated. Environmental safeguarding is governed by various sets of legislation, with the most noteworthy for this project constituting the National Environmental Management Act (No. 107 of 1998) and the National Water Act (No. 36 of 1998).

Cost incurred due to the above shall be included in the scheduled rates in the Pricing Data.

PS 10. HEALTH AND SAFETY AGENT AND ENVIRONMENTAL CONSULTANT

The contact details for the Health and Safety Agent and for the Environmental Consultant are:

Health & Safety Agent	Environmental Consultant
Company: Johannesburg Water SOC	Company: Johannesburg Water SOC
Name: Mpho Mosia	Name: Joyce Ngobele
Contact details: 011 688 1476	Contact details: 011 688 1443

PS 11. GENERAL SECTION PAYMENT LIMITATION

The gross sum of items 8.3 and 8.4, as per SANS 1200A, may not exceed 15% of the total contract amount excluding contingencies and VAT. If the amount tendered for these items exceeds the above, the tender will be altered to the reduced amount by reducing these specific items.

PS 12. EMPLOYMENT OF LABOUR

The Contractor shall make every effort to employ staff from the local communities within the Johannesburg Metropolitan Area. Skilled workers may only be brought in from outside the local communities if such personnel are not available locally. The Contractor shall pursue a programme of recruitment and training of persons from the local communities, through either the CLO and/or LDO. The Contractor shall carry out a training programme for the duration of the construction process for local staff employed or to be employed by him on the site. Apart from satisfying the immediate requirements for unskilled labour, the development of the proficiency of these staff in semi-skilled and skilled categories such as carpenters, steel fixers, shutter hands, drivers, clerks etc. is

Employer:		Contractor:	
Witness:		Witness:	

required. The minimum total number of man days of work provided to the community, local to the construction site, shall be 45 000 for the contract.

The contractor must report on local labour employment as well as SMME employment in the required format on a monthly basis. This information must accompany monthly Payment Certificates, and if not provided, Payment Certificates will not be processed for payment.

PS 12.1 Interpretations

PS 12.1.1 Supporting documents

The Tendered Rules, Conditions of Contract, Standard, Supplementary and Specific Specifications and Construction Specifications and drawings shall inter alia be read in conjunction with this specification.

PS 12.2 Application

The provisions of this specification shall apply in respect of all workers and small, medium and micro enterprises other than the Contractor's key personnel, who are engaged on the execution of the works.

PS 12.3 Community Liaison Officer / Labour Desk Officer

The Project Steering Committee will identify a Community Liaison Officer (CLO) and/or Labour Desk Officer (LDO) to act as a liaison between the Contractor and the community. The CLO / LDO will, amongst other things, ensure that the employment of local labour proceeds smoothly.

All decisions regarding identification and hiring of labour, relieving labour of their duties, local problems and any other matters of local importance related to the Contract, will be made in consultation with the CLO / LDO.

PS 12.4 Appointment, Office and Replacement of CLO

The CLO will be appointed for the duration of the construction phase of this Contract.

The CLO will occupy his own office in the Contractor's camp from where he will fulfil his duties to identify, screen and nominate labour from the community in accordance with the Contractor's requirements.

The CLO will communicate with the Contractor daily regarding labour requirements.

Should it become apparent that the appointed CLO fails to meet his duties, he may be relieved from his duties and replaced by a new CLO in consultation and approval with the Employer's Agent.

PS 12.5 Duties of the CLO

- They will be available on site daily between the hours of 07:30 and 18:30, and at other times as the need arises.
- They will consult with the Contractor and the Employer's Agent daily to determine the labour requirements regarding number and skills, to identify possible labour disputes, and to inform local labourers timeously when they will be relieved.

Employer:		Contractor:	
Witness:		Witness:	

- They will be responsible for screening of candidates, informing them of their conditions of temporary employment and to ensuring their timeous availability.
- They will ensure that all workers who are involved in activities where productivity rates have been agreed, are fully informed regarding the expected level of productivity for the given tasks to be assigned as part of this Contract.
- They will attend disciplinary proceedings to ascertain that hearings are fair and reasonable.
- In consultation with the Contractor, They will determine the needs of the local labour for relevant technical training, and will be responsible for the identification of suitable trainees. They will also be required to attend some of the training sessions.
- They will keep a daily written record of his interviews and community liaison.
- They will attend the monthly Contractual site meetings to report about the local community labour involvement as well as any other relevant issues that need attention.
- They will act as a liaison officer between the Contractors on site and the local community through the project committee.
- They will be involved in all SMME related matters (Contracts, terminations etc.)

PS 12.6 Rates of Compensation

The Contractor's attention is drawn to Clause 1.4(d) of the Environmental Management Plan (Volume 2) regarding the preferential employment from local communities of labourers and where available skilled artisans.

The Contractor's shall pay Local Labour rates in accordance with the following:

GOVERNMENT GAZETTE, 17 December 2021, No. 45645. DEPARTMENT OF EMPLOYMENT AND LABOUR NO. R. 1605, LABOUR RELATIONS ACT, 1995, BARGAINING COUNCIL FOR THE CIVIL ENGINEERING INDUSTRY (BCCEI): RENEWAL OF PERIOD OF OPERATION OF THE WAGE AND TASK GRADE COLLECTIVE AGREEMENT (OR SIMILAR BARGAINING COUNCIL THAT MAY BE RELEVANT TO THE SCOPE OF WORKS, FOR E.G. THE METAL AND ENGINEERING INDUSTRIES BARGAINING COUNCIL, OR THE NATIONAL BARGAINING COUNCIL FOR THE ELECTRICAL INDUSTRY SA, etc.)

and any subsequent update to the relevant Collective Bargaining Agreement, that may be gazetted by the Department of Employment and Labour or Bargaining Council during the execution of this Contract.

It is expressly noted that the rates contained in the aforementioned Gazette or Collective Bargaining Agreement will apply to the Contractor or subcontractor(s) irrespective of whether the Contractor or subcontractor(s) is a member of the employer's organisations listed in the Bargaining Council, or not. It is equally noted that the rates contained in the aforementioned Gazette

Employer:		Contractor:	
Witness:		Witness:	

or Collective Bargaining Agreement will apply to all employees employed for the purposes of executing the Contract (and specifically those defined as local labour) irrespective of whether those employees are members of the trade unions listed in the gazette, or not.

In the absence of a relevant Collective Bargaining Agreement, the labour rates as stipulated by the City of Johannesburg shall apply.

PS 12.7 Scheduled Item

PS.12.7.1a Community Liaison Officers / Labour Desk Officer Unit: Provisional Sum

The tendered sum shall include full compensation for the provisions of the CLO /LDO including salary (market related), provision of an office, transport costs, the cost of typing, printing and distributing notices, and for all other obligations to perform their job.

Employer:		Contractor:	
Witness:		Witness:	

PORTION 2 : PROJECT SPECIFICATION FOR CIVIL WORKS

PSCE 1. INTRODUCTION

The detailed specific requirements for Civil Scope of Works to be carried out at the Johannesburg Water's NWWTW for the Dewatering Building Belt Press Replacement and Associated Ancillaries is as provided below:

PSCE 2. CIVIL SCOPE OF WORKS

The scope of work under this project will be executed on a live, operational plant and the Contractor must therefore take cognisance of this fact when compiling the Occupational Health and Safety Plan and shall accommodate appropriate working procedures. It is considered essential that the final effluent licenced quality shall take precedence over the Contractor's rate of progress when performing the work and the Contractor shall in the construction programme make adequate allowance, therefore.

The scope of work under this project shall be read in conjunction with the drawings listed in section PS.2.2 of this document outlining the Employer's layout requirements. The Civil works to be carried out under this Contract shall include, but not limited, to the following:

PSCE 2.1. General Civil Engineering Requirements

- The Civil Engineering portion of works designed by the Employer Agent are as provided Contract Drawings and the Contractor shall execute the project Scope of Works with reference to the provided drawings, unless otherwise indicated by the Employer's Agent.
- The Contractor shall provide the Employer's Agent with all the necessary information to allow the Employer's Agent to amend tender drawings to construction status. The information required shall include;
 - o A general arrangement drawing which clearly illustrates the footprint and orientation of the equipment specified in the respective Datasheet and the project specification.
 - o The Tenderer shall clearly indicate in the Datasheet should there be any special structural and/or civil requirements needed to be allowed for by the Employer Agents in the proposed Tender drawings provided in Volume 4 for the offered or specified units.
- The Tenderer shall take note of construction sequence for civil structures with associated changeover between the old existing services to the new structures. The cable trenches and ducts shall be constructed in a manner that does not allow any water seepage.

PSCE 2.2. Erection, Setting-Out and Service Identification

The Contractor's erection staff shall arrive at the Site on dates to be agreed by the Employer's Agent. Before they proceed to Site, the Contractor shall satisfy

Employer:		Contractor:	
Witness:		Witness:	

themselves that sufficient items have arrived on Site so that no delay will be incurred on this account.

The Contractor shall be responsible for setting up, service identification and erecting the Plant to the line and level required and shall ensure that, where items are to be built-in, they are kept in position whilst being built in.

The Contractor will shall be required to identify all existing services within the construction servitude and set out the work as required. Identification of existing services shall be carried out in the presence of the Employer's Agent or Representative prior to construction commencement as per the approved construction programme.

PSCE 2.3. Demolition of Structures

The demolition scope shall include the following;

- Existing MCC building for the four (4) Set C Belt Presses located next to the wash water supply pumps in the North-East section of the Dewatering Building;
- Existing MCC building for the six (6) Set A Belt Presses located at the far North West corner section of the Dewatering Building;
- Existing plinth and bund wall for the four (4) Set C Belt Presses;
- Existing brick wall located between the existing four (4) Set C Belt Presses and the four (4) existing Set B Belt Presses;
- Breaking of the concrete floor to construct support plinths for the ten (10) new Belt Presses;
- Breaking of the existing wash water pump plinths;
- Existing sludge valve bank for the four (4) Set C Belt Presses and the redundant equipment concrete bases as indicated on JW14060R-ME-001 & JW14060R-ME 002; and
- Any other areas as identified with the Employer's Agent or Representative during construction.

PSCE 2.4. New MCC Building for the six (6) Set A Belt Presses -(JW14060R-CE-001 & JW14060R-CE-002)

The construction of the New MCC "A" building includes;

- Site clearance, excavation and preparation to build a 12x8 m MCC building,
- Reinforced concrete foundation and brick cable trenches;
- Superstructure comprising of face brick walls, ventilation louvres, fire walls and doors, as per specified requirements.
- Angle pitch concrete roof with derbigum waterproofing,

Employer:		Contractor:	
Witness:		Witness:	

- Concrete apron slab around the MCC building and access ramps to the building doors,
- Fixing the interlocking paving around the MCC Building apron slab,
- Storm water drainage within dewatering building and around the MCC building,
- Supply and Installation of Standard 1.2m for a (x1) single and (x1) door access frame and Jamb combination type DV with full louvres as per JW14060R-STD-001 typical details,
- Supply and installation of a 6mm thick hot dipped galvanised kicker plates "vas-trap" to close of the open cable trenches in the building with 50x50x6mm angle iron installed on the edges of the cable trenches,
- Supply and installation of safety signs for MCC buildings as per detail drawings in accordance with SANS 1186
- Slip Joint between brickwork and underside roof slab, 2 layers 3 ply asphaltic waterproofing membrane over 2 mm thick tempered Masonite over smooth mortar bed (Typical see "Detail 2" on JW14060R-CE-001 & 2).

PSCE 2.5. New MCC Building for Belt Presses Set C with Solar Battery Room

The construction of the New MCC "C" with Solar Battery Room as per JW14060R-CE-003 & JW14060R-CE-004 and shall include;

- Site clearance, excavation and preparation to build a 10x6 m MCC and a 4x3 m Solar Battery Room,
- Reinforced concrete foundation and brick wall cable trenches;
- Superstructure comprising of face brick walls, ventilation louvres, fire walls and doors, as per specified requirements.
- Slopped concrete roof with derbigum waterproofing with a 3mm thick standard flashing between the Dewatering Building cladding or sheeting and the MCC roof.
- Concrete apron slab around the MCC building and access ramps to the building doors,
- Fixing the interlocking paving around the MCC Building apron slab,
- Storm water drainage within and outside the MCC building,
- Supply and Installation of Standard 1.2 m for a (x2) single and (x1) double door access frame epoxy coated mild steel door and Jamb combination type DV with full louvres (2mm steel plate riveted to inside face of louvres) as per JW14060R-STD-001 typical details,
- The access door for the Solar Battery Room shall be through the electronic access provisions and specification made under the electrical scope of works.

Employer:		Contractor:	
Witness:		Witness:	

- Supply and installation of a 6 mm thick hot dipped galvanised kicker plates “vas-trap” to close of the open cable trenches in the building with 50x50x6 mm angle iron installed on the edges of the cable trenches,
- Supply and installation of safety signs for MCC buildings as per SANS 1186 as per the identified risk associated with the installed equipment.
- Slip Joint between brickwork and underside roof slab, 2 layers 3 ply asphaltic waterproofing membrane over 2 mm thick tempered Masonite over smooth mortar bed (for Typical Details see "Detail 2" on drawing JW14060R-CE-003 & 4).

PSCE 2.6. General Civil associated Scope of Works

The general work to be carried out under this Contract comprises inter alia, of the following:

- The rehabilitation works related to the following;
 - o Dewatering Building,
 - o Wash Water Reservoir (DAF East and West tanks)
 - o Unit 3 Chlorine Contact Chamber wash water transfer pump station
 - o Unit 3 Substation 1
 - o Unit 3 Chlorine Contact Chamber bypass channel final effluent channel civil configuration for bypass pump installation.
- Construction of Belt Press plinths and bund walls as per JW14060R-ME-006 & JW14060R-ME-007.
 - o Construction of the bund walls and equipment plinths shown in drawings JW14060R-CE-005, JW14060R-CE-006 & JW14060R-CE-007 for the associated mechanical equipment.
- Fabrication, supply and installation of hot dipped Galvanised – working platform as per drawing JW14060R-STD-002 and the relevant layout drawings associated with the following;
 - o 152x152x23 H steel section for the x4 Belt Press support legs.
 - o Extension chute of the Belt Press discharge chute supports from 50x50x6mm angle iron.
 - o Access stairs, handrails and walkway for to all x10 New Belt Presses as per drawings JW14060R-ME-001 & JW14060R-ME-002,
 - o Access cat ladder, walkway, handrails, and mixer support for the New Polyelectrolyte holding tank as per drawing JW14060R-ME-005,
 - o Access stairs, handrails and walkway to the pipework and equipment as per drawing JW14060R-ME-003, JW14060R-ME-004 and JW14060R-ME-008
 - o Supply of pipework supports as per the details as per drawings JW14060R-ME-008 & JW14060R-ME-009.

Employer:		Contractor:	
Witness:		Witness:	

- o Dewatering Building sliding manual sliding doors with the typical details as per drawing JW14060R-STD-001 and the existing plant door specification on site.
- Supply and installation of Louvre Panels retrofitted into Building sheeting Louvre panel Type NLD size 800 x 500mm.
- Supply and install fasteners, and re-bolting of the existing Sheeting to the existing dewatering building in accordance with project specification with replacement of cladding and sheeting as identified with the Employer's Agent or Representative that is damaged.
- Strip and quote for refurbishment of the existing crawl beams and re-install as per drawing JW14060R-CE-008 & JW14060R-CE-009.

PSCE 3. VARIATIONS & ADDITIONS TO SANS STANDARD SPECIFICATIONS AND MEASUREMENT & PAYMENTS

This Contract, JW14060RR, is based on the SANS 1200 series standard specifications listed on PS 5.1PS 5.1.3 above. In this section, allowance for amendment has been made to the SANS specification to include in the project specification alternative material, methods of construction and/or additional requirements specified to suit this particular contract.

The number of each clause and each payment item consist of a prefix PS followed by a number corresponding to the relevant clause or payment item in the SANS standard specification.

SANS 1200A: CIVIL ENGINEERING CONSTRUCTION: PRELIMINARY AND GENERAL

This portion of the specification covers variations and additions to the SANS 1200 Standardised Specifications. The clause numbers hereunder consist of a prefix, such as "PSA" indicating an amendment to SANS 1200 A and a number that represents the number of the clause in SANS 1200.

(REFER SANS 1921-1 CLAUSE 4.14)

Add the following before the first paragraph:

The Contractor's construction camp shall be fenced off and shall contain all offices, stores, workshops, testing laboratories, accommodation, toilet facilities etc. The location of the camp shall be subject to approval by the Employer's Agent.

Add to the Sub-Clause:

Neither housing nor shelters are available for the Contractor's employees, and the Contractor shall make their own arrangements to house their employees and transport them to site.

The Employer will place an area of ground at the disposal of the Contractor. The temporary facilities and ablution facilities shall comply with the requirements of the Local Authority.

Employer:		Contractor:	
Witness:		Witness:	

On completion of the Works or as soon as the Contractor's facilities are no longer required the Contractor shall remove such facilities and clear away all surface indications of their presence unless specified to the contrary elsewhere. The site is to be rehabilitated as described elsewhere.

PSA 3 MATERIALS

PSA 3.1 Quality

Add the following to this sub-clause:

No used or recycled material may be used in the Works unless expressly authorized by the Employer's Agent.

Materials specified as being to the approval of a Standards Bureau shall bear the official mark of the appropriate standard.

Samples of concrete aggregates and pipe bedding material are to be delivered and tested at an approved laboratory.

Alternative materials or equipment proposed by the Contractor shall be tested. The test, as well as the materials or equipment, shall be approved by the Employer's Agent prior to any such materials or equipment being built into the works and all costs involved in testing shall be deemed to be included in the rates tendered.

PSA 3.3 Ordering of Material

The quantities set out in the Schedule of Quantities have been carefully determined from calculations based on data available at the time and should therefore be considered to be only approximate quantities. The Contractor shall, before ordering materials of any kind, check with the Employer's Agent whether or not the scope of work for which the materials are required, is likely to change substantially. No liability or responsibility whatsoever shall be attached to the Employer for materials ordered by the Contractor except when ordered in accordance with the confirmation issued by the Employer's Agent.

PSA 3.4 Name Boards

The numbers of name boards noted in the Bill of Quantities are to be provided under this contract.

No other name boards other than stated above shall be allowed. The Contractor shall erect the name boards at locations indicated by the while establishing himself on Site, but not later than 14 days after the start of the Contract.

The name boards shall comply with the requirements as stipulated by the Employer's Agent.

On completion of the works, the Contractor shall obliterate all particulars on the name board and remove the board from the site, prior to the release of retention money.

Employer:		Contractor:	
Witness:		Witness:	

PSA 3.5 Site Office

Replace this Sub-Clause with the following:

PSA 3.5.1 Specification for Office & Meeting Room Furniture

In addition to the furniture supplied by the Employer, the following items shall be provided under this Contract:

- a. One (1) office desk each with a surface area of at least 1.5m² with lockable drawers with keys.
- b. One (1) drawing rack for A0 drawings. The hangers shall be of the "Barhold" type with ten hangers per drawing rack.
- c. One (1) drawing table with an inclined surface area of at least 3m² and a smooth top constructed to the dimensions as directed by the Employer's Agent's Representative.
- d. Two (2) sturdy and comfortable chairs fitted with padded seats and backrests.
- e. Venetian blinds or roller blinds, opaque type fitted to all the Employer's Agent's offices.
- f. One (1) large meeting table to accommodate approximately 15 people.
- g. Fifteen (15) plastic chairs with metal frames; and
- h. One (1) plastic rubbish bin.
- i. Laptop with the following minimum specifications: Core I5-1135G7 processor, 8 Gig DDR4 RAM, 500GB SSD hard drive, 19.5 inch external monitor, security cable, carry case, mouse and Windows 10 operating system, Microsoft Office Business Suite 2019 and 20 Gigs of Data.
- j. Software – One (1) Microsoft Office Business Suite 2010 (Word, Excel, Outlook, Powerpoint), One (1) Autocad 2021, One (1) Civil 3d 2021, three (3) MS Project 2010 and Four (4) Voloview (drawing viewer).

PSA 3.5.2 Employer's Agent's Meeting Room and Employer's Office

The Contractor shall provide one prefabricated site meeting room and one office similar to the existing meeting room and offices of approved dimensions with at least 35m² in floor area for the meeting room and 18m² in floor area for the Employer's Office. The rooms shall be completed, furnished and ready for use not later than three weeks after the commencement date of the Contract.

The timber floor of the office shall be at least 300mm above the surrounding ground level. Doors shall be provided at each end of the meeting room and each shall be provided with a suitable 3 lever lock and two keys.

Windows shall be provided, with a minimum glazed area of 15% of the floor area. At least half of this area must be able to open and shall be fitted with burglar bars and all the windows shall be fitted with venetian or other approved blinds.

The meeting room will be equipped with furniture supplied under PSAB 3.2.1.

Employer:		Contractor:	
Witness:		Witness:	

Two (2) air conditioning units shall be supplied with the meeting room with capacity for the air volume of the room as per PSAB 3.2.6 and one (1) air conditioning unit shall be supplied for the Employer's Office.

Adequate electric fluorescent lighting and four (4) 15-amp power points.

PSA 3.5.3 Car Ports

Carports shall be so constructed as to protect the vehicles parked under them at all times against rain, hail and sun. Shade netting will not be permitted for the carports. Preference is for corrugated iron sheeting for the roof and sides. The carports shall each be at least 15 m² in area and their floors shall consist of a layer of broken stone or concrete to minimise dusty and muddy conditions. **Five** car ports are required.

PSA 3.5.4 Areas Surrounding Offices

The access and other roads and parking areas surrounding the existing offices shall be treated and maintained to make them dust free either by using crushed stone or bituminous surfacing. They shall be well drained and kept trafficable and free from mud and weeds at all times. They shall also be maintained and kept clean and tidy at all times.

PSA 3.5.5 Air-conditioning Units and Heaters

The Contractor shall provide and install air-conditioning units and heaters as specified. The air-conditioning units shall be electrically operated compressor type with closed circuit, and not an evaporation type. The capacity of the air-conditioning units shall be at least 2,2 kW. The heaters shall preferably be of the space-heating type without exposed elements and shall have a capacity of not less than 1,5 kW.

PSA 3.5.6 Ablution units

Ablution facilities for the sole use of the Employer's Agent's staff and visitors must be provided.

PSA 3.6 Services

PSA 3.6.1 Sanitary arrangements

The Contractor shall be responsible for providing all sanitary services on the site.

The Contractor shall also make provision for the removal of all domestic rubbish on a regular basis.

PSA 3.6.2 Water and Electricity

The Contractor shall provide a constant supply of clean potable water suitable for human consumption.

The cost of all water & electricity required for the Employer's Agent's purposes shall be borne by the Contractor. All buildings supplied shall include the provision of 220 V electricity.

Employer:		Contractor:	
Witness:		Witness:	

PSA 3.6.3 Maintenance

The Contractor shall provide all labour, equipment and material which may be necessary to keep all accommodation in a neat and clean condition, and repairs shall be done without undue delay.

PSA 3.7 General

- a. The Contractor shall not order any materials, equipment or fittings on the basis of their having been specified or scheduled without the written confirmation of the Employer's Agent having been obtained. No building shall be erected without the Employer's Agent's written instructions as to the exact position and orientation of the building.
- b. Unless otherwise agreed upon, the meeting room shall be erected in close proximity to the Employer's Agent's offices.
- c. The required facilities shall be completed, ready for occupation as specified, not later than three (3) weeks after the commencement date of the contract.
- d. The ownership of the meeting room and Employer's Office shall remain the property of the Employer at the end of the Contract.
- e. The ownership of the furniture in PSAB 3.2.1 and PSAB 3.2.3 shall remain the property of the Employer.
- f. The Contractor shall take all reasonable precautions to prevent unauthorised entry to the offices and to ensure the general security of the offices and meeting rooms.
- g. No accommodation shall be erected without the prior approval of the Drawings by all local or Government authorities requiring such prior approval.

PSA 4 Plant

PSA 4.2 Contractor's Offices, Stores and Services

Add the following:

The Contractor shall make the necessary arrangements with the relevant authority for the provision of services such as telephone and water for domestic and/or construction purposes.

The electrical wiring of all buildings shall be carried out by registered and licensed electricians in accordance with the requirements of SANS 0142 and the regulations of the local authority.

The Contractor shall not be obliged to make use of local water and electricity services and shall be at liberty to obtain them from approved alternative sources.

Should the Contractor make use of local services, he shall make arrangements, where applicable, for connections to be made, complete with meters, from

Employer:		Contractor:	
Witness:		Witness:	

these services for use at the Site. All costs incurred in respect of these connections and the meters, pipes, cables, etc. from the connections to his facilities, the cost of the water consumed, the cost of the removal of sewage (not chemical toilets), and the cost for finally disconnecting and removing the services shall be paid by the Contractor, who shall include full compensation for such costs in his tendered rates for the various items of work requiring the use of one or more of the services. The Contractor shall furnish the Employer's Agent with documentary proof that proper notice has been given to the relevant authority for termination of the services.

The Contractor's camp shall be kept neat and clean at all times and all surplus or rejected material shall be removed from site immediately.

The Contractor under this Contract shall supply his own distribution board for distributing the power to his facilities. He shall be responsible for distribution of power and water supply to other mechanical and electrical Contractors on the Site. Payment for these services to other Contractors shall be arranged between the Contractor under this Contract and the other Contractors. The Employer will not be involved in any arrangements in this regard.

The Contractor shall deliver to the Employer's Agent a detailed drawing of the proposed layout of his offices, stores and services before erecting same.

Sufficient backup services shall be provided to ensure the uninterrupted execution of the Works such as storage tanks for water for use in the mixing of concrete, standby electrical power for work at night and for electrical plant and equipment used on Site.

PSA 4.3 Plant and Equipment

Add the following to this sub-clause:

The Contractor is required to provide all plant and materials necessary to carry out the works as required. No additional allowances other than those already specified in the Bill of Quantities shall be allowed for with respect to plant and materials.

Add the following to this sub-clause:

The Contractor is required to provide all equipment necessary to carry out the works as required. No additional allowances other than those already specified in the Bill of Quantities shall be allowed for with respect to equipment.

Construction equipment shall be suited for the onsite intended use and shall comply with all relevant safety aspects required by the OHS Act.

PSA 5 Construction

PSA 5.1.1 Setting Out of the Works

Delete this sub-clause and replace with the following:

The Contractor shall set out the works and maintain their correct position, not only according to the Contract Documents but also according to any drawings

Employer:		Contractor:	
Witness:		Witness:	

or orders that he may receive from time to time from the Employer's Agent. The Contractor shall:

- a. be held responsible for the accuracy of the setting out for the full period of the Contract.
- b. use equipment and instruments that can ensure the necessary accuracy.
- c. be held responsible for the correction of any error at his own expense and
- d. update the plans, which are kept on site so that all the changes approved by the Employer's Agent are reflected on the drawings. These drawings will represent record drawings and must consequently reflect the Works as they are actually built. The cost for this shall be deemed to have been included in all works construction rates. The Contractor must check drawings periodically and after completion of the Contract they shall be handed over to the Employer's Agent.
- e. confirm the levels and coordinates of all benchmarks prior to commencing with construction.

PSA 5.1.3 Alterations, Additions, Extensions and Modifications to Existing Works

The Contractor is required to verify the accuracy of all drawings and levels provided by the Employer's Agent prior to commencing with any construction activities.

Where the Works require that alterations, additions, extensions and / or modifications be carried out to existing works or facilities, these shall be carried out strictly in accordance with the requirements of the relevant authorities.

PSA 5.4 Protection of Overhead and Underground Services

Add the following:

Timely written notice shall be given by the Contractor to the Employer's Agent and to the authority or department concerned of the Contractor's intention to work across or near any existing works or services and such work shall not commence until the necessary permission has been received. The Contractor will not be entitled to claim for any delay in the construction programme caused by compliance with the requirements of this clause. Work across or near any existing works or services shall be carried out in compliance with the requirements of the relevant authority or department.

Whilst every effort will be made to ensure that any information relating to underground services is correct, the Employer and Employer's Agent takes no responsibility for the accuracy, or for the completeness of the information. The Contractor will be held responsible for any damage to services and shall be liable for the cost of making good the damage. All such costs incurred by the Employer will be deducted from monies due to the Contractor.

Manhole covers; valve boxes, hydrants, etc. shall not be covered over and shall be accessible at all times.

Employer:		Contractor:	
Witness:		Witness:	

After an existing service has been passed in laying the service pipe, but before backfilling has been started, the Employer's Agent or relevant authority shall be informed in order that they may certify in writing that the service has not been damaged.

PSA 5.7 Safety

Add the following:

1. The Contractor shall at all times observe adequate safety precautions on Site to ensure the safety of his own staff as well as that of the public and other persons engaged in or about the Works. In this respect he shall observe all laws, ordinances and regulations pertaining to his work.
2. The Contractor's attention is specifically drawn to the following Acts, and particularly to the relevant regulations under each Act, copies of which shall at all times be kept by him on the Site:
 - The Factories, Machinery and Building Work Act (Act 22 of 1941)
 - The Explosives Act (Act 26 of 1956)
 - The Mines and Works Act (Act 27 of 1956)
 - The Occupational Health and Safety Act (Act 85 of 1993)
3. The Contractor is also required to comply with the safety precautions set out in the following publications, copies of which shall also be kept by him on the Site:
 - The Code of Practice relating to the safety of men working in civil Engineering inspection pits and small diameter vertical shafts. (Transactions of the South African Institution of Civil Engineers, Vol. 2, No. 11, November 1960, obtainable from the Secretary, S.A. Institution of Civil Engineers, Private Bag X200, Halfway House, 1685).
 - The Operator's Handbook on Sewage Purification (1965) Chapter 26. Safety Precautions published by the Institute of Water Pollution Control (Southern African Branch).
4. The Contractor shall provide suitable and safe access by way of ladders, gangways, etc. to all parts of the Works as may be required for construction purposes or for inspection by the Employer's Agent or the authorised Inspectors in terms of the above-mentioned Acts.
5. All precautions shall be taken to protect workmen against falling material and/or objects and other dangers whilst they are carrying out their duties. Shaft and trenches shall in every way be made and kept safe for persons working therein.
6. All persons working, inspecting or supervising in places where falling material and/or objects could be encountered shall be provided by the Contractor with hard hats of a type approved by the Inspector of Mines, the use of which shall be strictly enforced.

Employer:		Contractor:	
Witness:		Witness:	

7. The Contractor shall provide a properly equipped first aid box, which shall be accessible at all times.
8. Where adequate safety precautions are not being observed, the Employer's Agent may order the Contractor to comply with minimum safety requirements at the latter's expense. Compliance with such order will not absolve the Contractor from any of his responsibilities and obligations under the Contract.
9. The Contractor shall display on a prominent place the following emergency information:
 - **Local Police:** Telephone number
 - **Local Ambulance:** Telephone number
 - **Local Fire Brigade:** Telephone number
 - **Nearest Doctor:** Name
Telephone number (office hours)
Telephone number (after hours)
Consulting room street address

PSA 5.8 Ground and Access to Works

Add to the Sub-Clause the following:

On completion of operations the Contractor shall restore the ground surface, wherever it may have been disturbed, to its original condition by filling in all ruts with material similar to the material within the rut and levelling the ground and, where necessary, planting grass and shrubs as may be required. Any boundary fences which have been removed or damaged by their operations and activities shall be repaired and/or reinstated at the Contractor's expense. Ground restoration must include proper placement of topsoil profile.

PSA 8 Measurement and Payment

PSA 8.1.2.3 Contractor to Price all Items

Add the following paragraph;

"The grouping of payment items under one all-inclusive rate is prohibited. Each payment item shall have its own rate. Where the Contractor elects not to insert a rate for any particular item, then it shall be deemed to be zero".

PSA 8.2 Payment

PSA 8.2.2 Time-related Items

In the event that the net total extension of time granted in terms of the Contract and/or delay in the anticipated date of award of the Contract results in the

Employer:		Contractor:	
Witness:		Witness:	

official date for completion extending into or past a Christmas Builders Holiday period which did not fall within the tendered period for completion based on the anticipated date of award, and extension of time equivalent to the number of normal working days falling within that holiday period shall reduce to 25% of that applicable in terms of the above. It should be noted that time-related charges for the Christmas Builders Holiday period falling within the tendered period for completions based on the anticipated date of award of the Contract will be paid for at the full rate since such holidays are to be included in the tendered period for completion.

The anticipated date of award referred to above shall be the date stated in the Contract Documents. If the date is not stated it shall be considered to be any date within the period of validity of the Tender.

Delete the last four lines of this sub-clause, i.e. the paragraph commencing with the word "Note..."

PSA 8.3 Scheduled Fixed-Charged and Value-Related Items

PSA 8.3.1 Contractual Requirements

Add the following to this clause:

As indicated in the Contract Data (Clause 8.6.13), any claims against the insurance effected by the Employer shall be subject to the Contractor being responsible for the payment of the amount stated in the Policy as being the Deductible (First Amount Payable) as defined in the Policy.

PSA 8.3.2.1 Facilities for Employer's Agent

Add the following to this sub-clause:

d)	Latrine facilities	Unit: Sum
e)	Board room to accommodate 15 personnel	Unit: Sum
f)	Carports (5 of)	Unit: No
h)	Construction & setting out of survey beacons (3 No. of)	Unit: Sum
i)	Furniture for offices & meeting room	Unit: Sum
j)	Laptop, Data & Software	Unit: Sum

PSA 8.3.2.2 Facilities for the Contractor

(f) Tools and Equipment

Add the following new sub-clause:

"The sum shall cover the cost of supplying all hand tools and equipment, as necessary for proper execution of the works. **Unit: Sum**"

Add the following new sub-clause:

(k) Security of works

Employer:		Contractor:	
Witness:		Witness:	

"The sum shall cover the cost of supplying 24hr security at the Contractors camp as well as all other areas of the Works for the duration of the Contract. The cost should also include all other security requirements, as deemed necessary by the Contractor. Refer to clause PS7.2. **Unit: Sum"**

Add the following new sub-clause:

(l) Personal Protection Equipment

"The sum shall cover the cost of supplying all personal protective equipment, as deemed necessary by the Contractor and in accordance with the Health & Safety Plan. **Unit: Sum"**

PSA 8.4 Scheduled Time Related Items

PSA 8.4.2.1 Facilities for Employer's Agent

Add the following to this sub-clause:

e)	Latrine facilities for the sole of the Employer's Agent	Unit: Sum
f)	Boardroom to accommodate 15 personnel	Unit: Sum
g)	Carports (5 No. of)	Unit: No
h)	Construction & setting out of survey beacons (3 No. of)	Unit: Sum
i)	Furniture for offices and meeting rooms	Unit: Sum
j)	Laptop, Data & Software	Unit: Sum

PSA 8.4.2.2 Facilities for the Contractor

Add the following new sub-clause:

k) Security of Works

"The sum shall cover the cost of supplying all security works, as deemed necessary by the Contractor, refer to clause PS7.1 **Unit: Sum"**

l) Water Tanker for Dust Suppression

The rate shall include for the full-time supply and operation of a water tanker, with assistant to keep all the roads and work areas dust free for the duration of the contract. The rate shall include for the filling of the tanker from a designated water source. **Unit: Sum"**

PSA 8.4.3 Supervision for Duration of Construction

Add the following to the Clause:

The sum stated shall include, at minimum, the cost of full time, on-site supervision in the form of a Site Agent and Contracts Manager; whose qualifications and level of experience meet the requirements stated in the Functionality Criteria (Volume 1, Part 1, Tender Procedures). Both resources will be expected to provide the full range of Project Management Services as they relate to the Works. **Unit: Sum**

Employer:		Contractor:	
Witness:		Witness:	

PSA 8.4.4 Compliance with Local Content Requirements

The sum stated shall include, at minimum, the cost of all items required to ensure compliance with local content obligations. These may include (but are not limited to), packaging of works, sourcing, evaluation and negotiations, appointments, contracts, liaison with Ward councillor, CLO and JW Stakeholder Relations, etc. Additionally, the sum stated should include any additional items that the Contractor may deem necessary. **Unit: Sum**

PSA 8.5 Sums Stated Provisionally by Employer's Agent

(b) (3) Add the following sub-items:

a) Additional tests ordered by Employer's Agent **Unit: Prov Sum**

The provisional sum shall cover the cost of additional tests specifically ordered by the Employer's Agent. Tests shall be executed by an approved commercial service provider.

c) Community Liaison Officer **Unit: Prov Sum**

The provisional sum shall cover the cost of advertising, interviewing and employing the CLO. Additionally, it should include the CLO's salary for the duration of the Contract.

d) Training of targeted labour and SMME's

The Employer intends to train and to develop the skills of Local Labour and/or SMME's from local communities, at the Employer's cost. The Contractor shall, in consultation with the Employer's Agent, develop a Training and Skills Development Plan, in accordance with the requirements of the Employer. Once the Training and Skills Development Plan has been approved by the Employer's Agent, the Contractor shall implement, maintain records, and submit all information relating to the Plan, to the Employer. Training that is required for the Contractor's personnel in the normal course of business or for project requirements shall not be funded through the Skills Development and Training budget that is made available by the Employer.

The sum shall be in full compensation for the provision of training to targeted labour according to the specification of the Employer and approved by the Employer's Agent. **Unit: Prov Sum**

e) Training of Interns

The sum shall be in full compensation for the provision of training of interns according to the specification of the Employer and approved by the Employer's Agent. **Unit: Prov Sum**

f) Signage for Buildings

The sum shall cover the full cost of the supply and installation of signage onsite. **Unit: Prov Sum**

g) GPR Survey

Employer:		Contractor:	
Witness:		Witness:	

The sum shall cover the full cost of a GPR survey to identify all existing sub-surface services as directed by the Employer's Agent. The survey submission must include all drawings in DWG and PDF format. **Unit: Prov Sum**

h) Protection of Existing Services

The sum shall cover the full cost of protecting the identified existing services which may be exposed during the duration of the Contract. **Unit: Prov Sum**

i) Application for Environmental regulation

The sum shall cover the full cost for Environmental Regulation which may be required during the duration of the Contract. **Unit: Prov Sum**

j) Environmental Control Officer

The sum shall cover the full cost of an Environmental Control Officer during the duration of the Contract. **Unit: Prov Sum**

k) Full time Environmental Liaison Officer

The sum shall cover the full cost of a Full time Environmental Liaison Officer during the duration of the Contract. **Unit: Prov Sum**

l) Project Mentor

The sum shall cover the full cost of a Project Mentor during the duration of the Contract. **Unit: Prov Sum**

m) Contractor's percentage to cover cost of handling cost and charges

PSA 8.7 Daywork

Replace this clause with the following:

PSA 8.7.1 Expenditure on Daywork Items

Wages paid to workmen and invoices of cost of materials delivered on site. **Unit: Prov Sum**

PSA 8.7.2 Supervision, Overheads and All Other Costs

Extra over item PSA 8.7.1 for supervision, overheads and all other costs related to the Daywork items under item PSA 8.7.1 for the following:

a) Skilled Labourers	Unit: Percentage of Prov Sum
b) Unskilled Labourers	Unit: Percentage of Prov Sum
c) Material	Unit: Percentage of Prov Sum

PSA 8.7.3 Plant Hire Rates

Types and sizes indicated in the bill of quantities **Unit: hours**

a) Labour

Employer:		Contractor:	
Witness:		Witness:	

The labour charges to be reimbursed under the Daywork item PSA 8.7.1 in the Schedule of Quantities shall be the actual amount of wages paid to workmen, chargehands and gangers, (but not foremen), employed on Daywork with the authorisation of the Employer's Agent. The labour charges will be paid only for the time that the workmen are actually employed on Daywork.

Leave pay, bonuses, subsistence allowances, employer's contributions to medical schemes and provident funds and the like shall not be included in the above-mentioned labour charges but will be deemed to be covered by the percentage rate tendered by the Contractor against the items PSA 8.7.2(a) and PSA 8.7.2(b) scheduled for this purpose under Daywork in the Schedule of Quantities.

This percentage rate shall also be deemed to allow for the use of small tools, supervision, insurances, overhead expenses, transport of workmen, housing and feeding (if the liability of the Contractor) profit and any other expenses in connection with workmen employed on Daywork and shall also include for everything else covered under the allowances as stated in Clause 6.5 of the GCC.

b) Materials

The material charges to be reimbursed under the Daywork item PSA 8.7.1 scheduled in the Schedule of Quantities shall be the invoiced cost as approved by the Employer's Agent, less any discount granted by the Supplier. Only the actual quantities of materials used, as verified by the Employer's Agent, will be paid for.

The cost of transportation to site, storage, transportation to the point of use on site, insurance, superintendence and administrative costs, overhead expenses and profit shall be deemed to be covered by the percentage rate tendered by the Contractor against the item PSA 8.7.2(c) scheduled for this purpose under Daywork in the Schedule of Quantities. The percentage rate tendered shall also include for everything else covered under the allowances as stated in Clause 6.5 of the GCC.

c) Plant Hire Rates

The rates tendered for the hire of plant shall be applicable only to plant that the Contractor has on the site and shall be total all inclusive unit prices which shall include, inter alia, for all fuel and lubricants; for the wages of operators, drivers or attendants; for all tools, accessories, equipment and everything else necessary; for all depreciation, maintenance and repair costs; for overhead expenses, profit and for everything in accordance with Clause 6.5 of the GCC.

The hire charges shall be paid only for the time that the plant is actually working on the Daywork as authorised by the Employer's Agent.

Payment will not be made in respect of established, fixed or static plant on the site such as static concrete batching and mixing plant, cocopan track, monorails, static generators, compressors, pumps, lighting, ventilation plant and the like which are covered under other items but which may be used for Daywork.

Employer:		Contractor:	
Witness:		Witness:	

PSA 8.8 Temporary Work

PSA 8.8.4 Relocation of Services

Excavation for exposing existing services in the following depth ranges below ground level:

- a. 0,0 m up to 2,0 m:
 - i. Soft material **Unit: cubic metre (m³)**
 - ii. Intermediate material **Unit: cubic metre (m³)**
 - iii. Hard material **Unit: cubic metre (m³)**
- b. Exceeding 2,0 m up to 4,0 m:
 - i. Soft material Unit: cubic metre (m³)
 - ii. Intermediate material Unit: cubic metre (m³)
 - iii. Hard material Unit: cubic metre (m³)
- c. Extra over sub-items (a) and (b) above for hand excavation by means of hand tools such as picks, crowbars and pneumatic tools in close vicinity of services or where no blasting or machine excavation is allowed:
 - i. Soft material Unit: cubic metre (m³)
 - ii. Intermediate material Unit: cubic metre (m³)
 - iii. Hard material Unit: cubic metre (m³)

The unit of measurement shall be in cubic metre of the material removed as specified.

The rates shall include full compensation for all cost to excavate and break down the various classes of materials, including the cost of all the necessary additional effort, plant, tools, materials, labour and supervision.

Add the following New Clauses

PSA 8.9 Work Stoppage

The rate tendered shall cover all unforeseen work stoppages which may be attributed to community disruptions, COVID-19 related delays etc, and will be assessed at the discretion of the Employer's Agent. Rate to be based on the Contractors total Time Related Preliminary & General items. **Unit: Days**

PSA 8.10 Sub-Contractors (SMME's)

PSA 8.10.1 Main Contractor Overhead Charges and Profits

The Main Contractor shall retain liability and responsibility for the management, scheduling, and quality control of all works performed by approved sub-contractors (SMME's). This item will be calculated as a percentage of the sum

Employer:		Contractor:	
Witness:		Witness:	

of works allocated to SMME's and shall include the process to appoint a sub-contractor, as well as all costs and charges to manage all sub-contracted works. (Note: This amount must be at a minimum of 30% of the total contract value). **Unit: Percentage of total amount of work done by SMME's (%)**

PSA 8.10.2 Fixed Charge Items for SMME Contractual Requirements

This item will be calculated as a percentage of the approved amount towards Fixed Charged Preliminary and General Items allocated to SMME's as compensation for Overhead Charges and Profits for the Main Contractor.

Unit: Percentage of total amount of Fixed Charge Items for SMME's (%)

PSA 8.10.3 Time Related Items for SMME Contractual Requirements

This item will be calculated as a percentage of the approved amount towards Time Related Preliminary and General Items allocated to SMME's as compensation for Overhead Charges and Profits for the Main Contractor.

Unit: Percentage of total amount of Time Related Charges for SMME's (%)

PSA 8.10.4 Payments on behalf of Sub-Contractor by Main Contractor

Provisional Sum to cover costs incurred by the Contractor when making payments on behalf of the sub-contractor (ref Special Conditions) or to provide ad-hoc services on behalf of the sub-contractor.

Unit: Prov. Sum

PSA 8.11 As-Built Survey

Add the following:

"As built information/Survey shall be provided by the Contractor for all the Works completed.

This information must be certified as a true and correct reflection of the finished works and must be provided in hard copy and electronic (PDF and AutoCAD [*.dwg]) format. The price tendered for carrying out such work shall be inclusive of all costs, albeit direct or indirect to the Contractor. The survey must be carried out by an independent surveyor.

Further no Certificate of Completion of Works or portion of the Works shall be issued until such time as the Contractor provides the Employer's Agent with this information."

Employer:		Contractor:	
Witness:		Witness:	

SABS 1200 AB – EMPLOYER’S AGENT’S OFFICE

PSAB 1 SCOPE

Replace this Clause with the following:

This section covers the provision of accommodation for the Employer’s Agent’s resident staff. This accommodation shall include the necessary additional offices and furniture as well as the provision of all the services required. The Contractor will be required to supply a meeting room, an Employers office, a Employer’s Agent’s Representative’s Office and five car ports.

All furniture supplied shall be new.

PSAB 3 MATERIALS

PSAB 3.1 Name Boards

The numbers of name boards noted in the Bill of Quantities are to be provided under this contract.

No other name boards other than stated above shall be allowed. The Contractor shall erect the name boards at locations indicated by the Employer’s Agent while establishing himself on Site, but not later than 14 days after the start of the Contract.

The name boards shall comply with the requirements as stipulated by the Employer’s Agent.

On completion of the works, the Contractor shall obliterate all particulars on the name board and remove the board from the site, prior to the release of retention money.

PSAB 3.2 Site Office

Replace this Sub-Clause with the following:

PSAB 3.2.1 Specification for Office & Meeting Room Furniture

In addition to the furniture supplied by the Employer, the following items shall be provided under this Contract:

- k. One (1) office desk each with a surface area of at least 1.5m² with lockable drawers with keys.
- l. One (1) drawing rack for A0 drawings. The hangers shall be of the “Barhold” type with ten hangers per drawing rack.
- m. One (1) drawing table with an inclined surface area of at least 3m² and a smooth top constructed to the dimensions as directed by the Employer’s Agent’s Representative.
- n. Two (2) sturdy and comfortable chairs fitted with padded seats and backrests.

Employer:		Contractor:	
Witness:		Witness:	

- o. Venetian blinds or roller blinds, opaque type fitted to all the Employer's Agent's offices.
- p. One (1) large meeting table to accommodate approximately 15 people.
- q. Fifteen (15) plastic chairs with metal frames; and
- r. One (1) plastic rubbish bin.

PSAB 3.2.2 Employer's Agent's Meeting Room and Employer's Office

The Contractor shall provide one prefabricated site meeting room and one office similar to the existing meeting room and offices of approved dimensions with at least 35m² in floor area for the meeting room and 18m² in floor area for the Employer's Office. The rooms shall be completed, furnished and ready for use not later than three weeks after the commencement date of the Contract.

The timber floor of the office shall be at least 300mm above the surrounding ground level. Doors shall be provided at each end of the meeting room and each shall be provided with a suitable 3 lever lock and two keys.

Windows shall be provided, with a minimum glazed area of 15% of the floor area. At least half of this area must be able to open and shall be fitted with burglar bars and all the windows shall be fitted with venetian or other approved blinds.

The meeting room will be equipped with furniture supplied under PSAB 3.2.1.

Two (2) air conditioning units shall be supplied with the meeting room with capacity for the air volume of the room as per PSAB 3.2.6 and one (1) air conditioning unit shall be supplied for the Employer's Office.

Adequate electric fluorescent lighting and four (4) 15-amp power points.

PSAB 3.2.4 Car Ports

Carports shall be so constructed as to protect the vehicles parked under them at all times against rain, hail and sun. Shade netting will not be permitted for the carports. Preference is for corrugated iron sheeting for the roof and sides. The carports shall each be at least 15 m² in area and their floors shall consist of a layer of broken stone or concrete to minimise dusty and muddy conditions. Five car ports are required.

PSAB 3.2.5 Areas Surrounding Offices

The access and other roads and parking areas surrounding the existing offices shall be treated and maintained to make them dust free either by using crushed stone or bituminous surfacing. They shall be well drained and kept trafficable and free from mud and weeds at all times. They shall also be maintained and kept clean and tidy at all times.

Employer:		Contractor:	
Witness:		Witness:	

PSAB 3.2.6 Air-conditioning Units and Heaters

The Contractor shall provide and install air-conditioning units and heaters as specified. The air-conditioning units shall be electrically operated compressor type with closed circuit, and not an evaporation type. The capacity of the air-conditioning units shall be at least 2,2 kW. The heaters shall preferably be of the space-heating type without exposed elements and shall have a capacity of not less than 1,5 kW.

PSAB 3.2.7 Ablution units

Ablution facilities must be provided for the sole use of the Employer's Agent's staff and visitors and shall be of the chemical type, maintained in a hygienic and sanitary condition and shall be removed on completion of the works. The facilities provided shall conform to the local health authority requirements as applicable and the Contractor shall pay all sanitary feeds and charges.

PSAB 3.3 Services

PSAB 3.3.1 Sanitary arrangements

The Contractor shall be responsible for providing all sanitary services on the site.

The Contractor shall also make provision for the removal of all domestic rubbish on a regular basis.

PSAB 3.3.2 Water and Electricity

The Contractor shall provide a constant supply of clean potable water suitable for human consumption.

The cost of all water & electricity required for the Employer's Agent's purposes shall be borne by the Contractor. All buildings supplied shall include the provision of 220 V electricity.

PSAB 3.3.3 Maintenance

The Contractor shall provide all labour, equipment and material which may be necessary to keep all accommodation in a neat and clean condition, and repairs shall be done without undue delay.

PSAB 3.4 General

- a. The Contractor shall not order any materials, equipment or fittings on the basis of their having been specified or scheduled without the written confirmation of the Employer's Agent having been obtained. No building shall be erected without the Employer's Agent's written instructions as to the exact position and orientation of the building.
- b. Unless otherwise agreed upon, the meeting room shall be erected in close proximity to the Employer's Agent's offices.

Employer:		Contractor:	
Witness:		Witness:	

- c. The required facilities shall be completed, ready for occupation as specified, not later than three (3) weeks after the commencement date of the contract.
- d. The ownership of the meeting room and Employer's Office shall remain the property of the Employer at the end of the Contract.
- e. The ownership of the furniture in PSAB 3.2.1 and PSAB 3.2.3 shall remain the property of the Employer.
- f. The Contractor shall take all reasonable precautions to prevent unauthorised entry to the offices and to ensure the general security of the offices and meeting rooms.
- g. No accommodation shall be erected without the prior approval of the Drawings by all local or Government authorities requiring such prior approval.

PSAB 3.5 Insurance

The Contractor shall keep all the site offices, furniture and equipment insured against loss, damage or breakage and shall indemnify the Employer, the Employer's Agent and his staff against claims in this regard for the full duration of the Contract.

PSAB 4.2 Internet Access (New Clause)

Add new Sub-Clause:

The Contractor shall supply a minimum of three connections via "Wi-Fi" to a secured internet service for the sole use of the Employer's Agent s and the Employer's Agents Representatives to connect to the internet at a reasonable level of service (Min 20Mbps, uncapped and unshaped).

PSAB 4.3 Survey Equipment (New Clause)

Add new sub-clause:

The Contractor shall provide when necessary the Employer's Agent with the necessary Survey Equipment to enable the Employer's Agent to perform Engineering Surveys and to confirm the accuracy of the Contractor's setting out and construction.

The Contractor shall maintain the equipment in good working order and keep it clean until the completion of the works.

PSAB 5.5 Survey Assistants

Delete the first sentence and substitute the following:

The Contractor shall make available when necessary to the Employer's Agent two suitably educated labourers for use on and about the site for survey and other work directed by the Employer's Agent at all reasonable times.

Employer:		Contractor:	
Witness:		Witness:	

PSAB 8 MEASUREMENT AND PAYMENT

PSAB 8.2.1 Fixed and Time-related Charges

Add to the sub-clause:

The Tenderer is to include, under the Time-Related Charges, a sum of **R 750,00** per week for a period of time equal to the Time for Completion plus and additional time associated with delays attributed to the Contractor cover the cost of the Employer's Agent and the Employer's Agents Representatives internet costs.

PSAB 8.2.2 SCHEDULED ITEMS

PSAB 8.2.1 Quality Control Plan and Compliance thereof Unit: Sum

PSAB 8.2.2 Compliance with the Occupational Health and Safety Act and Specification.....Unit: Sum

PSAB 8.2.3 Compliance with the Environmental Management Plan..... Unit: Sum

PSAB 8.2.4 Plan Liaison with Authorities, opportunities to, and Co-operation with others on site.....Unit: Sum

PSAB 8.2.5 Provision of the Internet Access Unit: Provisional Sum

The provisional sum tendered shall cover all costs connected with the requirements stipulated in Clause PSAB 4.2.

PSAB 8.2.6 Photographic record of work Unit: Provisional Sum

Allow a provisional sum for the monthly progress photographs including aerial photography required for the project.

PSAB 8.2.7 Protective clothing and testing equipment Unit: Provisional Sum

Allow a provisional sum for the purchase of protective clothing and testing equipment required by the Employer's Agent and his staff.

PSAB 8.2.8 Stationery for the Employer's Agent's Staff Unit: Provisional Sum

Allow a provisional sum for the supply of stationery to the Employer's Agent and his staff for the project.

PSAB 8.2.9 Computer Equipment for the Employer's Agent's Staff Unit: Provisional Sum

Allow a provisional sum for the supply of computer equipment to the Employer's Agent and his staff for the project.

PSAB 8.2.10 Providing augment reality 3D modelling or BIM..... Unit: Provisional Sum

Allow a provisional sum for Providing an augment reality 3D modelling or BIM in order to produce a 3D model of the Upgraded Belt Press Building.

PSAB 8.2.11 Contractor's percentage to cover the costs of handling the provisional sum items pay ref. PSAB 8.2.5, 8.2.7, 8.2.8, and 8.2.9.

The sums tendered shall include for all the requirements contained in the relevant Specifications.

Employer:		Contractor:	
Witness:		Witness:	

PSC SABS 1200 C - SITE CLEARANCE

PSC 3 MATERIALS

PSC 3.1 Disposal of Materials

Replace the contents of this clause with the following:

“Topsoil shall be stockpiled on site for later re-use in accordance with the provisions of the attached Environmental Management Plan. All other material resulting from Site Clearance operations (including but not limited to, builder’s rubble, concrete, trees, pipes etc.) shall be removed from site and disposed of in an approved municipal dump site.

No burning of vegetation will be permitted.”

PSC 8 Measurement and Payment

PSC 8.1 Basic Principles

Add the following:

“The rates tendered shall include for the removal from site (where applicable) of all materials resulting from the clearing operations including all haul and any charges levied by the approved municipal dump at which the material is disposed.”

PSC 8.2 Scheduled Items

PSC 8.2.9 Transport materials and debris to unspecified sites and dump

Delete this item:

Rates tendered shall include for all haul to a registered municipal dump including any dumping charges levied.

PSC 8.2.11 Supply, install, maintain and remove temporary fencing. Unit: m

The rate shall cover the cost of all labour, plant and materials required to install a temporary security fence.

PSC 8.2.12 Supply, install, maintain and remove temporary security gate Unit: No

The rate shall cover the cost of all labour, plant and materials required to install temporary security gates. The gates shall be of suitable size and quality in order for all the Contractors plant to gain access as well as to create a secure site establishment.”

Employer:		Contractor:	
Witness:		Witness:	

PSD SABS 1200 D - EARTHWORKS

PSD 2 INTERPRETATIONS

PSD 2.3 Definitions

Replace the definition "Specified density" with the following:

"Specified density. The specified dry density expressed as a percentage of modified AASHTO dry density."

Replace the definition "stockpile" with the following:

"Stockpile (Verb). The process of selecting and, as may be necessary, loading, transporting and off-loading material in a designated area for later use and a specific purpose."

Add the following definitions:

"Fill. An embankment or terrace constructed from materials obtained from excavation or borrow. In roads, it includes the earthworks up to the underside of the selected subgrade level.

Fill (material). Material used for the construction of an embankment or terrace.

Roadbed. The natural in situ material on which the fill, or in the absence of fill, any pavement layers, are to be constructed.

Payment line. Means the excavation profile given on the Drawings or determined by the Employer's Agent for the Temporary and/or Permanent Works and to which payment for excavation will be made."

PSD 3 MATERIALS

PSD 3.1 Classification for Excavation Purposes

PSD 3.1.1 Method of Classifying.

After the first paragraph add:

"Inspection of the material for any classification other than soft excavation shall be undertaken by the Employer's Agent prior to any excavation. Levels of the occurrence of hard rock excavation shall be measured and agreed, recorded and signed by both the Employer's Agent and the Contractor before commencement of hard rock excavation."

New sub-clause

PSD 3.1.3 Method of Excavation

Employer:		Contractor:	
Witness:		Witness:	

The method of excavation shall be at the discretion of the Contractor provided that the work complies with the specification and the following requirements and conditions:

- a) Excavations shall be confined within the limits defined by the drawings or as instructed by the Employer's Agent;
- b) Surfaces in excavations shall at all times be formed to shed storm water and groundwater without ponding;
- a. No additional allowance above the Contract unit rates will be made on account of the excavated materials being wet.
- c) No additional allowance above the Contract unit rates will be made for shoring of trenches. The shoring of trenches in order to comply with safety regulations is to be included in the tendered rates.
- d) Where topsoil is to be removed prior to excavation, this will be considered a separate operation and will be measured as such. The Contractor or its representative shall jointly, with the Employer's Agent, keep a record of the depths, dimensions and classification of excavation."

PSD 3.1 Selection

PSD 3.3.1 General

Add the following:

The Contractor will be required to stockpile the surplus excavated material on sites to be designated on the drawings or by the Employer's Agent.

The Contractor shall be entirely responsible for the selection of suitable material for all backfilling and embankments from excavation on the site and from borrow pits.

PSD 5 CONSTRUCTION

PSD 5.1 PRECAUTIONS

PSD 5.1.1 Safety

PSD 5.1.1.1 Barricading and lighting

Delete the Sub-Clause and substitute with the following:

"Without diminishing any obligation which the Contractor may have in terms of any Act, Ordinance or other legislation, the Contractor shall ensure that all excavations by which the safety of persons may be endangered are protected as set out in Clause 13 of the General Safety Regulations of the Occupational Health and Safety Act, 1993 and that watchmen are employed to ensure that barricades, barriers and lights are effective at all times."

PSD 5.1.1.2 Safeguarding of excavations

In sub clause (a) delete the words:

"Machinery and Occupational Safety Act" in the third and fourth lines and substitute "regulations to the Occupational Health and Safety Act, 1993".

Employer:		Contractor:	
Witness:		Witness:	

PSD 5.1.2 Existing Services

Add the following to the Sub-Clause:

“In all cases where other services as shown on the drawings may interfere with excavations or where ordered by the Employer’s Agent, the Contractor shall carefully excavate by hand to expose, prove and mark the position of such service prior to the commencement of any main earthworks in the area.

Such exploratory work shall at all times be carried out well in advance of normal construction so that any possible changes to the design of the works necessitated by the proving of services, can be carried out without delay to the construction programme.

In all cases where underground power or telephone cables, watermains or other services are shown on the drawings, either crossing or adjacent to excavations, or where from site observations it can reasonably be accepted that such services are likely to exist where excavations are to take place, the Contractor shall, without instructions from the Employer’s Agent, carefully excavate by hand, to expose and prove position of such prior to the commencement of the main excavations in the area. The cost of this pilot trenching shall be included under the payment clauses provided for the main excavation. However, where any buried service is not located by the excavation of pilot trenches in the expected position, the Contractor shall immediately report such a circumstance to the Employer’s Agent who will decide what further searching or other necessary action is to be carried out and instruct the Contractor accordingly.

Should any service be damaged by the Contractor in carrying out the Works and should it be found that the procedure laid down in this clause has not been followed then all costs in connection with the repair of the service will be to the Contractor’s account.

The trench width required for proving of services need only be of sufficient width to enable the service to be exposed.”

PSD 5.1.2.4 Negligence

Replace the text of this sub-clause with the following:

“Any damage arising from negligence by the Contractor shall be made good at its cost to the satisfaction of the Employer’s Agent and/or the Authority concerned.”

PSD 5.1.3 Stormwater and Groundwater

Add the following to this Sub-Clause:

Over and above his general obligations in regard to dealing with water as specified in SANS 1200 A, the Contractor shall be responsible for preventing the ingress of water into the foundation excavations. The preventive measures shall include the construction of proper drainage channels, diversion channels,

Employer:		Contractor:	
Witness:		Witness:	

berms, sumps, and the supply, operation and maintenance of the necessary bailing and pumping equipment if required.

The dewatering measures, with the exception of pumping, shall be maintained until the backfilling has been completed, after which all settled silt, mud, etc. shall be removed from the exposed surfaces where necessary. Between the various construction stages, pumping may be interrupted as may be decided by the Employer's Agent. The draining or pumping of water from foundation excavations shall be so done that no concrete materials will be carried away.

PSD 5.2 METHODS AND PROCEDURES

PSD 5.2.1 Site Preparation

PSD 5.2.1.2 Conservation of topsoil

Add the following:

"Topsoil that has been stripped on the instruction of the Employer's Agent, shall be stockpiled and conserved for later use in designated temporary stockpile sites as specified in the Environmental Management Specification and as agreed with the Employer's Agent. The area occupied by the stockpile shall be so shaped and tidied after removal of the stockpile that erosion by wind and weather is minimised. If required by the Employer's Agent, the area shall be hydroseeded.

Topsoil stockpiles shall not exceed 1,5m height."

PSD 5.2.2 Excavation

PSD 5.2.2.3 Disposal

Add the following:

"Where ordered by the Employer's Agent, the Contractor shall dispose of excess excavated material in an approved municipal dump."

Add the following Sub Clauses:

PSD 5.2.2.4 Utilization of Excavated Material

Excavated material and material recovered from temporary work shall, in so far as it is suitable, be utilized for backfill. Material unsuitable for use as backfill or in excess of the quantity required to complete the backfill shall be spoiled or utilized as directed by the Employer's Agent.

PSD 5.2.2.5 Excavation limits for payment purposes

For measurement and payment purposes, the limits of the excavations for structures shall be as shown on the Drawings.

Where no excavation limits are shown on the Drawings and the Employer's Agent has decided that formwork has to be provided for the sides of a concrete

Employer:		Contractor:	
Witness:		Witness:	

member, the limits of the excavation for measurement and payment purposes shall be the vertical planes 0.5 m outside the perimeter of the concrete member for which the formwork is to be provided, and the founding level shown on the Drawings.

PSD 5.2.2.6 Unsuitable Material

Boulders, logs or any other unsuitable excavated material shall be taken to spoil.

Where, in the opinion of the Employer's Agent, unsuitable material is encountered at founding level, such material shall be removed and replaced with foundation fill in accordance with the requirements of clause PSD 5.2.3.4 of this section and as directed by the Employer's Agent.

PSD 5.2.2.7 Preparation of the Founding Surface

Where hard material suitable for founding is encountered at the founding level, it shall be cut and trimmed to a firm surface, either level, stepped or serrated, as may be required.

Where there are indications that the material at the founding level will be soft material or hard material that will deteriorate rapidly on exposure, the excavation of the final layer with a thickness of 150 mm shall be postponed until just before the blinding layer is placed.

Where shown on the Drawings or ordered by the Employer's Agent, excavations shall be extended to a specified depth below the given undersides of the slabs and footings to make provision for the placing of a concrete blinding layer.

PSD 5.2.3.3 Backfill and Fill Near Structures

a. General

When placing backfill and fill, the following precautions shall be taken:

- i. In so far as it is possible, the material shall be placed simultaneously to approximately the same elevation on both sides of a structure or structural member where appropriate. If conditions require that backfill or fill be placed appreciably higher on one side than on the opposite side, the additional material on the higher side shall not be placed until authorized by the Employer's Agent and preferably not until the concrete has been in place for 14 days, or until tests show that the concrete has attained sufficient strength to withstand any pressure safely that has been created by the backfill or fill or by the method of construction.
- ii. The material behind structural members restrained at the top by the superstructure, e.g. portal type structures, shall be placed as stated on the Drawings or as directed by the Employer's Agent.

b. Backfill

Employer:		Contractor:	
Witness:		Witness:	

Excavated areas around structures, between the structure and the vertical walls of the surrounding excavation, shall be backfilled with approved material in horizontal layers not exceeding 150 mm in depth after compaction, to the level of the original ground surface or to the level specified on the Drawings. Each layer shall be moistened or dried to the optimum moisture content for the material and be compacted to a density of not less than 93 % of modified AASHTO density, except that, in a road prism, the material shall be compacted to a density of not less than 93 % of modified AASHTO density. In cases where structures are founded on backfill material, the density shall be as specified in the Project Specifications but shall not be less than 95 % of modified AASHTO density.

c. Prevention of Wedge Action

Before the fill in the space between a structure and any adjacent sloping fill and the backfill between a structure and the sloping sides of the surrounding excavation is constructed, the slope of the fill and of the sides of the excavation shall be benched or serrated in order to prevent wedge action between the structure and the fill or the sides of the excavation during backfilling and compaction.

The distance between the exposed face of the structure and the toe of the fill or excavation side shall be sufficient to allow proper compaction.

PSD 5.2.3.4 Foundation fill

If, during the course of excavation, it is found that the material at the indicated founding depth does not have the required bearing capacity as specified on the Drawings, the excavations shall be extended at the discretion of the Employer's Agent until satisfactory founding material is encountered. The Employer's Agent reserves the right to order the Contractor to make up the difference in levels with foundation fill.

Where the foundation fill consists of rock or crushed stone, it shall be constructed as directed by the Employer's Agent.

Foundation fill consisting of granular material shall be constructed in layers not exceeding 150 mm in thickness after compaction. Each layer shall be moistened or dried to optimum moisture content for the material and be compacted to a density of not less than 95 % of modified AASHTO density.

Mass concrete fill to be used shall be of the class or mix specified or directed by the Employer's Agent.

PSD 5.2.4.2 Topsoiling

Delete this Sub-Clause and refer to Section PSVA.

Employer:		Contractor:	
Witness:		Witness:	

PSD 5.2.4.3 Grass or Other Vegetation

Delete this Sub-Clause and refer to Section PSVA.

PSD 5.2.5 Transport for Earthworks

Delete Clauses 5.2.5.2 and replace with the following:

PSD 5.2.5.2 Haul to an approved municipal dump site
The rates tendered for the disposal of material to an approved municipal dump shall include for all haulage."

PSD 8 MEASUREMENT AND PAYMENT

PSD 8.2 Computation of Quantities

Add the following to Clause 8.2.1 at the end of a):

"3) the material is used to backfill around or above structures."

PSD 8.2.2 Add the following to Clause 8.2.2:

"Bulk excavation pay-line volumes for the Sub-Stations and related infrastructure shall be calculated in accordance with the sections as shown on the relevant drawings indicating earthwork details.

The general principles used in determining this pay-line are as follows:

- All permanent slopes shall be constructed at a slope of 1 vertical to 2 horizontal.
- In order to provide working space around the building, the Contractor may, at its own risk steepen the lower portions of the slopes, provided that;
 - o Where these areas are situated in intermediate or hard material, the slopes do not exceed those recommended in the geotechnical report (unless this is backed up by a proper design by a competent geotechnical engineer), or
 - o The sides of the excavation are properly shored;
- Regardless of the amount of working space required by the Contractor and the method of achieving this, excavation volumes will be calculated using a pay-line that extends from the base of the building foundation at a slope of 1:1. Any additional excavation required to achieve the working space will be deemed to be included in the rates;
- Similarly, the volume of backfill that will be measured shall be calculated using the theoretical pay-line shown on the drawings and described above. Any additional backfill required to backfill the Contractor's working space shall be deemed to be included in the rates."

Employer:		Contractor:	
Witness:		Witness:	

PSD 8.2.3 Add the following to Clause 8.2.3:

“Prior to commencement of any excavation, the contractor shall notify the Employer’s Agent in good time to ensure that measurements, cross-section, levels of the undisturbed ground, or any other relevant information are taken in order that the excavation quantities can be agreed upon between the Employer’s Agent and the Contractor.”

PSD 8.3 Scheduled Items

PSD 8.3.2 Bulk Excavation

- b. Extra over for: Delete pay items (3) and (4).

Add the following new sub-clause:

“c) Extra-over for spoiling material in an approved municipal dump:

1. Soft material.....Unit: m³
2. Intermediate material.....Unit: m³
3. Hard material.....Unit: m³

The rate shall cover the additional cost of hauling the material off site to an approved municipal dump and any charges levied by the dump. The extra-over rate shall also be applicable to any material originating from pipe trenches, the excavation of which is paid for under the relevant items contained in SANS 1200DB – Excavation (Pipe Trenches)”

PSD 8.3.3 Restricted Excavation

- a. Excavation for restricted foundations, footings and pipe trenches in all materials and use for backfill or embankment or dispose

Add the following to this pay item

- i. In the case of structures, excavation will be scheduled to different depths as follows:
 - a. 0 m up to 2 m **Unit: Cubic metre (m³)**
 - b. Exceeding 2 m up to 4 m **Unit: Cubic metre (m³)**
 - c. Etc. in increments of 2 m depths **Unit: Cubic metre (m³)**
- (ii) Extra over item (i) above for additional excavation required by the Employer’s Agent after the excavation has been completed
Unit: Cubic metre (m³)

The limits for the successive depth ranges shall be measured down from the average surface to the agreed founding level.

The unit of measurement shall be the cubic metre of material measured in the original position before excavation. The quantity of excavation for each depth range shall be calculated from the nett outlines of the excavation limits shown on the Drawings and the depth of excavation completed within each range.

Employer:		Contractor:	
Witness:		Witness:	

Irrespective of the total depth of the excavation, the quantity of material within each depth range shall be measured and paid for separately.

Where no excavation limits are shown on the Drawings and formwork has to be provided to the sides of concrete members, an additional quantity of excavation shall be measured to 0,5 m outside the concrete perimeter in order to provide a working space.

Where foundation fill is constructed in an excavation, the quantity of excavated material measured for payment shall be the material excavated between the average ground surface, and the founding level, from the prism with vertical sides or as specified or directed by the Employer's Agent.

In no case shall any of the following volumes of excavation be included in the measurement for payment:

- i. The volume of excavation in excess of the abovementioned limits.
- ii. The volume included within the excavated road prism, contiguous channels, ditches, etc. for which payment is provided elsewhere in the Specifications.
- iii. The volume of water or other liquid (except the volume of mud, muck or similar semi solid matter, which has not resulted from the construction operations and which cannot be pumped or drained away).
- iv. Sloping sides of excavations required to make the excavation safe.

The tendered rate shall include full compensation for excavation in each class of material, including overbreak in hard material, the spoiling or stockpiling of material, the hauling of excavated material within the defined Site boundaries, for any additional excavation the Contractor may require for additional working space outside the authorized limits, for trimming and cleaning the bottoms and sides of excavation, and for strutting, shoring and safeguarding excavations.

If, after a foundation excavation has been completed, cleaned and trimmed ready for blinding, the Employer's Agent orders further excavations on account of changed dimensions and/or founding conditions, an extra over payment (item PSD 8.3.3(a)(ii) for the additional excavation shall be payable in full compensation for any additional costs to the Contractor over and above the normal excavation costs.

PSD 8.3.3(b) Extra-over for:

Delete pay items (3) and (4).

PSD 8.3.5 Extra Excavation in All Materials to Provide Working Space Around Structures

Delete this Sub-Clause and refer to Sub-Clause PSD 5.2.2.5.

PSD 8.3.10 Grassing or other vegetation cover

Delete this clause and refer to section PSVA..

Employer:		Contractor:	
Witness:		Witness:	

PSG SABS 1200G - Concrete (Structural)

PSG 2.3 Definitions

PSG 2.3 a) General

Adverse Weather

a) delete "25° C" and replace with "32° C"

Add the Following Sub-Clause

i) Concrete Finishes

a) Class F1 Surface Finish

After repair work has been done to surface defects, no further treatment of the as-stripped finish will be required. This finish is required on concealed formed surfaces

b) Class F2 Surface Finish

This finish shall be equivalent to that obtained from the use of square-edged timber panels and boards wrought to the correct thickness, or shutter boards or steel forms arranged in a regular pattern. This finish is intended to be left as struck. Although minor surface blemishes and slight discolouration will be permitted, large blemishes and severe stains and discolouration shall be repaired where so directed by the Employer's Agent.

c) Class F3 Surface Finish

This finish shall be that obtained by first producing a Class F2 surface finish with joint marks which form an approved regular pattern to fit in with the appearance of the structure. All projections shall then be removed, irregularities repaired, and the surface rubbed or treated to form a smooth finish of uniform texture, appearance and colour.

ii) Unformed Surfaces: Classes of Finish

a) Class U1 Surface Finish (rough)

The top surface shall be screed-off with a template to the required cross-section and tamped with a tamping board to compact the surface thoroughly and to bring mortar to the surface, so as to leave the surface slightly rough but generally at the required elevation.

b) Class U2 Surface Finish (floated)

The surface shall first be given a Class U1 surface finish and after the concrete has hardened sufficiently, it shall be wood-floated to a uniform surface free from trowel marks. For non-skid surfaces such as on those exposed to pedestrian traffic, the surface shall then be given a broom finish. The corrugations so produced shall be approximately 1mm deep, uniform of appearance and width and shall be perpendicular to the centre line of the pavement.

Employer:		Contractor:	
Witness:		Witness:	

c) Class U3 Surface Finish (smoothly finished)

The surface shall first be given a Class U1 surface finish, and after the concrete has hardened sufficiently, it shall be floated with a steel float to a smooth surface to within 5mm of the position shown on the drawings, and to within 2mm of the required level."

PSG 2.3 b) Quality

Change the following Sub-Clause:

Sample (of concrete). The minimum volume of uncompacted freshly mixed concrete required in terms of SANS Method 861-2 for a designated test (eg 16 dm³ for the compressive strength test for 3 cubes of nominal side 150 mm).

PSG 2.3 c) Strength

Change the following Sub-Clause:

Valid test result. The average result obtained from the testing of three test cubes of concrete in accordance with SANS Method 862-1, Method 861-3 and Method 863.

PSG 3.2 Cement

PSG 3.2.1 Applicable Specifications

Add the following:

Change this Sub-Clause as follows:

Cementitious materials for concrete shall comply with:

- a. SANS 50197-1-Cement-part 1: Composition, specification and conformity criteria for common cements.
- b. SANS 55167-1: 2011 Part 1-Ground granulated blast-furnace slag.
- c. SANS 55450-1: 2011 Part 2-Fly ash.
- d. SANS 53263-1: 2011 Silica fume for concrete Part 1.

Under no circumstances shall a "masonry cement" complying with SANS 50413-1 be used for concrete.

Before any concrete is produced, the Contractor shall submit full details of the cement to be used for the production of concrete to the Employer's Agent for approval. The name of the manufacturer of the cement and the place of manufacture shall also be submitted for approval.

PSG 3.2.2 Alternative Types of Cement

Add the following to this Sub-Clause:

The following materials may be used:

CEM II as described in SANS 50197-1.

Employer:		Contractor:	
Witness:		Witness:	

A site blend comprising, by mass:

- 70 parts of CEM I.
- 30 parts of fly ash.

The type of cementitious material to be used for specific structures or structural elements may be specified by the Employer's Agent.

For concrete pavements and floors that have joints sawn at an early age, the strength class of the cementitious material shall be 42,5N, 42,5R 52,5N or 52,5R.

PSG 3.2.3 Storage of Cement

Add the following to this Sub-Clause:

Where the cement is supplied in bags, the bags shall be closely and neatly stacked to a height not exceeding 12 bags, and they shall be so arranged that they can be used in the order in which they were delivered to the Site.

Cement shall not be kept in storage for longer than 6 weeks from the date of manufacture without the Employer's Agent's permission.

The Employer's Agent may order the removal of cement, which is older than 6 weeks, from the Site or the alteration of the design mix if he does allow its use. Alternatively, he may allow the cement to be used in concrete of less critical importance, as in blinding layers.

PSG 3.3 Water

Add to the Sub-Clause:

"If potable water is not used in the concrete, samples of the water proposed for use in the concrete shall be submitted to the Employer's Agent for their **approval in terms of Clause 3.1.**"

PSG 3.4 Aggregates

PSG 3.4.2 Use of Plumbs

Add New Sub-Clause:

The use of plumbs will not be permitted in any of the strength concrete specified on the Works."

PSG 3.4.3 Storage of Aggregates

Add the following:

When aggregates of different chloride content are stored on the site, their use in the various classes of concrete shall be strictly controlled."

Employer:		Contractor:	
Witness:		Witness:	

PSG 3.4.4 Aggregate Quality

Fine and coarse aggregates must comply fully with the requirements of SANS 1083.

Records of grading analysis tests on all the aggregate shall be kept.

Fine aggregate must be clean, naturally occurring, siliceous sand or approved crushed rock. The broken shell content determined in accordance with SANS Method 5840 must not exceed 30 percent by mass. In addition, for water retaining structures the following shall apply: fine aggregate grading is to comply with the table below. It may be necessary to blend two sands in order to meet the grading envelope. The maximum variance of the fineness modulus (FM) of the fine aggregate shall not exceed 0.2. Revision to the submitted mix design must be carried out where this becomes unavoidable.

SIEVE SIZE (MM)	% PASSING
4,75	100 – 90
2,36	100 – 75
1,18	96 – 60
0,60	60 – 40
0,30	40 – 20
0,15	20 – 10
0,075	6 – 3 (6 – 15)*

* If crusher sand

The coarse aggregate shall all be retained on a screen with 4,75mm nominal aperture size with the exception of dust content, which shall not exceed 0,5 percent by mass. Flakiness indices determined in accordance with SANS Method 5847 must not exceed 30 percent in the case of 26,5mm aggregate size and 25 percent in the case of 19,0mm aggregate size respectively."

PSG 3.5 Admixtures

PSG 3.5.1 Approval of Admixtures Required

Add the following:

- Water proofing additive with tracing agent or similar approved.
- Minimum dosage 0,8% by weight of cementitious content, with 20year warranty and all to manufacturers specifications. Concrete to be placed, protected and cured according to SANS 10100-2"

PSG 3.5.3 Specifications:

Employer:		Contractor:	
Witness:		Witness:	

Add the following Sub-Clause:

Admixtures shall comply with the requirements of ASTM C-494 and full details of the brand and type shall be submitted to the Employer's Agent for approval. Air entraining agents shall comply with the requirements of ASTM C-260 and full details of the brand and type shall be submitted to the Employer's Agent for approval.

PSG 4 PLANT

PSG 4.1 General

Add the following subclause:

PSG 4.1.1 Minimum plant

The Contractor shall have the following minimum plant available and in sound working order:

- a. One concrete mixer of sufficient capacity to complete a section of the floor or road between construction joints within 4 hours and without interruption.
- b. Two concrete vibrators, at least one of which shall be powered by an internal combustion engine.
- c. One air compressor.
- d. Suitable and adequate plant to transport concrete and other material and equipment at all stages of construction.
- e. Storage tanks of adequate capacity to ensure that sufficient water will be available before commencement of every major concrete-placing operation.

If the Plant used for placing concrete is electrically or mechanically powered, the Contractor shall also provide some other approved, non-electrically-powered standby means for placing concrete at an adequate rate in the event of a power or mechanical failure of the main Plant."

PSG 4.2 Batching Plant

Add to the Sub-Clause:

- d. admixtures may be batched to an accuracy of within 2 % of the mass required.

PSG 4.5 Formwork

PSG 4.5.1 Design

Add the following:

"All formwork or scaffolding required for any part of the Works shall be designed by the Contractor, and before commencing with the erection of any formwork or scaffolding, the Contractor shall submit the methods he proposes to use to

Employer:		Contractor:	
Witness:		Witness:	

the Employer's Agent for approval. The Employer's Agent has the authority to order alterations to the design or the sizes of any part of the formwork or scaffolding. The Contractor shall check the safety and suitability of all such alterations. The fact that the Employer's Agent has approved or altered any part of the formwork or scaffolding shall not be construed as relieving the Contractor of his responsibility with regard to the strength and stability of the formwork or scaffolding."

PSG 4.5.2 Finish

Add the following to this Sub-Clause:

All external corners shall be chamfered by the fixing of fillet strips into the corners of the formwork to form 20 mm x 20 mm chamfers, all at no extra payment.

PSG 4.5.3 Ties

Add the following:

"No plugs, bolts, ties or clamps of any description used to hold the formwork will be allowed to project into or through the concrete unless expressly approved by the Employer's Agent.

Only approved tie-rods consisting of solid rods (that remain embedded in the concrete) and with removable ends shall be used to hold the formwork of the walls. The removable tie-rod ends shall facilitate removal without damage to the concrete, and no permanently embedded parts of such tie-rods shall have less than 50 mm of cover to the finished concrete surface.

The cavities left in the concrete when the tie-rod end cones are removed shall be soundly caulked with a cement mortar to which an approved shrinkage-reducing agent has been added and shall be neatly finished to a smooth surface uniform with that of the surrounding concrete.

The cost of supplying special tie-rods as well as the filling of cavities left by the tie-rod cones shall be included in the rates tendered for formwork under the appropriate pay items.

On no account shall formwork be secured to reinforcing bars."

Only patented ties shall be used on water-retaining structures. Ties must be suitable for grouting to a depth at least equal to the concrete cover or 50 mm. Details of ties to be used shall be submitted to the Employer's Agent for approval.

PSG 5 CONSTRUCTION

PSG 5.1 Reinforcement

PSG 5.1.2 Fixing

Add the following:

Employer:		Contractor:	
Witness:		Witness:	

"The Employer's Agent will inspect the reinforcing after it has been fixed in place, the formwork has been cleaned, cover blocks have been positioned, and before concreting commences.

Welding of reinforcing steel will not be permitted."

PSG 5.1.3 Cover

Add the following:

"The distance between pipes in the concrete and the reinforcing steel shall nowhere be less than

- a. 40 mm or
- b. 5 mm plus the maximum size of the coarse aggregate, whichever is the largest."

The cover of concrete over reinforcement shall be measured from the outside of any reinforcement bar or stirrup. Minimum cover shall be in accordance with the dimension shown on the relevant drawing. Unless otherwise shown on the drawings, minimum cover to reinforcement shall be 50mm.

PSG 5.2 Formwork

PSG 5.2.1 Classification of Finishes

- a. Smooth

Add the following to this Sub-Clause:

Smooth formwork is required where concrete will be in contact with backfill or where exposed formed surfaces will not readily be visible.

- c. Special

Add the following to this Sub-Clause:

Special smooth formwork is required where concrete surfaces are exposed and is to be carried down to 150mm below adjoining ground or paving level.

Imperfections such as small fins, bulges, irregularities, surface honeycombing, and slight surface discolorations shall be made good and repaired by approved methods including rubbing down or grinding to the complete satisfaction of the Employer's Agent. The finish of the concrete shall be accurate to Degree of Accuracy I as defined in terms of Clause 6.

Patching of the tie holes to match the colour of the concrete where exposed.

PSG 5.2.2 Preparation of Formwork

Add the following:

Surfaces of formwork that are to be in contact with concrete shall be treated with an approved release agent to prevent adhesion of the concrete during stripping. The joints between continuous formwork elements shall be closely butted and, where necessary, if undue leakage is expected, the joints shall be

Employer:		Contractor:	
Witness:		Witness:	

caulked, taped or packed with a sealing gasket, all at no extra payment. Paper, cloth or similar materials shall not be used for this purpose.

Any discolouration to the concrete by the release agent shall be permanently removed.

Construction joints shall be positioned as shown on the Drawings.

PSG 5.2.5 Removal of Formwork

Add the following subclause:

PSG 5.2.5.7 The Contractor shall make provision for the continued support of beams and slabs while the formwork is being removed and/or for back propping of beams and slabs.

PSG 5.3 Holes, Chases and Fixing Blocks

Add to the Sub-Clause:

Fixing blocks for the attachment of fixtures may be embedded in concrete provided that the strength or any other desirable feature (such as appearance) is not in the opinion of the Employer's Agent, thereby impaired.

PSG 5.5 Concrete

PSG 5.5.1 Quality

PSG 5.5.1.1 General

Add to the Sub-Clause the following:

Unless specifically stated in the Project Specification Prescribed Mix Concrete will not be used.

PSG 5.5.1.2 Consistency

Add to the Sub-Clause the following:

The slump, measured in accordance with SANS Method 862-1, shall be not less than 50 mm and not more than 80 mm, unless permitted otherwise by the Employer's Agent for specific applications.

PSG 5.5.1.5 Durability

Add to the Sub-Clause:

All water retaining structures shall be deemed to be exposed to severe conditions. The cement/water ratio shall be determined by the strength of the concrete specified but shall not be less than 2.0.

In addition to these requirements the cementitious material content shall not be less than 325 kg/m³ for structural concrete Grade 35/20.

For reinforced concrete the cement content should not exceed either 400 kg/m³ of ordinary Portland cement or cements containing G.G.B.S. or 450 kg/m³ where cements containing P.F.A. are used. For prestressed concrete the

Employer:		Contractor:	
Witness:		Witness:	

maximum cement content may be increased to 500 kg/m³ or 550 kg/m³ respectively.

PSG 5.5.1.6 Prescribed mix concrete

Delete the Sub-Clause and substitute the following:

Unless the Design mix is detailed on the drawings or in the Specification, all concrete shall be Strength concrete.

PSG 5.5.1.7 Strength concrete

Add the following to this Sub-Clause:

Before the commencement of any construction work, the Contractor shall submit a concrete mix design report to the Employer's Agent for approval. A reputable commercial laboratory shall compile this concrete mix design report.

Unless specified differently the grade of concrete to be used shall be as follows:

- a. Grade 35/20: All reinforced concrete structures
- b. Grade 35/20: All paving slabs and floor slabs
- c. Grade 15/20: Unreinforced foundations, pipe encasements and blinding
- d. Grade 10/20: Mass concrete and concrete filling
- e. Grade 15/10: Screeds and benching

PSG 5.5.2 Batching

Add the following to this Sub-Clause:

Equipment for mass batching shall be clearly marked to show the mass of each material required for a batch.

PSG 5.5.2.3 Aggregates

Add the following to this Sub-Clause:

Batching of aggregates shall be by mass to an accuracy of within 2 % of the mass required. No volume batching will be permitted.

PSG 5.5.3 Mixing

PSG 5.5.3.1 Mixing at construction site

Add to the Sub-Clause:

- i) Site batching shall be by mass using an approved type of weigh-batching plant.

PSG 5.5.3.2 Ready-mixed concrete

Add the following:

Ready-mixed concrete may be used on the Site. The Contractor shall take samples for testing from every load delivered to the Site.

Employer:		Contractor:	
Witness:		Witness:	

PSG 5.5.5 Placing

Add the following:

Concreting of the floor between construction joints shall be carried out in both directions from a point on the floor in order to close the gap with fresh concrete.

PSG 5.5.6 Compaction

Add the following to this Sub-Clause:

PSG 5.5.6.3 Compaction shall be carried out by mechanical vibration with suitably sized equipment. Compaction by hand shall not be permitted.

PSG 5.5.6.5 Particular care shall be taken with the top section of the walls of the reservoir to prevent cracking.

PSG 5.5.7 Construction Joints

Add the following:

Should the Contractor's method of construction necessitate the placing of a construction or other joint in a position not shown on the Drawings, such method of construction and position of the joint shall be approved by the Employer's Agent in writing. The cost of such joint shall be included in the tendered rates and shall include scabbling of the concrete where steel reinforcement is continuous.

PSG 5.5.7.1b) Install a controlled expansion self-healing concrete waterstop (Size: 19 x 25 x 5mm), guaranteed as a system with the crystalline waterproofing additive with tracing agent, to primed joint surface between concrete pours by an approved applicator as per manufacturer's instructions.

PSG 5.5.7.3 a) Construction joints when concrete is not more than 24 hours old:

The surface of the concrete shall be brushed with a wire brush, loose material removed and the surface dampened. New concrete shall be placed directly in contact with the old concrete and compacted thoroughly.

b) Construction joints when concrete is more than 24 hours old:

The surface of the concrete shall be sand blasted or chipped with a light hammer, and swept clean. The surface shall then be wetted and allowed to become surface-dry before new concrete is placed directly in contact with the old concrete and compacted thoroughly.

Add the following Sub-Clause:

PSG 5.5.7.3 e) No vertical construction joints will be permitted in circular tanks.

PSG 5.5.8 Curing and Protection

Add the following:

Employer:		Contractor:	
Witness:		Witness:	

The curing methods of retaining the formwork in place or covering with a waterproof membrane are strongly recommended. Concrete will not be paid for unless properly cured and proof of curing is continuously visible on site.

The minimum period of moist curing shall be:

- 5 days for normal weather (temperature 18°C to 22°C, 65 % RH, low wind speeds).
- 7 days for hot weather with drying winds.
- 9 days for cold weather (temperature 5°C to 12°C).

PSG 5.5.10 Concrete Surfaces

PSG 5.5.10.2 Delete and replace with the following:

Where a wood-floated or steel-floated or power-floated finish or a screed topping or granolithic finish is required in terms of the project specification, the concrete shall, unless otherwise stated in the project specification, be finished to the tolerances specified below in the following degrees of Accuracy:

- For floors within buildings – degree of accuracy I shall apply;
- For all unexposed surfaces – degree of accuracy Iii shall apply;
- For all other surfaces – degree of accuracy II shall apply.

PSG 5.5.11 Watertight Concrete

Add the following:

All structures shall be deemed to be water retaining unless otherwise specified.

PSG 5.5.11.1 Testing of Water Tank

For a test of liquid retention, the structure should be cleaned and initially filled to the normal maximum level with the specified liquid (usually water) at a uniform rate of not greater than 2 m in 24 h.

When first filled, the liquid level should be maintained by the addition of further liquid for a stabilizing period while absorption and autogenous healing take place. The stabilizing period may be 7 days for a maximum design crack width of 0.1 mm or 21 days for 0.2 mm or greater. After the stabilizing period the level of the liquid surface should be recorded at 24 h intervals for a test period of 7 days. During this 7-day test period the total permissible drop in level, after allowing for evaporation and rainfall, should not exceed 1/500th of the average water depth of the full tank, 10 mm or another specified amount.

Notwithstanding the satisfactory completion of the test, any evidence of seepage of the liquid to the outside faces of the liquid-retaining walls should be assessed against the requirements of the specification. Any necessary remedial treatment of the concrete, cracks, or joints should, where practicable, be carried out from the liquid face. When a remedial lining is applied to inhibit leakage at a crack it should have adequate flexibility and have no reaction with the stored liquid.

Employer:		Contractor:	
Witness:		Witness:	

Should the structure not satisfy the 7-day test, then after the completion of the remedial work it should be refilled and if necessary, left for a further stabilizing period; a further test of 7 days' duration should then be undertaken in accordance with this clause.

PSG 5.5.11.2 Testing of Roofs

The roofs of liquid-retaining structures should be watertight and should, where practicable, be tested on completion by flooding the roof with water to a minimum depth of 25 mm for 24 h or longer if so specified. Where it is impracticable, because of roof falls or otherwise, to contain a 25 mm depth of water, the roof should have water applied by a continuous hose or sprinkler system to provide a sheet flow of water over the entire area of the roof for not less than 6 h. In either case the roof should be considered satisfactory if no leaks or damp patches show on the soffit. Should the structure not satisfy either of these tests, then after the completion of the remedial work it should be retested in accordance with this clause. The roof insulation and covering should be completed as soon as possible after satisfactory testing.

PSG 5.5.13 Grouting

Add the following:

PSG 5.5.13.1 Materials

- a. Water - Water for grout shall comply with the requirements given in Sub-Clause 3.3 of SANS 1200 G: 1982 (2002-07-30)
- b. (Aggregates - Notwithstanding the requirements of Sub Clause 3.4.1 of SANS 1200 G, the grading of fine aggregate (sand) and coarse aggregate (stone or pea gravel) shall conform to the grading given in Tables 1 and 2, respectively, below.
- c. Cementitious material – This shall be type CEM II complying with SANS 50197-1 and of strength class 42,5 N or higher.
- d. Admixtures - Admixtures shall comply with the requirements of Sub-Clause 3.5 of SANS 1200 G: 1982 (2002-07-30) and shall have a proven record of satisfactory performance under conditions encountered in the Republic of South Africa.
- e. Proprietary grouting materials - Unless otherwise approved by the Employer's Agent, proprietary grouting materials shall be obtained ready mixed in sealed pockets as supplied by the manufacturers.

Employer:		Contractor:	
Witness:		Witness:	

TABLE 1 - SAND				TABLE 2 - STONE OR PEA GRAVEL			
1		2		1		2	
Test sieve nominal aperture size (mm)		% Passing (by mass)		Test sieve nominal aperture size, (mm)		% Passing (by mass)	
9,75		100		9,5		100	
4,75		95 - 100		4,74		95 - 100	
1,18		45 - 65		2,36		0 - 5	
0,3 (300 μm)		5 - 15					
0,15(150 μm)		0 - 5					

PSG 5.5.13.2 Preparation and Procedures

- a. Before a machine or structural bedplate is placed on the concrete the following steps shall be carried out:
 1. All defective concrete, laitance, dirt, oil, grease, and loose material shall be removed from the concrete foundation by bush hammering, chipping, or other means until sound clean concrete is obtained. The surface of the foundation shall be scabbled but shall not be so rough as to interfere with proper placing of the grout. All foundation bolt sleeves shall be cut out or cut off flush if the sleeves cannot be removed. The top of the foundation shall be re shaped if necessary.
 2. The underside of each steel base, particularly in the bearing areas, shall be cleaned and any burrs and ragged edges removed before the base is placed in its final location.
 3. All holding down bolt sleeves shall be thoroughly cleaned of any materials that may prevent the grout from flowing freely to the bottom of the bolt sockets.
- b. The base shall be properly aligned and levelled and shall be maintained in that position during grouting.
- c. After the machine or structural bedplate has been placed the following precautions shall be observed:
 1. Shimming shall be kept to a minimum. Steel plates shall be used for packing and shall be ground to the required thickness, where necessary.
 2. Before grouting is started all loose dirt, oil, grease, and other foreign matter on the surface of the foundation, the undersides of bedplates, and in the bolt holes shall be removed by means of compressed air or

Employer:		Contractor:	
Witness:		Witness:	

other approved means. The surface of the foundation slab shall be thoroughly saturated with clean water, and all free water shall be removed from the surface and the bolt holes just before the grout is placed.

3. Grouting shall not be carried out until the alignment of all units to be grouted has been checked and approved by the Employer's Agent.
4. Special care shall be taken with grouting in hot or cold weather to ensure proper setting and gain of strength and, in the case of proprietary grouting materials, by having ice or hot water available, as the case may be, in accordance with the instructions of the manufacturer. Enclosures shall be provided for the grout such that, until it has set, its temperature will be in the range 15°C - 27°C.

Shields to protect the grout from the sun and from hot winds shall be provided by the Contractor when so ordered.

PSG 5.5.13.3 Formwork

Formwork for grouting shall comply with the applicable requirements of Clause 5.2 of SANS 1200 G: 1982 (2002-07-30). Forms shall be caulked where necessary. Adequate clearance between forms and bedplates shall be provided to enable the grout to be worked into place.

PSG 5.5.13.4 Mixing (All Free-Flowing Grouts Except Epoxy Grouts)

The grout shall be mixed to a homogeneous uniform mixture and delivered ready for placing at a temperature between 15 °C and 25 °C.

The materials and water shall be mixed in a mortar mixer for at least 3 min. or, in the case of small jobs only, shall be thoroughly mixed by hand, the entire mass being turned over enough times to ensure even distribution of its components.

The mixing shall be done as close as possible to the place(s) where the grout is placed. No more grout shall be mixed at any one time than can be placed in a period of 20 min. After the grout has been mixed, it shall not be retempered by the addition of water.

PSG 5.5.13.5 Grouting (All Free-Flowing Grouts Except Epoxy Grouts)

The grout shall be placed quickly and continuously to avoid the undesirable effects of over working. These effects are segregation, bleeding, and breaking down of initial set. The method of placement shall be subject to approval. The means of placing the grout shall be such that the grout will completely fill the space to be grouted, thoroughly compacted, free of air pockets, and will have evenly distributed contact over an area in excess of 80% or, in the case of expanding grout, 95% of the bearing area of the item to be supported.

Wherever practicable, grout shall be placed from one side only and where this is not practicable, care shall be taken to ensure that any entrapped air is released.

Employer:		Contractor:	
Witness:		Witness:	

After the grout has taken its initial set:

- a. the forms shall be removed.
- b. excess grout shall be so cut away as to leave a smooth and neatly finished job.
- c. except where the grout is intended to provide resistance to side thrust, all edges shall be trimmed at 45° to the vertical, from the bottom edge of the bedplate and
- d. all excess grout on or about the bedplates shall be removed.

Damage to paintwork, if any, shall be repaired within 24 hours. Packing plates, shims, and other levelling devices shall remain in position.

PSG 5.5.13.6 Dry-Packed Grout (Standard Dry Sand and Cement Grout)

Dry-packed grout shall have a minimum compressive strength at 28 d of 20 MPa. The quantity of water added after placing shall be kept to a minimum consistent with placing conditions, and the cement, sand and, where applicable, pea gravel proportions by mass shall be as follows:

- a. Where the clearance between bedplate and foundation is 25 mm or less :
1 part of cement and 2 parts of sand;
- b. Where the clearance exceeds 25 mm: 1 part of cement, 1 part of sand, and 1 part of pea gravel.

Dry packed grout shall be rammed by means of tamping rods against formwork placed along three sides of the bedplate.

PSG 5.5.13.7 Non-Shrink Grout with Metallic Aggregate

The manufacturer's instructions shall be observed when non shrink grout with metallic aggregate is used.

Where the clearance between the bedplate and the foundation is less than 50 mm a sand-based mix shall be used. Where the clearance exceeds 50 mm the Employer's Agent may order a mix with a base of sand plus pea gravel to be used.

PSG 5.5.13.8 Expanding Grout with Powdered Aluminium Additive

The manufacturer's instructions shall be observed when an expanding grout with powdered aluminium additive is used. Where the clearance between the bedplate and the foundation is less than 25 mm, a sand-based mix shall be used.

Where the clearance exceeds 25 mm the Employer's Agent may order mix with a base of sand plus pea gravel to be used.

Each batch shall be mixed for at least 6 min. after the powdered aluminium has been added. Where a ready mixed grout is used, the powdered aluminium shall be added at the placing site and the batch mixed as specified in PSG 9.4. Grout shall be placed within 45 min. after the addition of the powdered aluminium.

Employer:		Contractor:	
Witness:		Witness:	

The Contractor shall not use powdered aluminium additive when the ambient temperature is below 5°C.

PSG 5.5.13.9 Epoxy Grout (Epoxy Mortar Type Only)

The manufacturer's instructions shall be observed when an epoxy grout is used.

PSG 5.5.13.10 Testing (Clause 7)

The Contractor shall, where so ordered, carry out a site test for each grouting procedure and each grouting gang to be used. The tests shall be carried out on a dummy bedplate similar in configuration to that, which is to be grouted, but not exceeding 1 m in area unless otherwise ordered.

When the dummy bedplate is dismantled, the underside shall show a minimum grout contact area of 80 % with reasonably even distribution of the grout over the surface grouted except that, in the case of expanding grout, the minimum grout contact area shall be 95 %. The test shall show evidence of good workmanship and materials and the results shall be to the satisfaction of the Employer's Agent.

The Contractor shall, when so ordered, make standard test cubes from various grout mixtures and subject them to compression tests to determine whether the specified strength has been achieved. Test procedures shall comply with the relevant requirements of Sub-Clause 7.2.1 to 7.2.3(f) SANS 1200 G: 1982 (2002-07-30).

Add the following Sub-Clauses:

PSG 5.5.16 No Fines Concrete

PSG 5.5.16.1 Materials

Cement, aggregate and water shall comply with the requirements of Clause 3 of this section.

Each size of aggregate shall be a single sized aggregate graded in accordance with SANS 1083:2006.

PSG 5.5.16.2 Classes of No-Fines Concrete

No fines concrete shall be classified by the prefix NF and the size of the aggregate to be used. Class NF 20 means a no fines concrete with a 19 mm nominal size aggregate.

The volume of aggregate per 50 kg of cement for each class of no fines concrete shall be as follows:

Employer:		Contractor:	
Witness:		Witness:	

Class	Aggregate per 50 kg cement
NF 40	0,33 m ³
NF 20	0,30 m ³
NF 10	0,27 m ³

PSG 5.5.16.3 Batching and Mixing

Cement shall be measured by mass or full bags of 50 kg each and aggregate shall be measured by volume in approved measuring boxes or barrows.

The quantity of water added shall be just sufficient to form a smooth grout that will adhere to and completely coat each and every particle of aggregate and to be just wet enough to ensure that, at points of contact of the aggregate, the grout will run together to form a small fillet to bond the aggregate together. The mix shall contain no more than 20l of water per 50 kg of cement.

Mixing shall be carried out in an approved batch type mechanical mixer, but small quantities may be hand mixed.

PSG 5.5.16.4 Placing

No fines concrete shall be placed in accordance with the procedure agreed on by the Employer's Agent. It shall be placed in its final position within 30 minutes of mixing.

The no fines concrete shall be worked sufficiently to ensure that it completely fills the space to be concreted and that adjacent aggregate particles are in contact with one another. Excessive tamping or ramming shall be avoided and under no circumstances may the no fines concrete be vibrated.

PSG 5.5.16.5 Protection

All no-fines concrete shall be protected from the elements and loss of moisture. Protection against loss of moisture shall be accomplished in one or more of the following ways:

- Retaining formwork in place.
- Covering exposed surfaces with sacking or other approved material kept continuously wet.
- Covering exposed surfaces with plastic sheeting.

No-fines concrete placed during cold weather shall be adequately protected against frost for at least 3 days.

PSG 5.5.17 Joints in Structures

Employer:		Contractor:	
Witness:		Witness:	

PSG 5.5.17.1 Materials

a. General

All materials used in the forming, construction and sealing of permanent joints, as well as all proprietary or custom-built expansion joint assemblies shall be subject to the approval of the Employer's Agent.

When required by the Employer's Agent, the Contractor shall submit test certificates from an approved independent testing authority to show that the respective materials comply with the specified requirements, or a certificate from the patent holder or designer to certify that the manufactured item complies in all respects with relevant product specifications.

b. Joint filler

Joint filler shall comply with the requirements of the following specifications:

- i. American Association of State Highway Officials (A.A.S.H.O.) Standard Specification M153 54 Type I and III;
- ii. National Transport Commission "Standard Specification for Roads and Bridge Works";
- iii. Department of Public Works PW471 "Specification of Materials and Methods to be used" Section 3.13 Expansion Joints;

Joint fillers shall consist of closed cell expanded polyethylene with a density of not less than 100 kg/m³.

c. Sealants

Joint sealers shall consist of a two-component polyurethane sealing compound complying with the requirements of SANS 1077: 2009 (Ed. 1.2s).

The Contractor may use other sealants if approved by the Employer's Agent after submission of full specifications and information at tender stage.

d. Waterstops

Waterstops shall be of natural rubber, or plasticized, virgin, non biodegradable PVC, and of the type specified or shown on the Drawings.

- i. Natural rubber waterstops shall comply with the requirements of CKS 388.
- ii. Flexible polyvinyl chloride (PVC) rubber waterstops shall comply with the requirements of CKS 389.

e. Accessory materials

i. Primers

When a primer is to be used in conjunction with the sealant, it shall be of the prescribed proprietary material.

ii. Adhesives

Employer:		Contractor:	
Witness:		Witness:	

Adhesives used in conjunction with preformed seals shall be of a proven and approved type, which is compatible with the material of the seal.

iii. Bond breakers

Polyethylene tape, coated papers, metal foils or similar material may be used where bond breakers are required.

iv. Back-up material

Back-up material shall consist of a compressible material of correct width and shape in order to ensure that it will be in approximately 50 % compression after installation and that the sealant can be formed to the specified depth.

Back-up materials shall be compatible with the sealant used. Material containing bitumen or volatiles shall not be used with thermosetting chemically curing sealants.

f. Storage

All materials used in the forming, construction and sealing of permanent joints and all proprietary or custom built expansion joint assemblies shall be stored off the ground under cover that provides adequate protection against sunlight, physical or chemical damage or other factors that may cause deterioration.

PSG 5.5.17.2 Filled Joints

Filled joints shall be accurately formed to the dimensions shown and with the filler material specified on the Drawings. The filler shall be secured in position so that it will not be displaced during or after concreting if the filler is to remain permanently in the joint. In addition the filler shall be provided with a cut line prior to installation, e.g. factory perforated on the correct depth. This cut line, intended to aid removal of a portion of the filler to make room for the sealant, shall be in a position which coincides with the depth of the sealant.

Wherever polystyrene or a similar material, which is susceptible to damage, is used to form joints, it shall be lined with a hard surface on the side to be concreted. The hard surface shall be sufficiently resilient to ensure that the joint and surfaces can be formed free from defects.

PSG 5.5.17.3 Sealing of Joints

a. General

Sealed joints shall be made watertight over the full length of the joints, unless otherwise permitted by the Employer's Agent, and the joint dimensions shall be as shown on the Drawings.

b. Preparation of Joints

Employer:		Contractor:	
Witness:		Witness:	

The reaming of joints by sawing or other means shall be undertaken when edge spalling or ravelling can be avoided and shall be subject to the Employer's Agent's approval.

After removal of the temporary filler material up to the cut line or the breaking out of the excess concrete, the inside faces of the joint shall be wire brushed or grit blasted to remove all laitance and contaminants. Thereafter the joint shall be cleaned and blown out with compressed air to remove all traces of dust. Solvents shall not be used for removing contaminants from concrete and porous surfaces.

Care shall be taken to ensure that primers or adhesives are applied only to surfaces that are absolutely dry. The primer or adhesive shall be applied strictly in accordance with the manufacturer's instructions. Unless otherwise specified, the primer shall be applied within the temperature range of 10°C to 40°C and the sealant shall be applied after the curing period of the primer and within the period during which the primer remains active.

A bond breaking tape (or rope) shall be applied to the filler prior to adding the sealant in order to prevent bondage between sealant and filler.

c. Sealants

Sealants shall be applied strictly in accordance with the manufacturer's instructions by a person skilled in the use of the particular type of sealant. The trapping of air and the formation of voids in the sealant shall be avoided. The sealant shall be finished to a neat appearance flush with the edges of the concrete or to the specified depth.

Thermoplastic hot poured sealants shall not be poured into the joints when the temperature of the joint is below 10°C. The safe heating temperature shall not exceed the specified pouring temperature by more than 10°C.

Two part thermosetting chemically curing sealants shall not be applied after expiry of the specified pot life period, which shall commence once the base and activator of the sealant have been combined.

d. Preformed compression seals

The seal shall be inserted and secured with a lubricant adhesive which covers both sides of the seal over the full area in contact with the inside faces of the joint. The lubricant adhesive shall be applied immediately before the seal is inserted.

The seal shall be installed in a compressed state, with the appropriate equipment, so that the seal will remain in compression even under the most adverse conditions. The final position of the seal shall be as shown on the Drawings or as directed by the Employer's Agent.

Joints in seals shall be bonded or fused and shall be only at positions agreed on by the Employer's Agent.

e. Waterstops

i. General requirements

Employer:		Contractor:	
Witness:		Witness:	

The waterstops shall be supplied in unjointed standard production lengths. Site jointing shall be limited to the absolute minimum. Where lengths in excess of the standard production lengths are required, such longer lengths shall preferably be factory jointed.

At intersections, transitions and abrupt changes of direction, factory moulded watertight junction pieces shall be used so that any site jointing can be restricted to simple joints.

When a waterstop with a centre bulb is intersected, the centre bulb shall be continuous throughout the intersection irrespective of the makeup of the intersection.

ii. Rubber Waterstops

All joints shall be vulcanized and shall have a tensile strength of at least eighty (80) per cent of that of the unjointed material for water retaining structures, and fifty (50) per cent for other structures.

Site joints shall be vulcanized joints made in accordance with the requirements of these Specifications and the manufacturer's instructions, and with equipment prescribed or supplied by the manufacturer and approved by the Employer's Agent.

The vulcanizing process shall be a hot process with strict control on the pressure, the temperature and the time. The vulcanizing temperature shall be between 150 °C and 160 °C. The rubber shall not be heated above 160°C. The vulcanizing time for the specific type of rubber of the waterstops involved shall be determined with a curometer for the abovementioned vulcanizing temperatures before a vulcanized joint is made. The recommended pressure between the two sections which must be vulcanized is 3,4 MPa and the minimum allowable pressure is 2,4 MPa.

The contact faces of the sections to be jointed shall be accurately and evenly cut at the angle shown on the Drawings or prescribed by the Employer's Agent to obtain a precise fit and complete contact.

Care shall be taken to keep centre bulbs unobstructed at the joints so that the lateral flexibility of the waterstops will not be affected by the presence of clotted rubber inside the bulbs.

The rubber of the waterstop shall not have any porosity of voids between the contact faces of the sections and/or at the finished vulcanized joint, especially at the centre bulb.

The vulcanizing equipment shall comply with the following minimum requirements:

The heating elements shall be equipped with an automatic temperature control device to keep the elements at the required temperature.

It shall be equipped with an automatic temperature control device to keep the heating elements at the required temperature, with a device to measure the temperature at the vulcanizing plane, a device to

Employer:		Contractor:	
Witness:		Witness:	

measure the temperature applied to the external faces of the rubber, and with a pressure gauge to regulate the applied pressure within the specified limits in relation to the liquidity of the rubber.

During the vulcanizing process, the pressure shall be spread evenly over the entire contact area and the pressure plates shall be sufficiently rigid that they will not bend under the applied pressure. The cut-out forms of the pressure plates shall fit accurately over the waterstops so that all the faces of the waterstops will be in contact with the pressure plates.

The planes of contact of the two sections of the waterstops to be joined together shall be prevented from sliding from each other when pressure is applied to the plates.

A shield shall be available to shield the apparatus against wind, rain, etc. when joints are made in the open to ensure proper temperature control.

The apparatus as a whole shall be safe in all respects and shall comply with all the appropriate statutory requirements.

iii. Plasticized, Flexible PVC Waterstops

The waterstops shall be manufactured from high quality virgin material and shall not contain any scrap or reclaimed material. The waterstops shall be light coloured to reduce heat absorption when exposed to sunlight.

The waterstops shall be precision moulded or extruded to the required cross sectional profile, they shall be free from porosity or other imperfections, and shall be provided with eyelets so that they can be securely fixed to prevent displacement during concreting.

All joints shall be butt jointed hot welded joints. Where joints cannot be factory made, Site joints shall be made in accordance with the manufacturer's instructions with equipment prescribed or supplied by the manufacturer and approved by the Employer's Agent.

PSG 5.5.18 Building in of Pipes

The Contractor under this Contract shall be responsible for building in or caulking and making watertight around all pipes and fittings which pass through walls or under floors of the structures, irrespective of whether the Contractor himself supplies and installs the pipes and fittings, or the Employer purchases the pipes and fittings and the Contractor under this Contract takes delivery and installs them, or some other contractor (e.g. a plant supplier) supplies and installs the pipes and fittings in recesses or through holes left in the various structures for the reception of such pipes and fittings. In the latter case, the Contractor under this Contract will be paid for forming the openings for and caulking of these pipes or fittings under the item provided for this purpose in the Schedule of Quantities.

Employer:		Contractor:	
Witness:		Witness:	

Where pipes or specials are required to pass through or be set into concrete work, holes shall be left in the concrete.

Before commencing, the positioning in holes of any pipes/specials the Contractor shall:

- a. cut the reinforcement to allow the pipe to be installed.
- b. remove all shuttering and boxing remaining in the holes.
- c. make any alterations required to the position and shape of the holes.
- d. thoroughly clean the sides of the holes so as to obtain a satisfactory bond surface for the new concrete; and

After accurately positioning the pipes/specials in their respective holes, the Contractor shall fix the pipes/specials in the holes.

Immediately before grouting is carried out by the placing of mortar and concrete around the pipes, the surface of the existing concrete shall be saturated with water. All surplus water shall be removed, and the surface covered with a layer, approximately 12 mm thick, of mortar consisting of 3 parts of concrete sand and 1 part of cement.

The concrete ingredients shall be mixed and placed as dry as possible to obtain a dense, waterproof concrete. Where a watertight seal is required, the concrete shall be carefully worked around the puddle flange, if any, and the pipe barrel or body of the special, and shall be vibrated in layers so as to obviate any falling away from pipe/special surfaces of the concrete already placed. The whole shall, when set, form a dense, homogeneous, and waterproof mass. A spare vibrator with an independent power source shall be kept in readiness to ensure continuity of placing in the event of the breakdown of the duty vibrator.

Smooth formwork that has been suitably strengthened for use with a vibrator shall be provided for facing the concrete around each pipe/special.

Alternatively, pipes may be cast into the wall in which case the pipes shall be installed in the required position with the formwork fixed around them and the concrete worked thoroughly into contact.

PSG 5.5.19 Foundations for Mechanical Equipment

The mechanical contractors shall supply the holding down bolts for all mechanical equipment, together with all dimensions and other details necessary for the construction of the pedestals and holding down bolt pockets, or the fixing of the bolts. The Contractor shall either form pockets for the holding down bolts to be installed at a later stage or he shall position the bolts before the concrete is cast as ordered by the Employer's Agent. The mechanical contractor shall fix, align and level the mechanical equipment after which the Contractor shall grout up the units solidly by filling the voids inside and under the baseplates as ordered with an approved non shrink grout.

Employer:		Contractor:	
Witness:		Witness:	

PSG 5.5.20 Testing for Watertightness

The structure that has to be tested for water tightness shall be filled by water being gradually let in until the top water level has been reached. The water level will then be carefully noted and recorded by the Employer's Agent in relation to a fixed benchmark, and the structure shall be allowed to remain filled for a period of two weeks to permit complete absorption of water by the concrete.

Any loss of water, which may have occurred, shall then be made up by again filling the structure to the top water level and by allowing the water to remain undisturbed for a period of not less than four days. The structure shall be considered to be watertight if the drop in level in 96 hours (less the drop caused by evaporation) does not represent more than 0,06 % of the volume of the structure.

The evaporation shall be measured by the mean drop in level caused by the evaporation of the water in three flat containers floating in the water, being recorded.

The Contractor is free to attend the taking of all measurements by the Employer's Agent.

In the event of an appreciable leakage being evident or visible at any stage of the filling or testing, or in the event of the final degree of watertightness being unsatisfactory, the Contractor shall, when so ordered by the Employer's Agent, discontinue such filling or testing that shall, at his own expense, take approved steps to rectify the leakage, until a test proves that a sufficient degree of watertightness has been obtained.

Before the expiry of the period of maintenance, the Employer's Agent shall have the right to retest the structure for watertightness; results of such further tests will be made available for the information of the Contractor. In the event of these tests indicating an unsatisfactory degree of watertightness, the Employer's Agent will, before issuing the final certificate, again require the Contractor to rectify the leakage, at his own expense, in such a manner as will cause the least interruption of the water supply to consumers and as will ensure the soundness of the work, to the satisfaction of the Employer's Agent.

Should the failure of the structure to pass the first or any subsequent test for watertightness necessitate the draining of the structure, the Employer reserves the right to itself utilise the water by discharging it into its water reticulation network, in which case the Contractor:

- i. shall not have to pay for the subsequent refilling of the structure.
- ii. shall, if applicable, reimburse the Employer for any additional costs incurred to make the water fit for consumption; and
- iii. shall not be entitled to claim for extra time whilst waiting for the water to be discharged into the network.

The costs of retesting the structure for watertightness shall be borne by the Contractor.

Employer:		Contractor:	
Witness:		Witness:	

PSG 5.5.21 Sterilization of the Reservoir

After completion and before commissioning, the reservoir shall be cleaned, washed and disinfected.

All areas inside of the structure shall be washed to the satisfaction of the Employer's Agent and thereafter it shall be brushed with a 15mg/l calcium hypochlorite solution. Upon completion of the disinfection process, the wash water shall be drained from the structure and disposed of at a suitable location offsite. Thereafter the water tightness test can be carried out.

PSG 6 TOLERANCES

PSG 6.2 Permissible Deviations

PSG 6.2.3 Specified Permissible Deviations

Add the following:

Degree-of-accuracy II is applicable.

Every specified permissible deviation is binding in itself. The cumulative effect of permissible deviations will not be considered. The maximum permissible vertical deviation is subject to the other permissible deviations.

Replace subclause 6.2.3(d)(5) with the following:

	Permissible deviation		
	Degree of accuracy		
	III	II	I
	mm	mm	mm
"Vertically, per metre of height subject to a maximum of	5 50	3 30	2 10

PSG 7 TESTS

PSG 7.1 Facilities and Frequency of Sampling

PSG 7.1.1 Facilities

Add the following:

Testing will be done in accordance with SANS Methods 860, 861-3 and 863.

The Contractor shall provide sufficient storage capacity for the concrete cubes and shall arrange to have them tested by an approved laboratory.

The cost of all testing, including the cost of sampling, storage and transport of samples shall be included in the rates tendered for concrete work,

Employer:		Contractor:	
Witness:		Witness:	

PSG 7.3 Acceptance Criteria For Strength Concrete

Add the following:

Test results obtained from the supplier of ready-mixed concrete will not be accepted for evaluation in terms of subclause 7.3, but samples for testing shall be taken of such concrete at the point of placing.

PSG 8 MEASUREMENT AND PAYMENT

PSG 8.1 Measurement and Rates

PSG 8.1.1 Formwork

DELETE "or splays over 20 mm x 20 mm" FROM THE FIRST LINE OF PARAGRAPH 8.1.1.2.

Add the following to paragraph 8.1.1.2:

"Splays up to and including 20 mm x 20 mm will not be measured separately and will be deemed to be included in the formwork costs."

Add the following paragraphs:

8.1.1.7 For construction joints at kickers, all additional costs for formwork to edges up to 300 mm high will be deemed to be included in the rates tendered for vertical formwork to sides of walls and will not be measured separately in narrow widths.

8.1.1.8 No formwork will be measured to edges of blinding layers under structures, and the cost thereof (if needed) will be deemed to be included in the rates tendered for concrete in blinding layers.

8.1.1.9 Back-shuttering or formwork to top revealed surfaces of sloping or conical formwork will only be measured to surfaces of over 40° and up to 85° to the horizontal.

8.1.1.10 Formwork to horizontal surfaces in pump stations, valve chambers, manholes or sumps can either be removed through the manhole cover opening or the Contractor may use permanent formwork at his own cost as no claims in this regard will be considered."

PSG 8.1.2 Reinforcement

Replace the contents of this subclause with the following:

"The unit of measurement for steel bars shall be the ton of reinforcement in place, in accordance with the Drawings or as authorised by the Employer's Agent.

The unit of measurement for welded steel fabric shall be the square meterage of fabric reinforcement in place, and the quantity shall be calculated from the net area covered by the mesh, excluding overlaps.

Clips, ties, separators, stools and other steel used for positioning reinforcement will not be measured, unless these are shown on the bending schedules.

Employer:		Contractor:	
Witness:		Witness:	

The tendered rate shall include full compensation for the supply, delivery, cutting, bending, welding, placing and fixing of the steel reinforcement, including all tying wire, stools, supports and waste."

PSG 8.2 Scheduled Formwork Items

Add the following pay item:

PSG 8.2.7 Chamfers larger than 20 mm x 20 mm

- a. Size and member indicated **Unit: metre (m)**
- b. Ditto for other sizes **Unit: metre (m)**

The unit of measurement shall be the metre length of chamfer formwork provided. Chamfers 20 mm x 20mm and smaller will not be measured for payment and their cost shall be deemed to be included in the rates tendered for formwork.

PSG 8.4.3 Concrete

Item to be priced as per SABS 1200G 8.4.3 but to include admixture specified in PSG 3.5.1.

PSG 8.4.7 Grouting

Rate to cover supply and installation of all grouting for ferrol holes in concrete tank walls made up of material specified in PSG 4.5.3.

PSG 8.5 JOINTS

Delete this pay item and add the following pay item:

PSG 8.5.1 Expansion Joints

Forming expansion joint (Width of joint to be stated) **unit: metre (m)**

The unit of measurement shall be the square metre net area of one face of the concrete that constitutes the joint.

The tendered rate shall cover the cost of all materials and labour for the construction of the joint as specified or shown on the drawings, including the cost of formwork, surface roughening and cleaning, testing and making good.

PSG 8.5.2 Filled Joints

Forming filled expansion joint (Thickness and width of joint to be stated, material of joint filler to be stated) **unit: metre (m)**

The unit of measurement shall be the square metre net area of one face of the concrete that constitutes the joint.

Employer:		Contractor:	
Witness:		Witness:	

The tendered rate shall cover the cost of all materials and labour for the construction of the joint, including formwork, supply and installation of joint filler as specified, testing and making good.

PSG 8.5.3 Sealed Joints

Sealing of joints (Size of finished seal to be stated. Material of joint sealer to be stated). **Unit: metre (m)**

The unit of measurement shall be the linear metre net length of the position where the sealant is applied.

The tendered rate shall cover cost of supplying, preparing and application of the joint sealer as specified including testing and making good. Other costs related to the joint will be covered by items PSG 8.5.1 or 2 as the case may be.

PSG 8.5.4 Joints with Waterstop

Separate items will be scheduled for:

- a. Waterstops in a straight-line **Unit: metre (m)**
- b. Waterstops on a curve **Unit: metre (m)**
- c. Extra-over items (a) and (b) above for factory moulded intersection pieces (described) **Unit: Number (No)**

Full description of waterstop with the relevant dimensions to be stated.

The unit of measurement shall be the linear metre net length of waterstop installed, measured along its central bulb.

The tendered rate shall cover the cost of supplying and installation of the waterstop. Other costs related to the joint will be covered by items PSG 8.5.1; 2 and/or 3 as the case may be. Regarding the intersection pieces, the rate shall also include the joining of the intersection piece on site with straight or curved water stops.

PSG 8.7 Grouting

Add the following pay items:

PSG 8.7(c) Grouting in of equipment supplied and installed by the Plant Supplier

- i. using non shrink grout (state type) **unit: cubic metre (m³)**
- ii. using dry packed grout **unit: cubic metre (m³)**

The unit of measurement shall be the cubic metre of completed grouting.

The tendered rate shall include full compensation for supplying of all materials, mixing, applying and finishing to a steel float surface finish after installation of the Plant.

Add the following pay items:

Employer:		Contractor:	
Witness:		Witness:	

PSG 8.10 Testing Structures for Watertightness

The unit of measurement for testing for watertightness shall be the lump sum.

Unit: Lump sum

The tendered rate shall include full compensation for the provision of all labour, plant and materials necessary for testing the structure for watertightness as specified, and for emptying it afterwards, all to the satisfaction of the Employer's Agent.

PSG 8.12 Casting in Pipes

The tendered rate shall include full compensation for the provision of all labour, plant and materials necessary for the casting in of pipes (size, type and location indicated) as provided in Clause 5.5.18.

PSCE 4. GENERAL CIVIL ENGINEERING STANDARD SPECIFICATION

PQC Carpentry, Joinery and Ironmongery

PQC 1 Treatment of Timber

All timber, other than that to be used for joinery, shall be treated with an approved industrial wood preservative such as CCA (Copper-Chrome-Arsenate) in accordance with the statutory regulations and SANS 10005. Proof that such treatment has been carried out shall be given to the Employer's Agent, should he request it.

PQC 2 Wrought Face

All exposed woodwork, unless otherwise described, is to be wrought and for each wrought face a maximum of 1,5 mm will be allowed off the specified sizes. All wrought faces are to be finished smooth and free from tool marks.

PQC 3 Structural and Engineering Timber

All timber to be used in general structural work shall conform to the requirements of SANS 1783-2 for stress Grade V.5 with a density of at least 360 kg/m³, unless otherwise scheduled.

Where a stress grade other than V.5 is called for, the timber used shall conform to SANS 1783-2 for engineering timber. Where reference is made to SABS 1783 for Engineering Timber, the strength grade shall be V.10 with a density of at least 475 kg/m³, unless otherwise scheduled or shown on the drawings.

PQC 4 Shrinking, Wrapping and Twisting

Should any timber member shrink or warp more than 3 mm or twist more than 2° over its full length, it shall be removed, and new timber supplied and re-fixed in

Employer:		Contractor:	
Witness:		Witness:	

its place, together with any other member which may thereby be affected, at the Contractor's expense.

PQC 5 Prefabricated Roof Trusses

Prefabricated timber roof trusses shall be made from South African pipe complying with PQC 3 above, having a stress grading of V.6 and bearing the SABS mark. The joints shall be butted and joined with suitably sized "gang nail" or similar approved galvanised connector plates. Each joint shall be capable of withstanding a loading of at least 50% in excess of that imposed by the maximum design load for the truss.

The designs of the prefabricated trusses the Contractor proposes shall be carried out and signed off by a registered Professional Engineer and a copy of the drawings and a signed certificate to that effect shall be submitted to the Employer's Agent or Representative prior to the trusses being delivered to site. The drawings shall show the following minimum information for each type of truss required:

- a) The design spans.
- b) The overall height from underside of cross beam to apex.
- c) An elevation of the truss showing the size of all the members, the position of the purlins and the spacing of the trusses along the line of the roof.
- d) The "gang nail" plate sizes at every joint.
- e) The type of roof covering material and the design loading.

PQC 6 Roof Timber Work

PQC 6.1 Bolted Roof Trusses

These trusses, including the tie beams shall be made from timber having a stress grading of V.4 and shall be constructed to the dimensions shown on the drawings or as scheduled. The trusses shall be strongly framed, halved, checked and bolted together in the best manner and in accordance with acceptable practice. The work is to be soundly secured and accurately lined and set to conform with the overall sizes given. The timber shall be wrought where exposed to view.

Bolts, unless otherwise specified or scheduled, shall be 12 mm diameter, of adequate length and provided with a pair of 50 mm diameter x 2,0 mm thick circular washers.

Notwithstanding the above requirements, the Contractor shall arrange to have the truss designs checked by a registered Professional Engineer and submit a copy of a signed certificate to that effect to the Employer's Agent or Representative prior to the materials required to manufacture the trusses being placed.

PQC 6.2 Timber Wall Plates, Purlins and Other Members

Employer:		Contractor:	
Witness:		Witness:	

Timber roof members shall be manufactured from timber complying with PQC 3 above and shall be cut to the dimensions shown in the drawings, mitred and jointed where necessary. Joints in straight runs of timber shall be spliced and nailed, with the length of splice being at least 5 times the depth of the member and the nail centres equal to the depth. The number of joints shall be minimised to the satisfaction of the Employer's Agent or Representative.

All members which are built into brickwork or blockwork, and all faces of members exposed to the weather, shall receive a suitable, approved wood treatment.

PCQ 6.3 Facias and Barge Boards

Facias and barge boards shall be equal .

PQC 6.4 Eaves Closures

Eaves shall be concealed if scheduled and/or shown on the drawings.

PQC 7 Ceilings

PQC 7.1 Normal Sheeted Ceilings

The underside of roof tie beams shall be lined with the ceiling material shown on the drawings or as scheduled. Ceiling materials shall be nailed to the brandering with galvanised clout nails in countersunk holes and stopped with putty, where not covered with cover strips. Brandering shall be of at least 38 x 38 mm square section and shall be provided at no more than 560 mm centres to suit ceiling panels and with cross brandering, where required, at not more than 1 200 mm centres, cut in flush at joints and side nailed. All joints in the brandering shall be scarfed joints. The ceiling panels which shall not exceed the sizes recommended by the manufacturer, shall be nailed every 150 mm along the panel edges and at a distance of 10 mm in from the edge. Suitable metal strips, covering the joints and returned around cornice lines, shall be provided. Special serrated ceiling nails shall be used in accordance with the manufacturer's recommendations.

Ceilings shall be fitted only after completion, testing and acceptance of all electric wiring required to be laid in the roof space above, except where ordered to the contrary by the Employer's Agent or Representative.

A trapdoor 600 x 600 mm covered, framed and supported in accordance with acceptable practice, shall be provided to gain entry into each void in the ceilings.

Formed cove cornice 55 x 55 mm shall be fixed to the ceiling, plugged to walls and neatly mitred at all corners. Coving shall extend for the full peripheral length of all ceiling to wall junctions.

PQC 7.2 Patented Ceilings

Where the ceiling shown on the drawings or schedule is to be of a patented type, the materials supplied, and the workmanship of fixing shall be strictly in accordance with the manufacturer's specifications.

Employer:		Contractor:	
Witness:		Witness:	

PQC 7.3 Thermal Insulation to Ceilings

Thermal insulation materials shall comply with SANS 1381 and be of the required thickness, but not less than 50 mm. The insulation shall fully cover the total ceiling area, to be insulated as indicated on the drawings.

PQC 8 Wooden Doors and Frames

PQC 8.1 Door Frames

All wooden door frames shall be manufactured from hardwood (dark red meranti or better), rebated, and grooved if required for plaster, and dowelled into the floor with 16 mm diameter x 125 mm long steel dowels. Hardwood quadrant fillets, neatly mitred at angles, are to be fitted around all frames where abutting on concrete, plaster or brickwork. Door frames shall be secured to brickwork and concrete work with an approved type of fastening, spaced at not more than 600 mm centres.

PQC 8.2 Hardwood Doors

Hardwood doors shall be heavy duty framed, ledged, braced and battened solid wood doors of dark red meranti or similar approved hardwood manufactured in compliance with SANS 545, for Class 2 (semi-interior) exposure. The timber shall comply with SABS 1099 without any laminations and the finished door shall be 44 mm thick for use with solid timber frames.

Where steel frames are specified on the drawings or scheduled, the doors shall be 40 mm thick or such other thickness to suit the steel frames being supplied.

Double leaf doors shall be one way opening with rebated meeting stiles.

All exterior doors shall be of standard dimensions, except where scheduled to the contrary.

PQC 8.3 Interior Timber Doors

Interior timber doors shall be medium duty veneered doors in compliance with SANS 545 and suitable for Class 4 (dry interior) exposure. All doors shall have both edges concealed.

The veneer shall be of the natural finish suitable for varnishing, except where painting of the doors is required by the drawings or is scheduled in the Bill of Quantities, in which case the veneer shall be suitable for such painting.

All interior doors shall be of standard dimensions and 40 mm thick.

PQC 9 Ironmongery

PQC 9.1 General

Employer:		Contractor:	
Witness:		Witness:	

Approved locks, hinges, cabin hooks, door stops, and other hardware shall be provided to doors. All ironmongery and fixings shall be chromium plated on brass, except where otherwise specified.

PQC 9.2 Hinges

Hardwood doors in hardwood frames are to be provided with brass washered, brass pinned, brass butt hinges as scheduled with three hinges per leaf. Hinges on steel door frames shall be supplied with, and be part of, the pre-manufactured steel door frames.

Parliament hinges are to be supplied and fitted to doors where scheduled or shown on the drawings to enable those doors to open through approximately 180 degrees.

PQC 9.3 Door Locks and Furniture

Internal doors shall be fitted with a two-lever mortice lock unless otherwise scheduled.

External doors are to be fitted with a lock as scheduled, either a night latch (to be supplied by the Employer) and a Henderson No 463 bow handle, secured with brass bolts passing through the door with nuts on the inside or, a three lever mortice lock which shall be rebated if fitted on a pair of double doors.

WC doors are to be fitted with an approved indicator bolt and keep.

PQC 9.4 Keys

All keys supplied shall be clearly labelled. Two keys are to be supplied for each lock. Where scheduled, two identical master keys are to be supplied for each suite of locks e.g. two master keys for all of the two lever locks, two master keys for all of the three lever locks and two master keys for all night latches.

PQC 9.5 Cabin Hooks and Eyes

One 200 mm brass cabin hook complete with eye shall be supplied and fitted to each outward opening door and hardwood blocks are to be securely fixed to the adjoining walls, or to a 100 x 100 mm hardwood post set in concrete as scheduled.

PQC 9.6 Sundry Items

On all double doors, the second leaf to open shall be fitted with a brass barrel bolt and keep at top and bottom. In the case of doors with a height greater than 2,2 m, the upper barrel bolt shall be a monkey tail bolt with a tail of a suitable length.

Towel rails, toilet roll holders, hat and coat hooks, door stops and the like that are scheduled in the Bill of Quantities and/or shown on the drawings, are to be supplied and installed in accordance with good practice.

Employer:		Contractor:	
Witness:		Witness:	

PQC 10 Measurement and Payment

- PQC 10.1** Carpentry and joinery will be measured and paid for in accordance with the units and rates scheduled. The Contractor is to include for all beads, fillets, stops, grounds and all rebating, tenoning, grooving, housing, morticing, framing and planning and all other necessary work to complete the whole of the carpentry and joinery work in the best manner according to details on the drawings and/or in the Bill of Quantities. Payment for wood preservation will not be made separately as the cost is deemed to be included in the rates tendered for timberwork.
- PQC 10.2** Prices for timber work, where scheduled separately, shall include for all necessary working, cutting, trimmings, application of preservative to build in portions of the work, etc, and for providing all necessary cleats, spikes, bolts, nails, etc. Measurement of the various members shall be taken as that of each size of timber from which the member can be cut, taken to the nearest length of 150 mm in excess of the actual required length. **Unit: m**
- PQC 10.3** Factory made roof trusses shall be paid for by number for each building.....Unit: No
- PQC 10.4** Wall plates and purlins will be paid for per lineal metre. **Unit: m**
- PQC 10.5** Facias will be paid for per lineal metre. **Unit: m**
- PQC 10.6** Barge boards will be paid for per lineal metre. **Unit: m**
- PQC 10.7** Payment for ceilings will be made by the actual surface area of finished ..ceiling taking into account whether the ceiling plane is horizontal or sloping. **Unit: m²**
- PQC 10.8** Payment for ceiling brandering shall be made by area of ceiling to be attached thereto but only where scheduled separately. **Unit: m²**
- PQC 10.9** Payment for thermal insulation to ceilings, if scheduled or shown on the drawings will be made on the same basis as for the ceiling and for each specified thickness of insulation layer. **Unit: m²**
- PQC 10.10** Prices for coved cornices shall be per lineal metre. **Unit: m**
- Prices for ceilings and associated activities shall include the provision of all materials (including waste and fastenings) and for all labour and plant required to complete the ceilings as shown on the drawings.
- PQC 10.11** Payment for eaves closures/cladding will be made on the same basis as for ceilings (see PQC 10.7 above) **Unit: m²**
- PQC 10.12** Payment for ironmongery will be made per item supplied and installed and shall include for the provision of all labour, plant and materials required to complete the respective items of work. **Unit: No**

PQD Steel Doors and Frames

PQD 1 Doors

PQD 1.1 Pressed Steel Door Frames

Employer:		Contractor:	
Witness:		Witness:	

Pressed steel door frames shall be of welded one piece construction or of an approved knock-down type for assembly on site, and constructed of mild steel sheet, pressed or rolled to the required shapes.

Frames for walls one brick thick shall have a single rebate profile and the frame material shall be at least 1,6 mm thick. All other frames, unless otherwise specified, shall be double rebated and manufactured from metal at least 1,6 mm thick.

Frames shall be of widths required to suit the thickness of walls into which they are to be built and shall be fitted with suitable tie-bars and braces at bottom, and lugs for building in three to each jamb of frames without fanlights, and four to each jamb of frames with fanlights. Where fanlights are shown over doors, the frame shall be fitted with transoms of pressed or rolled steel sheet as above rebated for fanlights and for doors if required and shall have a nominal thickness of at least 1,6 mm thick metal. The rebates in frames and transoms for doors and fanlights shall be of widths required to suit the thickness of doors and fanlights.

Frames shall have holes as and where required for screws for fixing fanlight openers, keeps of spring catches, etc. Where fanlights are shown to be fixed into frames, the frames shall be holed and tapped in the rebates suitable for screws for fixing the top centres.

Frames for single doors shall be fitted with an approved chromium plated, or stainless steel (unless otherwise specified) adjustable striking plate keep, boxed in at the back of the frame with a sheet metal box welded on, and not less than two rubber buffers.

All welding shall be cleaned off smooth and flush on exposed surfaces and frames shall be cleaned and primed as described for steel windows, before leaving the manufacturer's works.

PQD 1.2 Steel Doors, Sidelights and Fanlights

PQD 1.2.1 General Requirements

Steel doors shall comply with the requirements of SANS 727, constructed from mild steel sheet of at least 1,6 mm thick metal.

All doors, sidelights and fanlights shall, in addition, comply with the following requirements:

- i) Suitable weather bars shall be provided to render external doors, etc, perfectly watertight.
- ii) Frames of doors, etc. where fixed to concrete columns, beams, etc, shall be provided with suitable lugs for fixing to plugs in the concrete at same spacing as the standard fixing lugs.
- iii) Doors, sidelights, fanlights and components, except where specified to be hot dip galvanised, shall be cleaned and primed as described below.

Employer:		Contractor:	
Witness:		Witness:	

Door, sidelights and fanlights unless otherwise shown, shall be of "one piece" construction, but where shown to be in two or more "one piece" units, the units shall be coupled together with standard coupling mullions and/or transoms.

Bottom openings in doors and sidelights shall be fitted with kicking plates of one thickness of 1,6 mm thick mild steel sheet fixed with metal beads.

Frames for outward opening doors shall be fitted at the bottom with sills of door framing section (stepped sills) and frames for inward opening doors with metal ties, welded to frames, for embedding in thresholds (flush sills).

After doors, sidelights and fanlights have been built in and before being glazed, they shall be checked for alignment, adjusted as necessary, and left in a satisfactory state and in good working order.

PQD 1.2.2 Stock Doors Units

Stock doors, sidelights and fanlights shall be of the type scheduled or shown on the drawings. The doors shall be constructed of not less than 33 mm universal steel sections, and sidelights and fanlights of 25 mm sections as described for windows.

Each leaf of a double door and each single door shall be hung on three steel hinges having brass pins. Hinges shall be of the parliament type where frames are set back from wall faces and where doors are shown to fold back against these faces. Fanlights shall be hung and fitted as described for steel windows.

PQD 1.2.3 Purpose made Door Units

Purpose made doors, sidelights and fanlights shall be as described in 1.2.2 above but constructed to the forms and sizes shown on the drawings. Unless otherwise specified, the doors shall be of not less than 33 mm universal sections and the sidelights and fanlights to standard 25 mm sections.

PQD 1.3 Payment for Doors

Door units shall be supplied and installed complete with frame, hinge, locks and bolts as scheduled or detailed on the drawings.

Each size and type shall be measured separately.

Unit: No

PQD 2 Steel Windows

PQD 2.1 Materials

Stock residential and industrial type steel windows shall comply with the requirements of SANS 727, and all other types shall comply with the constructional and other requirements of the above specification wherever applicable. All windows shall, in addition, comply with the following additional and/or amended requirements, viz:

- i) Suitable weather bars shall be provided to the bottom of inward opening and vertically pivot hung ventilators and also to the bottom of all outward opening

Employer:		Contractor:	
Witness:		Witness:	

ventilators where they occur above other ventilators and elsewhere as may be required to render the windows perfectly watertight.

- ii) Frames for windows where fixed to concrete columns, beams, etc, shall be provided with suitable lugs for fixing to plugs in the concrete, or with holes for screwing to plugs in the concrete, all at the same spacing as the standard fixing lugs.
- iii) Windows and components, except where specified to be hot dip galvanised, shall, before leaving the manufacturer's works, be cleaned by acid pickling, rinsing and drying, as laid down in SANS 10064, or by other approved means, to remove all scale, rust, grease, oil and foreign matter, and then primed with an approved red oxide zinc chromate primer applied by dipping or by means of spray guns.

Ventilators hung at one side to open outwards for windows above ground floors and not accessible for cleaning from an adjoining opening ventilator in the same window or from verandas, balconies and the like, shall be hung on projecting hinges.

Windows, unless otherwise specified, shall be of one piece construction but where shown to be in two or more "one piece" units, the units shall be coupled together with standard coupling mullions and/or transoms.

Windows shall be fitted with brass handles, stays, catches and other fittings as later described. Those for windows constructed of universal sections shall have a polished finish, whereas all other windows shall have a tumbled finish. The fittings shall be fixed in such a way as to be removable after the windows are glazed.

After the windows have been built in, but before being glazed in accordance with Particular Specification: PQE Glazing, they shall be checked for alignment, adjusted as necessary, and left in a satisfactory state and in good working order.

PQD 2.2 Construction

The various type of windows shall be constructed as follows:

i) Stock Residential Type Windows:

Stock residential windows shall be of the types shown on drawings, constructed of standard 25 mm steel sections with metal not less than 3 mm thick.

Side hung ventilators shall be hung on steel hinges having brass pins and shall each be fitted with a casement fastener and sliding stay.

Top hung ventilators shall be hung on hinges as above and shall each be fitted with combined fanlight stay and fastener size 200 mm for one pane high ventilator and size 250 mm for two panes with ventilators.

Bottom hung ventilators shall be hung on hinges as above and shall each be fitted with approved concealed friction side arms and a spring catch and keep.

Pivot hung ventilators shall be hung on friction pivots and shall each be fitted with a spring catch and keep.

Employer:		Contractor:	
Witness:		Witness:	

Projected out ventilators shall slide on approved spring loaded brass shoes, sliding in the channels of the fixed frame, and shall be balanced on steel arms, pivoted at ends and housed within the vertical frames; ventilators shall each be fitted with an approved casement fastener at the bottom.

ii) Purpose Made Residential Type Windows:

Purpose made residential type windows shall be as described in (i) above but constructed to the forms and sizes shown on the drawings.

iii) Stock Industrial Type Windows:

Stock industrial type windows shall be of the types shown on the drawings, constructed with main frames of not less than 33 mm steel sections with metal not less than 3 mm thick, and with ventilators of standard 25 mm sections with metal not less than 3 mm thick.

Pivot hung ventilators shall be hung on friction pivots and shall each be fitted with a spring catch and keep.

Bottom hung ventilators shall be hung on steel hinges having brass pins and shall each be fitted with approved concealed friction arms and a spring catch and keep.

iv) Purpose Made Industrial Type Windows:

Purpose made industrial type windows shall be as described in (iii) above but constructed to the forms and sizes shown on drawings.

PQD 2.3 Payment for Windows

Window units shall be supplied and installed complete as specified, scheduled and detailed on the drawings, excluding glazing which is measured separately.

Payment will be by number for each type and size.

Unit: No

The tendered rates shall include for the provision for all materials (including fastenings, hinges and ironmongery) except where scheduled separately, and for all labour and plant required to build the windows into the structures.

	Applicable Clauses	Kansai Plascon References	Dulux References
Pre-paint treatment:			
Bonding liquid	3.4.1	CVI.14	5147198
Knotting for timber	3.1	PK.2	-
Wood stopping	3.1	BS	-
Porous surface sealer	3.1	CVI 14	-
Primers for:			
Acrylic coat filler	3.2.1	PP 500	5147618

Employer:		Contractor:	
Witness:		Witness:	

Plaster (alkali resistant)	3.2.1	UC.56	5147200
Hardboard	3.2.2	UC 56	-
Softwood timber	3.2.2	UC.2	5147196
Galvanised iron	3.5.1	G.I.P.	5147204
	3.5.2		
Aluminium	3.5.3	SNS 1	-
Water-Based Paint Systems:			
PVA emulsion	3.2.1	EPL	5147037
Acrylic PVA	3.3.1	PEM 600	5147037
Texture coating	3.3.2	FLX	5147080
Acrylic roof paint	3.4.1	TRP	5147005
Oil-Based Paint Systems:			
Universal undercoat	3.2.2, 3.3.3, 3.5.2	UC.1	5147206
Stain for wood	3.2.3	W 1	5147400
Alloyed roof paint	3.5.1	AW 255	-
Gloss enamel	3.2.2, 3.3.3, 3.5.2	G - Range	5147208
Interior varnishes:			
wood-gloss	3.2.3	X.33	5147426
matt	3.2.3	X.44	5147430
Exterior varnishes:			
wood-gloss	3.3.4	-PNW - Gloss	5147422
matts	3.3.4	-PNW - Suede	-

PQH Painting

PQH 1 Scope

This specification covers the normal work required for small to medium size buildings. It does not cover the painting of steelwork (which is covered by SANS 1200 HC as amended by PSHC), but does include painting of galvanised iron for roof sheeting, gutters, downpipes, etc.

This specification should be adhered to, but as the formulation of paints is subject to continual modification, the specification for a particular material may be amended, should the paint manufacturer recommend an improvement thereto and provided such amendment receives the prior approval of the Employer's Agent or Representative.

Employer:		Contractor:	
Witness:		Witness:	

A change of specification purely to reduce costs by using less suitable materials will not be acceptable.

PQH 2 Materials

PQH 2.1 General

All materials which are to be used for painting under this Contract shall be from the same approved manufacturer (except in special cases which have had prior approval from the Employer's Agent or Representative) and shall be supplied in unopened containers. Thinning will be permitted only in conformity with the applicable manufacturer's recommendations.

The approved manufacturer of the paints shall be either Plascon or Dulux or as selected by the Contractor. Other manufacturer's products may be used, subject to them being approved by the Employer's Agent or Representative prior to any orders being placed.

The paint systems to be applied shall be the applicable of the systems itemised in PD 3.2 to 3.5 hereunder.

PQH 2.2 Approved Materials

The following materials, as supplied by the selected paint manufacturer, are approved for use under this Contract.

PQH 3 Application

PQH 3.1 Surface Preparation

All surfaces to be painted must be thoroughly degreased, clean and dry prior to commencement of painting. The local environs are to be free from dust whilst painting is in progress.

Ironmongery and fittings not to be painted shall either be removed and subsequently replaced or be suitably masked to prevent paint spots or streaks adhering to the surfaces.

All cracks are to be filled with the paint manufacturer's recommended filler suitable for the purpose and for the location (i.e. interior or exterior work). After drying, the filler is to be rubbed down to a smooth surface, flush with the adjacent surfaces.

Porous surfaces must be sealed in accordance with the paint manufacturer's recommendations. Timber work shall be knotted and stopped as necessary prior to commencing painting. All surface preparation shall be in accordance with the paint manufacturer's specifications.

PQH 3.2 Painting Interior Surfaces

PQH 3.2.1 PVA Emulsion System

Employer:		Contractor:	
Witness:		Witness:	

3.2.1.1	Cement plaster, & concrete	Apply one coat of acrylic filler coat followed by two coats of PVA emulsion paint
3.2.1.2	Gypsum plaster, hardwall plaster & gypsum board	Apply one coat of alkali resistant primer followed by two coats of PVA emulsion paint
3.2.1.3	Hardboard	Apply one coat hardboard primer followed by two coats of PVA emulsion paint

PQH 3.2.2 Gloss Enamel System

3.2.2.1	Cement plaster, gypsum plaster hardwall plaster & gypsum board	Apply one coat of alkali resistant primer followed by one coat universal undercoat and one coat of gloss enamel
3.2.2.2	Hardboard	Apply one coat hardboard primer followed by one coat of universal undercoat and one coat of gloss enamel
3.2.2.3	Softwood timber	Apply one coat of oil based wood primer followed by one coat of universal undercoat and one coat of gloss enamel

PQH 3.2.3 Stain and Varnish System

3.2.3.1	Softwood timber	Apply one coat of stain followed by two coats of varnish (matt or gloss as ordered)
3.2.3.2	Hardwood timber	Apply two coats of varnish (matt or gloss as ordered)

PQH 3.3 Painting Exterior Surfaces

PQH 3.3.1 Acrylic PVA System

3.3.1.1	Cement plaster, & concrete	Apply one coat of acrylic filler coat followed by two coats of acrylic PVA paint

Employer:		Contractor:	
Witness:		Witness:	

3.3.1.2 Asbestos board Apply one coat of undercoat followed by two coats of acrylic PVA paint

PQH 3.3.2 Texture Coating System

Cement plaster & concrete Apply two coats of texture coating paint

PQH 3.3.3 Gloss Enamel System

Cement plaster As per 3.2.2.1 for interior surfaces
Softwood timber As per 3.2.2.3 for interior surfaces

PQH 3.3.4 Varnish System

Hardwood Apply two coats of ultra violet resistant varnish (matt or gloss as ordered)

PQH 3.4 To Roof Areas (Other than Galvanised Iron)

PQH 3.4.1 Acrylic PVA System

Cement tiles, clay tiles, asbestos tiles, & asbestos sheets Apply one coat of bonding liquid followed by two coats of acrylic emulsion roof paint

PQH 3.5 To Non Ferrous Metal Surfaces

PQH 3.5.1 Galvanised Iron Roofs

Apply one coat G.I metal primer followed by one coat micaceous iron ore roof paint

PQH 3.5.2 Galvanised Iron Tubes etc

Apply one coat G.I metal primer followed by one coat universal undercoat and one coat gloss enamel

PQH 3.5.3 Aluminium Surfaces

Employer:		Contractor:	
Witness:		Witness:	

Apply one coat of aluminium primer followed by one coat of universal undercoat and one coat of gloss enamel.

PQH 4 Measurement and Payment

Measurement and payment for paintwork will not be made separately, except where so scheduled in the Bill of Quantities. In the latter case, the prices tendered are to cover for the provision of all materials, plant and labour necessary to prepare the surfaces and complete the work as specified. Payment will be made by lump sum for the entire painting work, or by individual sum for each unit scheduled, or by area.

:Individual Sum

Painting of windows will be measured as the overall size of the window frame with both sides being measured and with no deductions made for glazed areas.

Unit: m²

PWB Building Works: Building Specification

PWB 1. SCOPE

This Section deals with the requirements for the building work required to be constructed.

PWB 2. Materials, Workmanship and Products

PWB 2.1 Materials and Workmanship

Materials and workmanship, etc., shall be of the best of their respective kinds. Only new and undamaged materials shall be used in the Works. Materials to be permanently installed in to the Works shall not be used for any temporary purposes on site. Work shall be for the approval of the Employer's Agent and shall be executed in accordance with the relevant manufacturer's written recommendations and instructions.

PWB 2.2 Proprietary Products

For the purpose of submission of tender's items in the bills of quantities have not been described by trade names, catalogue references, etc., at the request of the Employer. Rates supplied shall be for the best type and manufacturer available. The Tenderer shall supply a list of types and manufacturers of items tendered.

Once the Contract has been signed the approval of the Employer's Agent shall be obtained prior to any substitution and where products or materials, etc., other than those listed are used, adjustments in the rates will be made, if deemed necessary.

Employer:		Contractor:	
Witness:		Witness:	

PWB 3. Brickwork

PWB 3.1 Materials

- i) Cement shall comply with SABS 1200 G - Concrete
- ii) Sand shall comply with SANS 1090, washed where necessary and screened through a 2.4 mm mesh sieve.
- iii) Concrete bricks shall comply with SANS 1215 and shall have a minimum compressive strength of 7 MPa.
- iv) Brickwork reinforcement shall be manufactured from hard drawn steel wire conforming to BS 785 and shall consist of two 2.8 mm diameter main wires with 2.5 mm diameter cross wires at 300 mm centres welded at intersections.

Brickwork reinforcement shall be lapped not less than 300 mm at end joints and for a length equal to the width of the widest reinforcement at intersections.

PWB 3.2 Mortar

Mortar shall comply with Table 1.

TABLE 1: Mortar Classes

Mortar Class	Portland Cement Kg	Lime Litres	Sand (measured loose and damp) Litres max.
I	50	0 - 10	130
II	50	0 - 40	200
III	50	0 - 80	300

Mortar mixing shall be done with mortar mixing machines or on clean non-absorbent close jointed platforms. The platforms shall be well cleaned before mixing each batch.

PWB 3.3 Setting up and Building in of the Door Frame, etc.

Wherever windows, frames, etc., are fixed in brickwork or concrete or against steel or wood, they shall be left perfectly watertight and the descriptions shall be deemed to include for the following:

- Building of brickwork hard up against windows, frames, etc., cutting of mortises and pinning or building in of lugs in mortar or screwing to plugs in concrete, including holes, screws and plugs, bedding solid in mortar around windows, frames, etc., as necessary and pointing all round on both sides.
- Screwing to wood at not exceeding 500 mm centres, including all necessary countersunk screws and holes.
- Necessary bracing and strutting of door, frames, etc., to prevent distortion.

Employer:		Contractor:	
Witness:		Witness:	

PWB 3.4 Paving, Sills, Copings, etc.

Bricks and ties shall be soaked with water before fixing and shall be solidly bedded and jointed in Class 1 mortar and pointed with slightly keyed joints.

Descriptions of brick or tile sills, copings, treads, risers, skirtings, etc., shall be deemed to include for fair ends and angles except where different bricks or tiles are used, or special cutting is required and for cutting and fitting between reveals.

PWB 3.5 Protection

Faced brickwork, quarry tiles, etc., shall be carefully protected from damage and mortar splashes and shall be thoroughly cleaned down as the work proceeds.

PWB 3.6 General Brickwork

PWB 3.6.1 General

Care shall be taken to keep cavities free from mortar droppings or other mortar and temporary openings shall be left at the bottom of walls through which any droppings, etc., can be removed on completion and on completion these are to be bricked up.

Weep holes shall be formed, at approximately 900 mm centres, in the outside skin of cavity walls by leaving open perpends in the lowest course of brickwork immediately above the damp-proof course.

Brickwork shall be built within normally accepted tolerances being vertical as reflected on a builder's level and without bowing or bulging. Bowing or bulging in excess of 10 mm over any 3 m length will be rejected as unacceptable.

Where brickwork, built to unacceptable tolerances, is not condemned by the Employer's Agent, any resultant additional costs involved in modifications to finishes or other components shall be for the account of the Contractor.

PWB 3.6.2 Brickwork

Brickwork shall be built in stretcher bond and Class II mortar shall be used.

The brickwork shall be carried up in a uniform manner, no part being raised more than 1.2 m above adjoining work.

Where necessary, bricks shall be soaked with water before being laid and the course of bricks last laid shall be well wetted before laying a fresh course upon it.

Walls in thicknesses of more than one skin shall have the skins tied together with wire ties, at least five ties per square metre.

Employer:		Contractor:	
Witness:		Witness:	

Hollow walls, unless otherwise specified, shall be built of two half brick skins with cavity between, tied together with wire ties, at least five ties per square metre.

The cavities shall be kept free of rubbish, mortar droppings and projecting mortar.

Descriptions of beam filling shall be deemed to include for cutting and fitting between roof members, carrying hard up to the underside of roof coverings and flushing up in mortar.

Brick walls described as "above plate level" shall be deemed to include for cutting around roof timbers.

Mortar joints to brickwork shall be not less than 5 mm or more than 10 mm thick and descriptions of brickwork, unless otherwise specified, shall be deemed to include for raking out joints whilst the mortar is soft to form an adequate key for plaster or mortar backing.

PWB 3.6.3 Samples

Samples of the bricks to be used on site including face bricks and stock bricks shall be submitted to the Employer's Agent for their approval and after approval of same these samples shall be retained by the Employer's Agent.

Notwithstanding the approval of any samples the Contractor shall ensure that all bricks used on site are well cured and not subject to excessive shrinkage.

Immature bricks shall be rejected.

PWB 3.7 Faced Brickwork

PWB 3.7.1 General

Facing bricks shall be sorted to ensure that proper mixing of the bricks within the colour range of each type of facing brick used is obtained. Sudden changes in the colour of face work in any one type of facing brick will not be acceptable. The various types of facings shall be even in size and shape and equal to samples submitted to and approved by the Employer's Agent before use.

PWB 3.7.2 Bedding and Pointing, etc.

Faced work, except where otherwise specifically described, shall be built in horizontal stretcher bond Class II cement mortar with 9 x 9 mm horizontal joints and perpend, raked out and pointed with square recessed horizontal joints well rubbed to leave a smooth and brushed finish.

Facing bricks shall be sorted to ensure that proper mixing of the bricks within the colour range of each facing brick being used is obtained.

All perpend are to be accurately kept. Scaffold boards against faced work shall be turned away from walls during rain. All electrical conduiting shall be built into facings. No chasing will be allowed, and the Contractor shall allow in their prices for facings accordingly.

Employer:		Contractor:	
Witness:		Witness:	

PWB 4. Waterproofing

PWB 4.1 Materials

Damp proofing and waterproofing shall comply with the Specifications and requirements given in Table 2 below.

TABLE 2: WATERPROOFING MATERIALS

MATERIAL	SANS SPECIFICATION	TYPE AND/OR ADDITIONAL REQUIREMENTS
Bituminous damp-proof course to wall, sills, etc.	248	Type FV
Polyethylene sheet in damp-proof course to walls, sills etc.	952	Type B
Ditto to floors and basements	952	Type C
Mastic asphalt for roofing	297	-
Mastic asphalt for damp-proof coursed and tanking	298	-
Bituminous roofing felt	92	Type 60
Polyethylene sheet for the waterproofing of flat roofs	952	Type A
Chloroprene rubber sheet (for waterproofing)	580	At least 2.5 mm thick and 1200 mm wide
Sealing compounds with two-component polysulphide base	110	Type 2 Gun Grade

PWB 4.2 Application

Waterproofing materials shall be applied in accordance with SANS 10021.

PWB 4.3 Damp Proof Course on Walls

All joints in damp-proof course on walls shall be lapped a minimum of 150 mm except at junctions and corners where the lap shall equal the full thickness of the wall. The damp proof course shall be laid over the full width of all walls, two courses above final ground level as well as under all window sills.

PWB 4.4 Insulation

Insulation shall be heavy industrial grade aluminium foil based or other approved insulating sheets. For purlin spacings of more than 1 200 mm reduce the effective span of the sheets by introducing galvanized wire stringers at 600 mm c/c. All insulation side seams shall have a minimum overlap of 100 mm sealed with 50 mm wide approved adhesive tape.

Employer:		Contractor:	
Witness:		Witness:	

PWB 5. Carpentry and Joinery

PWB 5.1 Materials

Materials and workmanship, etc., shall be of the best of their respective kinds. Only new and undamaged materials shall be used in the Works. Materials to be permanently installed in to the Works shall not be used for any temporary purposes on site.

PWB 5.2 Concrete Roof Tiles

Concrete roof tiles on 38 x 38 mm battens on 114 x 38 mm S.A.P. planed all round, timber trusses to manufacturer's design. Trusses shall be tied to a 114 X 38 mm wallplate with hoop iron ties through a minimum of six courses brickwork.

The pitch shall be as per the drawing.

The eaves shall have a 600 mm overhang and all externally exposed trusses are to be treated with 2 coats carbolineum.

Fascias and bargeboards are to be of fibre cement and painted with 2 coats of Acrylic PVA.

PWB 5.3 Door

The external door shall be 44 mm thick framed, ledged and braced door (meranti) with 44 mm thick stiles and top rail and 22 mm thick middle and bottom ledges and braces. The edges of stiles and top rail to be rebated and grooved for and filled in with 22 mm thick tongued, grooved and V-jointed boarding, twice countersunk screwed to each ledge from the inside. Faces of doors shall be machine sanded to a smooth and even surface.

PWB 5.4 Ironmongery

The door shall be fitted with a rebated mortise lock. Each lock shall have two keys and shall be clearly marked.

PWB 5.5 Joinery

No joinery shall be primed until it has been inspected and approved by the Employer's Agent. Skirtings, cornices, rails, etc., shall be in single lengths wherever practicable and shall have splayed heading joints where necessary. Skirtings shall be trenched at back.

PWB 5.6 Protection

All joinery liable to injury shall be covered with temporary casing to the satisfaction of the Employer's Agent. All exposed faces of joinery which are eventually to be stained, oiled or varnished shall be oiled to preserve them during building operations.

Employer:		Contractor:	
Witness:		Witness:	

PWB 5.7 Fixing, etc.

Where joiner's work is described as fixed to walls, etc, except where specifically stated, no particular method of fixing is specified, but the Contractor may employ any approved method of fixing, etc., plugging, steel nailing, power nailing or power bolting provided that the method used is suitable for the requirements of the specific member to be fixed.

Descriptions of fixing of timber shall be deemed to include for nails, screws, plugs, adhesives, etc.

All nails and screws shall be of the size, length and type appropriate to their respective uses. All screws for hardwood joinery work shall be brass.

PWB 5.8 Ceilings

Ceilings shall consist of plaster board or fibre-cement as indicated on the drawings and shall be suspended from the roof or nailed to the brandering. Panels shall be connected by exposed tees and insulation material shall be approved by the Employer's Agent.

PWB 5.9 Timber Roof Construction

The plates, joints, rafters, purlins, brandering and other pieces used for the construction of the roof and trusses shall be of the dimensions, spacing and construction, as shown on the Drawings.

All the joints in the framework shall be of the most appropriate type, accurately formed and adequately secured with fasteners as specified.

Employer:		Contractor:	
Witness:		Witness:	

PWB 6. GLAZING

PWB 6.1 Materials

PWB 6.1.1 Glass

The glass quality should be such that no deterioration would occur after glazing is applied and should be in accordance with CKS 55.

The glass shall be clear, and free from imperfections or scratches.

Sheet glass shall be flat-drawn, clear glass, unless otherwise specified, with thicknesses as follows:

Panes smaller than 0,75 m ² in size	3 mm
Planes larger than 0,75 m ² but not exceeding 1,5 m ²	4 mm

PWB 6.1.2 Putty

Putty shall comply with SABS 680 and shall be smooth and not too hard or soft when applied. Application shall be without cracks.

All defective putty shall be removed and replaced at the Contractor's expense and putty repainted.

PWB 6.1.3 Glazing

Glass panes to be cut to suit openings with sufficient clearance to prevent cracking caused by movement or vibration. The glass shall be bedded and backfilled with putty as specified in SABS Code of Practice 0137.

Putty shall be trimmed with straight, smooth surfaces and cleaned. As soon as the putty has dried, a paint primer shall be applied.

During construction, all glass panes shall be clearly marked for safety purposes but shall be handed over clean and without cracks on project completion.

Employer:		Contractor:	
Witness:		Witness:	

PWB 7. FLOOR COVERINGS

PWB 7.1 Approval of Screeds

Before laying the floor coverings, the Contractor shall satisfy himself that the surface to receive the floor covering is laid level and true and finished to a suitable surface to take the floor covering and that all screeds, etc., are thoroughly dry before the floor covering is laid.

PWB 7.2 Floor Tiling

Floor tiles shall be best quality of their respective types, true and regular in shape, free from cracks, chips and other defects, uniform in colour and equal to samples submitted to and approved by the Employer's Agent. Special care shall be taken to preserve arises and faces during transit and handling.

PWB 7.3 Fixing, etc.

On a concrete floor, tiles shall be well soaked in water before laying and solidly bedded in 3:1 sand/cement mortar and flush pointed on all exposed faces with semi dry cement mortar pressed in. On no account may liquid grout be poured on.

PWB 7.4 Adhesive Fixed Floor Tiling

Where specified as adhesive fixed, tiles shall be fixed to adequately cured plaster backing or screeded bedding in strict accordance with the recommendations of the adhesive manufacturer and with an adhesive approved by the manufacturer of the tiles.

The work shall be carried out by skilled workmen experienced in laying this type of floor finish.

Employer:		Contractor:	
Witness:		Witness:	

PWB 8. Plastering

PWB 8.1 Preparatory Work

Surfaces shall be clean and free of oil and thoroughly wetted directly before any plastering or other in-situ finishes are commenced. Concrete surfaces shall be slushed with a mixture of one-part cement and one part coarse sand or otherwise treated to form a proper key.

PWB 8.2 Finish

All final coats of paving and plastering shall be executed in one operation without any blemishes. No touching up of finished work will be permitted.

PWB 8.3 Screed

Screeds shall be composed of one part cement and four parts sand; steel floated to true, even, level and fine textured finish suitable to receive finish specified. All screeds to receive vinyl or other similar floors shall have a smooth polished finish, (cement sprinkle and steel floating) in accordance with the recommendations of and to the entire satisfaction of the flooring specialist.

PWB 8.4 Plaster

PWB 8.4.1 Thickness

Skim plaster shall be 6 mm thick and all other plaster shall be not less than 10 mm and not more than 20 mm thick.

PWB 8.4.2 Patching

All cracks, blisters and other defects shall be carefully cut out and made good and the whole of the plaster work is to be left in perfect and clean condition on completion.

PWB 8.4.3 Internal Angles

Square and coved internal angles shall be finished to a radius of not more than 25 mm at junctions of plaster at walls and ceilings.

PWB 8.5 Cement Plaster

Cement plaster shall be composed of one-part cement and five parts sand. Internal plaster shall be finished with a steel trowel.

PWB 8.5.1 Tolerances

The tolerance for finished surfaces of screeds and granolithic shall be 3mm in 3000mm and of plaster to walls 6 mm in 3000 mm. Extremely tight tolerances!

Employer:		Contractor:	
Witness:		Witness:	

PWB 9. Painting

PWB 9.1 Materials

The internal plastered surface and ceiling shall be painted with an undercoat complying with SANS 681 Type 1 and 2 finishing coats of high gloss enamel paint for internal use complying with SANS 630 Grade 1.

Materials for paintwork shall be delivered to the site in unopened containers and applied in accordance with the manufacturer's instructions. Materials shall be suitable for application to the surfaces concerned. Undercoats shall be recommended by the manufacturer of the finishing coats. Thinners and other agents shall not be used without approval.

PWB 9.2 Preparatory Work

PWB 9.2.1 General

All walls and ceilings shall be thoroughly cleaned prior to commencement of painting and the premises kept clean and free from dust during painting operations. All surfaces not to be painted shall be protected against spotting and spilling and cleaned down and made good as necessary. Locks, door handles, and similar fittings or fixtures shall be removed (or masked) and refitted on completion of painting.

PWB 9.2.2 Plastered Surfaces, etc.

Plastered surfaces shall be thoroughly washed down and brushed in order to remove any traces of efflorescence and allowed to dry completely before any paint finish is applied. Before any paint is applied, holes, cracks and irregularities in plaster and other surfaces shall be filled with a suitable filler and finished smooth. Unfinished concrete surfaces shall have all projections rubbed off and shall be thoroughly cleaned with a spirits-of-salts solution (1 part concentrated spirits-of-salts to 4 parts water).

PWB 9.2.3 Wood Surfaces (Door and frame)

Knots in woodwork shall be treated with knotting and cracks, splits and holes caused by nails filled with a suitable filler. Wood surfaces shall be sanded smooth and coated with 3 coats of varnish complying to SANS.

PWB 9.2.4 Application of Paint

Undercoats and finishing coats may be applied by brush or roller.

Before subsequent coats of paint are applied the previous coat shall be properly dry and shall be sanded down where necessary.

Should a perfectly uniform finish and texture, free from any blemishes and with sufficient coverage, not be obtained as a result of defective preparation of surfaces and/or application, the Contractor shall apply an extra coat or coats of

Employer:		Contractor:	
Witness:		Witness:	

paint of the prescribed finish at their own expense to the satisfaction of the Employer's Agent.

PWB 9.3 Colour Scheme

A colour scheme for the internal wall shall be off white. The ceiling shall be white.

PWB 9.4 Protection and Cleaning

The Contractor shall provide necessary tarpaulins, covers, etc., for the protection of the works. Before the paintwork is commenced all floors shall be swept and walls dusted and no further sweeping, or dusting shall be allowed before all painted surfaces are perfectly dry.

PWB 9.5 Priming

The back of the wooden door frames in contact with brickwork, etc., and built in as the work proceeds, shall be primed before building in, whether the article is to be painted or not, to prevent moisture seeping into the wood from the masonry backing.

Priming to new external structural timbers shall be applied before the timbers are fixed in position and shall include all surfaces such as backs of fascias and barge boards.

PWB 9.6 Doors

All doors shall be left ajar after varnishing until the varnish is perfectly dry.

PWB 10. Precast Wall Cladding

Precast concrete elements to comply with SABS 1200GE.

Precast wall panes shall be manufactured to render a high quality, uncracked solid concrete. The exposed stone shall match the existing panels. Panels to be built into brick walls by means of galvanized steel elements cast into the panels.

Employer:		Contractor:	
Witness:		Witness:	

PWB 11. CONCRETE PALISADE FENCING

PWB 11.1 Materials

PWB 11.1.1 General

The palisade fencing shall consist of 10 pales per section. The posts shall be approximately 3 m in overall length with a curved front edge, tapering to the back and an overhang of at least 400 mm. At one position the posts shall have a slot to take the horizontal load bearing rail. All posts to be reinforced.

Pales shall be approximately 2,4 m long with a curved front edge and tapering to the back. The pales and rails shall be reinforced, and pales shall have slots to take the horizontal rails.

PWB 11.1.2 Concrete

Concrete strength to all precast items to be a minimum of 30 MPa at 28 days. The concrete shall have a high density and smooth finish, impermeable to water. Foundations to be of 15 MPa concrete.

PWB 11.1.3 Wire

All wire shall conform to the requirements of SABS 675 and shall be Class B galvanized.

Barbed wire shall either be high-tensile grade, single strand or mild steel grade, double strand, uni-directional twist wire. Barbs shall be spaced at a maximum of 150 mm intervals.

Razor concertinas shall consist of high tensile wire with continuous strip of razors crimped to the wire for the entire length of the wire. Coils shall be attached together by clips to give a concertina configuration when pulled apart.

PWB 11.2 Construction

The posts shall be installed in 400 x 400 x 600 mm deep concrete. A beam of 200 mm wide x 150 mm deep 15 MPa concrete shall be cast insitu at the base of the pales. Pales shall be embedded 50 mm deep into the beam. The beam shall be cast below ground level except where the ground surface is rock, concrete, tarmac, paving blocks or other material that cannot be excavated.

Employer:		Contractor:	
Witness:		Witness:	

PWB 13. Scheduled Items

PWB 13.1 Brickwork

PWB13.1.1 230 mm thick (specify type) Unit : m²

The unit of measurement shall be the square meter of each type of brickwork built, calculated from the leading dimensions of the brickwork. Areas of pipes etc, built into brickwork shall not be included in the area measured. At corners and intersections common to more than one brick wall, the areas shall be measured only once.

The tendered rates shall include full compensation for the construction of the brickwork complete as specified, including pointing, the building-in of conduits, beams, pipe sleeves, doors, windows, the raking-out of joints, damp-proof course, etc.

PWB 13.2 Precast wall panels

PWB13.2.1 Reinforced precast concrete wall panels with exposed Unit: m²

stone finish to match existing

PWB 13.3 Plaster work

PWB13.3.1 Single coat up to 25 mm thick (finish specified) Unit: m²

The unit of measurement shall be the square meter of each type of coat completed as specified.

The tendered rates shall include full compensation for the construction of the plaster work, including the supply of all materials, mixing applying, finishing, forming reveals, joints, etc, complete as specified. It shall also include for cleaning and preparing existing brickwork where applicable.

PWB 13.4 Timber Roof Trusses

PWB13.4.1 Design, supply and erect timber roof trusses Unit: Sum (drawing no indicated)

The unit of measurement in lump sum shall include the design, supply and installation of the trusses as well as a designer's certificate approving the final product.

PWB 13.5 Iron Mongery

PWB13.5.1 Steel doors and frames. Unit : No

(type and size indicated)

Employer:		Contractor:	
Witness:		Witness:	

PWB13.5.2 Steel window frame Unit : No

(type and size indicated)

The rate shall include the supply and installation of the door, door frame or window frame including hinges, handles, locks, door stops, and any other work required to complete the installation. In the case of windows, the rate shall include glazing, window wills and damp-proof sheeting.

PWB 13.6 Ceilings

PWB13.6.1 Plaster board ceiling Unit: No

(type and thickness indicated)

The rate shall include the construction of the ceiling complete with exposed tees, brandering and insulation blanket.

PWB 13.7 Fencing

PWB13.7.1 Concrete palisade fencing (type) Unit : m

The rate shall include supply, delivery and erection of the fencing material as well as excavation and concrete for bases and beams and grouting. The rate shall also include barbed and or razor wire where applicable.

PWB 13.8 Miscellaneous work

PWB13.8.1 Painting of buildings (building indicated) **Unit: Lump Sum**

PWB13.8.2 Plumbing in buildings (building indicated) **Unit: Lump Sum**

PWB13.8.3 Wiring of buildings (building indicated) **Unit: Lump Sum**

PWB13.8.4 Cleaning of building..... **Unit: Lump Sum**

The unit of measurement for all painting, plumbing and electrical wiring to be carried out at each building shall be the lump sum and shall include all work necessary to render a complete product. This includes but not limited to doors, door and window frames and walls.

The lump sums tendered shall also include full compensation for all temporary works and safety precautions and for the protection of the Works, for fitting, etc. in the case of wiring, the replacement of defective work and cleaning up after completion, all as specified, for painting in section 806, and for plumbing and wiring in this section and in the applicable regulations.

Employer:		Contractor:	
Witness:		Witness:	

PWC Subsurface Drains

PWC 1. Materials

PWC 1.1 Pipes for subsurface drains shall be one of the following types as specified:

- a) Perforated pitch-fibre pipes which comply with the requirements of SABS 921.
- b) Perforated or slotted Unplasticised PVC or HDPE pipes.
- c) Porous concrete pipes which comply with the requirements of BS 1194.
- d) Vitrified clay pipes which comply with the requirements of SABS 559 (excepting the requirement regarding nominal diameter) and which have special joints intended for subsoil drains may be specified or used if the Employer's Agent or Representative approval is obtained in advance, provided that, where the gaps at the joint do not conform to the requirement for the slots specified below, the grading of the permeable material shall be suitably adapted to meet the design requirements for preventing permeable material from entering the pipe.

The size of perforations in perforated pipes shall in all cases be 8 mm in diameter plus or minus 1,5 mm, and the number of perforations per meter shall not be fewer than 26 for 100 mm pipes and 52 for 150 mm pipes. Perforations shall be spaced in two rows for 100 mm pipes and in four rows for 150 mm pipes, as shown on the Drawings.

Slotted pipes shall have a slot width of 8 mm with a tolerance of 1,5 mm in width. The arrangement of slots shall be subject to the Employer's Agent or Representative approval, but the total slot area shall not be less than that specified for perforations.

Pipes without slots or perforations required for transporting subsoil water from the subsoil drain proper to the point of discharge shall be unperforated HDPE or PVC pipes of the types specified above.

PWC 1.2 Geotextiles

Geotextiles shall be a non-woven, spun or thermic-bonded continuous filament fabric consisting of at least 85% by mass of polypropylene, polyester or other approved material and manufactured for civil-engineering applications by a recognized manufacturer. The brand and type of geotextile to be used shall be as specified in the Project Specifications or on the Drawings or as directed by the Employer's Agent or Representative

PWC 1.3 Polyethylene sheeting

Polyethylene sheeting shall be black in colour with a minimum thickness of 0,25 mm and manufactured by a recognized manufacturer.³

Employer:		Contractor:	
Witness:		Witness:	

PWC 1.4 Pre-manufactured drainage system

The pre-manufactured drainage system to be used against walls and abutments shall consist of a heavy duty HDPE extruded drainage net (core) wrapped in a 2 mm thick geotextile

PWC 2. Measurement and Payment

PWC 2.1 Geotextiles (specify type) Unit: m²

The unit of measurement will be calculated from the dimensions on the drawings. The rate shall include for the supply and installation of the material, including wastage and overlap. For drains it shall also include a 200 mm overlap on the top surface.

PWC 2.2 Pipes in subsurface drains Unit: m²

(indicate type and diameter)

The unit is measured along the centre line of the pipe and includes fitting lengths. The rate shall include supplying, laying and jointing of pipes (couplings included).

PWC 2.3 Polyethylene sheeting 0,25 mm thick Unit: m²

The sheeting will be measured net from the specified dimensions. The tendered rate shall include supply, installation and bonding of sheeting including overlap and wastage.

PWC 2.4 Pre-manufactured drainage system Unit: m²

The drainage system will be measured as the net area covered by the drainage system. The tendered rate shall include supplying and fixing, including fixing nails, wastage and overlap.

PWC 2.5 Concrete outlet structure for sub-surface drains, formwork included (specify concrete class) Unit: m³

The measurement shall be for the volume of specified class concrete provided for the structure.

The rate tendered shall include all materials required, excavation, formwork, scaffolding, backfill and cat ladders or step irons as indicated on the drawing.

Employer:		Contractor:	
Witness:		Witness:	

PORTION 3: PROJECT SPECIFICATION FOR MECHANICAL WORKS

PSX.1 Introduction

This section of the Specification provides details of the mechanical works required to complete the installation for Northern Wastewater Treatment Works, Dewatering Building Belt Press Replacement and Associated Ancillaries.

The design of the Permanent Works outside the battery limits of the mechanical works is the responsibility of the Employer unless indicated otherwise.

PSX.2 Mechanical Scope of Works

PSX2.1 Decommission, removal, and disposal of existing equipment Scope

The Contractor shall decommission and remove all non-operational mechanical equipment relating to the Scope of Works and shall dispose-off in accordance to Johannesburg Water Asset management policy.

The Scope of Works shall include but not limited to decommissioning, removal, handling & transportation, and disposal of redundant or identified decommissioned identified mechanical equipment. The scope shall include;

- Decommission and removal of the existing four (4) Set C and six (6) Set A Belt Presses with associated ancillaries such as pipework, conveyor belts, mechanical and structural equipment.
- Removal of all the uPVC pipework conveying sludge inside the dewatering building for the (4) Set C and (6) Set A Belt Presses.
- Reconfiguration of the portion of the main wash water pipeline bypassing the DAF tanks.
- Removal of the redundant pipework (suction manifold) between the DAF tank and the wash water distribution pumps in the dewatering building.
- Decommission and removal of the Wash water supply pumps and strainer including portions of the pipework to install the new equipment as per drawings No. JW14060R-ME-008 and JW14060R-ME-009.
- Decommission and removal of the Wash water transfer pumps including above ground pipework (suction and delivery) located at the Unit 3 Chlorine Contact chamber.
- Decommission and removal of the polyelectrolyte dosing and transfer pumps with associated pipework for make-up and holding tanks
- Decommission and removal of some of the polyelectrolyte silo and associated equipment and pipework.
- Decommission and removal of the Sludge supply pumps.

Employer:		Contractor:	
Witness:		Witness:	

PSX2.2 Dewatering Filter Belt Press Equipment

PSX2.2.1 General Plant Description

The Dewatering Building consists of fourteen (14) Filter Belt Presses (FBP) and the Employer wishes to replace ten (10) of them with a new, reliable, and efficient filter Belt Presses. The Belt Press areas are denoted as follows;

- Set A – consisting of six (6) Belt Presses located in the North-West section of the building as shown in JW14060R-ME-002.
- Set B – consisting of four (4) Belt Presses located in the middle section of the dewatering building as shown in JW14060R-ME-001 and JW14060R-ME-002.
- Set C – consisting of four (4) Belt Presses located in the North-East section of the dewatering building as shown JW14060R-ME-001.

PSX2.2.2 Scope of Works

The Scope of Works for the Dewatering filter Belt Presses with associated ancillaries' equipment shall include the design, manufacturing, packing, supply, delivery to site, handling, storage, erection, installation, testing, commissioning, and trial operation of the equipment. The Dewatering filter Belt Press Scope of Works shall include, but not limited to the following:

- Ten (10) replacement Dewatering filter Belt Presses as follows;
 - o Set A – consisting of six (6) Belt Presses as per drawing No. JW14060R-ME-001 & JW14060R-ME-002; and
 - o Set C – consisting of four (4) Belt Presses as per drawing No. JW14060R-ME-001.
- In-situ design, fabrication, supply and installation of the following as per drawing No. JW14060R-ME-006 & JW14060R-ME-007;
 - o Sludge cake extension chute;
 - o Filter Belt Press structural support; and
 - o Filtrate collection hopper with a 110NB flanged single discharge point underneath the filter Belt Press.
- Variable in-line static flocculation mixer for each of the 10 filter Belt Presses.
- Polyelectrolyte solution injection device for each of the 10 filter Belt Presses as per drawing No. JW14060R-ME-006 & JW14060R-ME-007
- Automatic filter Belt Press spray devices or nozzles
- Centralized lubrication system
- Filter Belt Presses associated sludge and wash water feed connection nozzles and related internal pipework.
- Procurement supply and delivery of critical spares as identified by the Employer's Agent for the existing four (4) Set B Belt Presses.

Employer:		Contractor:	
Witness:		Witness:	

PSX2.2.3 Battery Limits

The battery limits for the Dewatering filter Belt Press shall be as follows:

- Existing equipment associated with dewatering plant; and
- The existing conveyor belts within the dewatering building boundaries.

PSX2.2.4 Specific design, performance and operational parameters

The equipment shall be designed for a minimum safe and satisfactory operation acceptable life expectancy of 15 years under ambient conditions prevailing on site.

Each dewatering filter Belt Press shall be able to operate with a sludge mass feed rate range of 600 to 900 kg DS/hr. The filter Belt Press shall achieve a minimum final solids concentration of the sludge cake of $\pm 18\%$ by mass with a minimum of 95% capture rate and less than 200 mg/L of suspended solids in the filtrate.

Flocculation mixing design shall ensure the effective mixing of the sludge and polyelectrolyte and ensure that there is sufficient time to achieve the designed flocculation before feeding the sludge onto the filter belt. The filter Belt Press unit shall have an effective width of up to 2.2 m.

Sludge ploughs shall be strategically positioned on this section to assist with the removal of excess liquid, drainage of filtrate from the flocculated sludge and ensure that no blinding of the belts occurs due to sludge movement. The Sludge ploughs shall ensure a uniform distribution of sludge across the working width of the belt. Sludge ploughs shall be adjustable safely without the need to stop the machine.

The pressure dewatering section shall comprise a set of not less than 10 no. dewatering pressure rollers of adequate size to achieve the required degree of dewatering with the pressure being evenly distributed on the sludge to prevent it from being squeezed through or out of the sides of the filter cloth. Rollers shall be of rigid design to prevent uneven pressure and cake distribution due to deflection of the rollers. The minimum diameter of the pressure rollers shall be 215mm and with a thickness of 7mm. The belt press roller design and positioning shall be such that rewetting of the sludge is prevented through effective continuous release of filtrate from the belt press.

The pressure rollers shall be designed using a minimum design load of 15 N per linear millimetre with a maximum deflection of less than 1.5mm for the entire length of the roller between the end bearing supports.

The spray nozzles shall be specifically designed for filter belt washing purpose and the spray pattern design shall be of overlapping to avoid blind spots. The wash water system shall be designed for a pressure range of 6 - 9 Bar with maximum water consumption of ± 15 m³/hr. The belt filter nozzle header shall be accessible for inspection and maintenance purposes.

A scraper mechanism shall be provided for the continuous removal of sludge cake from the filter belt. Scrapers shall be positioned in such a way that it does not damage the filter belt or cause excessive wear. The scraper blade shall allow for adjustment to accommodate operational wear and the blade shall be constructed from abrasion-resistant material. The Belt Press roller design and positioning shall be such that

Employer:		Contractor:	
Witness:		Witness:	

rewetting of the sludge is prevented through the effective continuous release of filtrate from the Belt Press.

The filter belts shall be provided as part of the filter Belt Press assembly and shall be manufactured from high permeable durable woven monofilament polyester fiber selected to satisfy the duty requirements specific to the operational condition with a minimum expected life of ± 3000 hours. The seam shall be rugged stainless steel. clipper seam with adequate strength to satisfy the operational requirements of the press such as belt tension and roller pressure, the clipper seem's shall be subject to the approval of the Employer's Agent or Representative

Belt tensioning system shall be provided with necessary means of adjusting the upper and lower belt tension under all operating conditions. The upper and lower belt shall be capable of being adjusted separately with reference to operational conditions. A hydraulic belt tensioning system with a proven record of operation in a similar wastewater environment is preferred.

The belt tensioning system shall have minimum and maximum value for belt tension adjustment required for belt tracking. The tensioning mechanism shall be designed to maintain set tension in case of component failure on one side of the belt and also designed to provide positive protection against over tensioning.

The belt tensioning system operation shall allow for manual adjustment of the belt during operation or with the belt stationary. A tension indicator shall be provided at each available point of belt adjustment. Protection shall be provided at the max and min position of the tensioning rollers for belt break detection and tensioning rollers for overload detection respectively.

A belt alignment system shall be provided to automatically control the alignment of the belt on the rollers under all operational conditions. The tracking device shall not use any components which would lead to any belt edge deformation or wear. The belt tracking system shall be able to react to belt movement and take corrective action relative to belt 'drift'.

The belt tracking system shall comprise a sliding guide roller on each belt. The control mechanism shall not have excessive belt wrap angles around the guide roller, non-excessive sliding travel, which could lead to belt filter deformation and wear.

The slewing mechanism shall include a hydraulic linear actuator coupled directly to the bearing housing on the slewing roller. The slewing bearing housing shall be provided with low-friction tracks.

All bearings shall be suitable for the operational environment such as corrosive and high-pressure washing. All bearings shall be greased and selected for a minimum bearing life of 200 000 hours (L10) and should be housed external to the press side frames, in cases where bearings are house internal by the Belt Press, the enclosure shall be design with the proper protection to ensure prevent moisture and other contamination which are likely to damage the bearing.

All bearing shall be off the shelf items, available from local distributors and suppliers, a complete detailed list of bearings in use in the Belt Press design shall be provided with the tender documentation for local availability assessment of the proposed bearing.

Employer:		Contractor:	
Witness:		Witness:	

A single drive unit is preferred in the interest of enhancing reliability with the use of the least components, and where dual drives are offered, the drives shall use an approved synchronizing system, subject to the approval of the Employer's Agent / Employer's Representative. The Gearbox and Motor shall comply with the Johannesburg Water (SOC) LTD's Particular Specifications and the overall efficiency of drive assembly shall be 85% minimum.

Other than the cake discharge openings all other openings shall not exceed 0.2m².

PSX2.2.5 Material of Construction

Belt Press components shall be constructed of the material in the Table below.

Table 4.2.1 Material of Construction for Filter Belt Press

COMPONENT	MATERIAL TYPE
Filter belt press framework and covers	304L Stainless Steel
Sludge Pipework:	304L Stainless Steel
Gravity Flow (filtrate) Pipework	Class 9 uPVC
Internal piping	316L Stainless Steel
Inline-mixer	Aluminium cast
Sludge cake chutes and Belt discharge scraper:	304L Stainless Steel
Pressure Rollers	Mild steel Vestosint, Polyamide 12 Fluidized bed powder coating with the following minimum requirements: • Thickness of 1mm • Density of >440g/dm² • Shore Hardness D 75 • Ball Indentation Hardness 90N/mm²
Perforated rollers	Hot dipped galvanized mild steel
Belt Supports:	304L Stainless Steel
Sludge ploughs	Epoxy Coated Gray cast iron to a minimum of 350microns.
Spray wash system:	304L Stainless Steel
Filtrate Collection Trays	304L Stainless Steel
Wearing Bars	Polyurethane / HDPE
All other accessories shall be of the manufacturer's standard, industry approved, and corrosion protected.	

Employer:		Contractor:	
Witness:		Witness:	

PSX2.3 Polyelectrolyte Storage Refurbishment and Upgrade

PSX2.3.1 General Plant Description

The existing polyelectrolyte storage is made-up of single storage silo and an emergency manual hopper feeding a single make-up tank. The silo and the manual hopper service one polyelectrolyte make-up tanks. The polyelectrolyte storage upgrade shall have an additional makeup tank to optimize the polyelectrolyte make up time and capacity.

PSX2.3.2 Scope of Supply

The Scope of Work for the dry powder polyelectrolyte storage equipment is the design, fabrication, strip & refurbish, supply, delivery, transport, handling, storage, erection, installation, testing and commissioning. The polyelectrolyte storage Scope of Work shall include, but not be limited to, the following:

- Existing Polyelectrolyte Silo Associated Works
 - o Refurbishment and reconditioning of the silo and support structures.
 - o Replacement and or installation of the following equipment:
 - Vibrating bin discharge equipment with motor
 - Dust Extraction Filter on top of the silo,
 - Level Indicator/ switch,
 - Silo Discharge Valve (Isolating Valve),
 - Silo Filling Valve and connecting Coupling,
 - Rotary vane dry feeder,
 - Air eductor and transfer blower with motor,
 - Flow switch,
 - Replacement of existing discharge piping into the existing make-up tanks and new discharge piping installation for the second make-up tank.
 - Silo roof equipment weather/ rain cover.
- Replacement of Manual Hopper (520kg storage) and Equipment
 - o Polyelectrolyte hopper,
 - o Arch breaking propeller or screw feeder with drive motor,
 - o Air eductor and transfer blower with motor,
 - o Discharge piping the two make-up tanks with associated valves. Indicator/ switch, and
- Safety shower and eye bath.

The Polyelectrolyte storage equipment shall be capable of withstanding outdoor conditions prevailing at the site such as dust, rain, resistance to ultraviolet light and corrosion, humidity, temperature, etc.

Employer:		Contractor:	
Witness:		Witness:	

PSX2.3.3 Battery Limits

The battery limits for the Dry powder polyelectrolyte storage and handling Plant shall be as follows:

- The face of flange of nozzle/piping connection point to Bulk Tanker piping.
- Compressor associated installation.
- The refurbishment of the polyelectrolyte silo shall be restricted to the outside walls.

PSX2.3.4 Specific design, performance and operational parameters

The contractor under this Contract will be required to strip the associated equipment of the polyelectrolyte silo and replace with new reliable equipment in accordance with the specification.

The design and layout of the lime plant shall be configured to facilitate inspection, operation and maintenance

Plant function	:	To store and dose dry (granular) powder Polyelectrolyte
Existing Polyelectrolyte Silo Capacity (Live mass.)	:	15 ton
Manual Polyelectrolyte hopper capacity (live)	:	500 kg (maximum Polyelectrolyte consumption per day).
No. of Silos to refurbish and recondition	:	1 no.
No. of Manual hopper to supply	:	1 no.
Jet Fan or blower nominal capacity	:	250 m ³ /hr @ 35 kPa

Both the polyelectrolyte silo and manual hopper shall be configured (with discharge pipework) such that the dry polyelectrolyte can be fed from the Silo or Manual hopper into either of the polyelectrolyte make-up tanks.

The dry powder polyelectrolyte shall be pneumatically conveyed into a storage silo, employing the blower on the bulk tanker. Exhaust air is cleaned by a dust filter integral to the silo. Manual Hopper shall be filled using bags of dry polyelectrolyte with the aid of crawl beam as per drawing No. JW14060R-CE-008.

Pipeline connection shall preferable be a quick connection with flexible hoses between the silo or hopper and the jet wet eductor.

The dry powder polyelectrolyte storage silo shall be watertight to prevent the ingress of water. The silo discharge shall have an isolating valve to enable flow isolation from the silo.

Employer:		Contractor:	
Witness:		Witness:	

The internal walls of the silo and manual hopper shall be smooth finish to enhance material flow, projections such as bolt heads and welding ridges in the internal wall shall be avoided at all times.

Where aeration pads are used, the aeration pads shall be installed a minimum 0.5 m above the silo outlet up to 1.5 m above the silo opening.

The dry powder polyelectrolyte shall be fed at a nominal discharge flow rate of 180 kg/hr for both polyelectrolyte silo and the manual hopper the feed to the polyelectrolyte solution make-up tank. The discharge shall flow shall be adjustable between 70% to 120% of the design nominal discharge rate.

PSX2.3.5 Material of Construction

Materials of construction shall be selected to storage the type of polyelectrolyte recommended for the effective sludge.

Table 4.3.1 Material of Construction for Polyelectrolyte Storage and Handling Equipment

COMPONENT	MATERIAL TYPE
General piping (indoors and Outside)	Hot Dipped Galvanised Mild Steel
Bolts & Nuts	Hot Dipped Galvanised Mild Steel unless otherwise stated in the Project specification
Concrete Anchors	316 Stainless Steel
Water Supply Piping	Hot Dipped Galvanised Mild Steel
Shower	304 Stainless Steel
Storage Silo Ladder & Hand Railing	Hot Dipped Galvanised Mild Steel
Dry Feed Hopper & Assoc. Parts	304 Stainless Steel
Air Eductor unit	304 Stainless Steel
Jet Wet Eductor Unit	316 Stainless Steel
Pressure Water Piping	Hot Dipped Galvanised Mild Steel
Dry Polyelectrolyte Piping (Indoors)	Hot Dipped Galvanised Mild Steel
Dry Polyelectrolyte Piping (Outdoors)	Hot Dipped Galvanised Mild Steel
Mechanical mixer impeller and shaft	316 Stainless Steel
Vibrating bin activator	Epoxy coated Mild steel
Silo and manual hopper	Epoxy coated Mild steel

Employer:		Contractor:	
Witness:		Witness:	

PSX2.4 Polyelectrolyte Tanks (Make-up and Holding) with Associated Equipment

PSX2.4.1 General Plant Description

The existing polyelectrolyte system uses a single polyelectrolyte make-up tank. The polyelectrolyte system shall be updated to increase redundancy and availability of the polyelectrolyte make-up equipment, the upgrade shall have two make-up tanks and three holding tanks.

PSX2.4.2 Scope of supply

The scope of work for the polyelectrolyte tanks with associated equipment is design, fabrication, strip & refurbish, supply, delivery, transport, handling, storage, erection, installation, testing and commissioning. The polyelectrolyte tanks scope of work shall include, but not be limited to, the following:

- Polyelectrolyte Solution Make-up system refurbishment and upgrade:
 - o Refurbishment of existing 35m³ polyelectrolyte solution make-up.
 - o Refurbishment and convention of existing 49 m³ polyelectrolyte solution holding tank to make-up tank.
- Polyelectrolyte Solution Holding system refurbishment and upgrade:
 - o Refurbishment of the existing 49 m³ polyelectrolyte solution holding tank.
 - o Manufacture, supply and installation of a NEW 49 m³ polyelectrolyte solution holding tank for the new Set C filter belt presses with the working platform as per JW14060R-ME-005.
- Replacement of mechanical low-speed agitator for both the make-up (2 no.) and holding tank (2 no.) with drive units i.e. gearbox, closed coupling and motor;
- Manufacturer, supply and installation of Jet wet eductor unit for the make-up tanks (2 no.); and
- Fabrication and Refurbishment of the access stairs, cat ladder, and working platform for all the tanks listed above as per provided drawings.

PSX2.4.3 Specific design, performance, and operational parameters

The polyelectrolyte make-up equipment shall be capable of handling and making-up between 0.25%-0.5% solution from the dry polyelectrolyte powder per batch made up. The equipment shall effectively ensure the minimum maturing time is achieved which shall typically be less than 1.5 hours but still maintaining a homogenous and fully activated Polyelectrolyte solution.

Polyelectrolyte make-up and holding tanks shall each be of an open tank design with a bird barrier to prevent birds from entering the tanks.

A mechanical low-speed mixer or agitator for both the make-up tank and holding as the polyelectrolyte solution is very shear sensitive. A maximum mixing energy of 30 W/m³ and speed shall be determined to achieve a homogeneous and maximum effective ageing (maturing) of the polyelectrolyte solution. The mixer shall incorporate one or two axial flow impellers at different heights along the shaft. The mixer shall

Employer:		Contractor:	
Witness:		Witness:	

operate from a high gear reduction ratio gearbox and driven by a high-efficiency motor mounted on a platform over the top of the tank with the design details specified in the Johannesburg Water Mechanical specification M08 for Gearboxes and E01 for Electrical Motors respectively.

The tanks shall have a flat base that should be sloped to a minimum fall of 2% to the draining nozzles or suction nozzles for the transfer or dosing lines in order to optimally collect all the polyelectrolyte solution in the tank. The tanks shall have a minimum of 3, 65mm draining nozzles.

The tanks platform shall be supported and design with structural beams and the requirements guided by SANS 10400-M and shall not rest on-top of the tank. The minimum structural requirements of the working platform shall be;

- Designed Load shall consider the total assembly mass of the mixer and its drive unit with a minimum number of 2 Operators times a minimum safety factor against structural failure of 1.5.
- Distance between the sides of the working platform shall not be less than 900 mm wide,
- Hand and knee rails on both sides of the working platform
- Kicker plates: 100 x 4,5mm attached on all sides of the platform
- There shall be an access staircase or cat-ladder to the top of the Tank i.e. working platform as determined in the Project specification.
- The working platform supporting the mixer and drive unit shall span across the diameter of the tank.

PSX2.4.4 Material of Construction

Materials of construction shall be selected to handle the type of polyelectrolyte recommended for the sludge treatment.

Table 4.4.1 Material of Construction for Polyelectrolyte Storage and Handling Equipment

COMPONENT	MATERIAL TYPE
General piping (indoors and Outside)	Hot Dipped Galvanised Mild Steel
Bolts & Nuts	Hot Dipped Galvanised Mild Steel unless otherwise stated in the Project specification
Concrete Anchors	316 Stainless Steel
Water Supply Piping	Hot Dipped Galvanised Mild Steel
Access, working platform and walkway	Hot Dipped Galvanised Mild Steel
Make Up Tank	304 Stainless Steel
Storage or dosing Tanks	304 Stainless Steel
Jet Wet Eductor Unit	316 Stainless Steel

Employer:		Contractor:	
Witness:		Witness:	

COMPONENT	MATERIAL TYPE
Pressure Water Piping	Hot Dipped Galvanised Mild Steel
Polyelectrolyte solution Piping (Indoors)	Hot Dipped Galvanised Mild Steel
Polyelectrolyte solution Piping (Outdoors)	Hot Dipped Galvanised Mild Steel
Mechanical mixer impeller and shaft	316 Stainless Steel

PSX2.5 New Polyelectrolyte Pumps (Transfer and Dosing) and pipework

PSX2.5.1 General Plant Description

The polyelectrolyte solution is transferred from make-up tanks to the respective Belt Presses holding tanks as per drawing No. JW14060R-CI-009. Holding tanks, each dewatering Belt Presses set has a dedicated polyelectrolyte dosing pump as per drawing No. JW14060R-CI-010 & JW14060R-CI-011.

PSX2.5.2 Scope of Supply

The Scope of Work for the polyelectrolyte solution transfer and dosing pumps from make-up and holding tanks is design, fabrication, supply, delivery, transport, handling (double handling if required), storage, erection, installation, testing and commissioning. The polyelectrolyte pumps and pipework scope of work shall include, but not be limited to, the following:

- Polyelectrolyte solution transfer pumps:
 - o Replacement of Four (4) and addition of two (2) new progressive cavity pumps (1 duty and 1 standby per holding tank) for transfer of polyelectrolyte solution as per drawing No. JW14060R-CI-009 with solids handling capabilities. The pump sets shall include motors, couplings (flexible or closed coupling), baseplates, safety guards, hold-down bolts etc.
 - o Replacement of interconnecting pipework between the polyelectrolyte make-up tanks and the four (4) replaced pumps. Further installation of new interconnecting pipework between the polyelectrolyte make-up tank and two (2) new pump installation. Piping installation shall include associated instrumentation installation as details in the relevant drawings i.e. i.e. both suction and discharge valves and pipework as per drawing No. JW14060R-CI-009.
- Polyelectrolyte solution dosing pumps:
 - o Replacement of seven (7) and addition of thirteen (13) new Progressive cavity pumps (duty and standby configuration per Belt Press) for dosing of polyelectrolyte solution as per drawing No. JW14060R-CI-0010 & JW14060R-CI-011 with solids handling capabilities. The pump sets shall include motors, couplings (flexible or closed coupling), baseplates, safety guards, hold-down bolts etc.
 - o Replacement of interconnecting pipework between the holding tank(s) and the seven (7) dedicated feed to each of the 6 Belt Presses. Further installation of new interconnecting pipework between the holding tank(s) and

Employer:		Contractor:	
Witness:		Witness:	

the thirteen (13) dedicated feed to certain Belt Presses from the six (6) set A and all the four (4) set C Belt Presses. Pipework shall include associated instrumentation installation as details in the relevant drawings .i.e. both suction and discharge valves and pipework as per JW14060R-CI-010 & JW14060R-CI-011; and

- An inline static mixer for the ten (10) Belt Presses feeds line for the polyelectrolyte solution and dilution water for final polyelectrolyte solution concentration of between 0.1% and 0.2%.

PSX2.5.3 Specific design, performance and operational parameters

The pumps supplied under this Contract shall be progressive cavity pump type and shall comply with the requirements of Mechanical Particular Specification M26 and M30 including the following supplementary requirements.

The pump(s) installation shall incorporate the means of flushing the chemical during intermittent operation in order to avoid crystallization of the chemical in the pump and the pipework. The pump shall handle the wash water provided for flushing.

The pumps shall be capable of handling polyelectrolyte solution with dry powder concentration by weight between 0.25%-0.5% and all other chemical properties as listed in the material safety data sheet of the recommended polyelectrolyte from the sludge testing.

The pumps shall be designed for the stated expected life and within the best efficiency region by countering the pressure gaps over the operation period using Pulsating dampeners (if exist) installed on the outlet of the pump. The tenderer shall provide with their offer the detailed technical information of the dampener from the OEM.

The curves shall indicate the following:

- Head (meters) vs. flow (m³/hr) and operating speed
- Power absorbed in kW
- Efficiency
- Net positive suction head curves indicating the safety operation

The efficiency curve shall be flat over a wide range in order to provide efficient working at various pump operating speeds for dosing.

Progressive Cavity type pumps with a rotating helix shall be 'V' belt or gearbox driven and all parts shall be fully corrosion-resistant to the chemical being pumped. Variation of pumped flow shall be provided by varying the motor speed using a VSD control unit.

If the belt drive is specified or offered, the speed reduction ratio shall be defined in the pump datasheet. The maximum allowable speed reduction ratio using a single reduction belt drive system shall be 3:1. The belt drives should comply with BS 3790; Specification for belt drives. All rotating elements shall be provided with adequate protecting covers or guarding to cater for all probable pulley sizes in-line with the speed or flowrate adjustments.

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The guards must be solid plate whilst allowing adequate air cooling for belts, design to avoid water ponding and contamination of the "V" belts. The guard shall be designed with provision for visual inspection without the removal of the guard cover.

Should one belt break, the remaining belt(s) must be capable of transmitting the required power without overloading the motor or causing unwarranted failures. All bearings shall be suitable for shaft rotation in both directions. All bearings shall be designed for a life of at least 100 000 hours at an (L10) rating. The rotating assembly shall be positively located in the axial direction and thrust bearings will, therefore, be required.

Polyelectrolyte Transfer pump

Pump function	:	Transfer of Polyelectrolyte solution
Nominal duty point definition per pump	:	28.8 m ³ /hr @ 6m
Minimum pumping capacity	:	28.8 m ³ /hr
Maximum pumping capacity	:	51.45 m ³ /hr
Speed control	:	Fixed speed
Pressure gauges required	:	YES (on each pump discharge side)
Priming lift	:	Flooded suction

Polyelectrolyte Dosing pump

Pump function	:	Dosing of Polyelectrolyte solution
Nominal duty point definition per pump	:	1.8 m ³ /hr @ 6m
Minimum pumping capacity	:	0 m ³ /hr
Maximum pumping capacity	:	1.9 m ³ /hr
Flow control	:	VSD
Pressure gauges required	:	YES (on each pump discharge side)
Priming lift	:	Flooded suction

PSX2.5.4 Material of Construction

Materials of construction shall be selected to handle the type of media being pumped. It shall be noted that in all applications the media may contain abrasive solids. The pump unit components shall be constructed of the material specified in Table 4.5-1 below.

Employer:		Contractor:	
Witness:		Witness:	

Table 4.5-1 Material Specifications:

COMPONENT	MATERIAL TYPE
Progressive Cavity Type Pumps	
Pump Casing or Housing	High material grade cast iron epoxy coated
Rotor	316 Stainless Steel
Stator	NBR or EPDM or approved equivalent base Polyelectrolyte
Pump component lining	Teflon (PTFE) or Fluro-elastomer/Viton (FPM)
V-belt guard	Mild steel epoxy coated
General Components	
Bearing Housing or coupling guard	High material grade cast iron epoxy coated
Coupling rod	316 Stainless Steel
O-rings	Approved synthetic rubber
Baseplate	Hot dipped Galvanized mild steel
Hold down bolts	316 Stainless Steel
Inline static mixer	Hot dipped Galvanized mild steel
Pipework	Hot dipped Galvanized mild steel
Fasteners	316 Stainless steel or Refer fasteners section of this document
All other accessories shall be of the manufacturer's standard, industry approved, and corrosion protected.	

PSX2.6 Wash Water and Sludge pumps with associated Pipework

PSX2.6.1 General Plant Description

The existing Dewatering Building wash water supply installation is a series pumping configuration and the installed mechanical equipment is in a state of disrepair. The wash water transfer pumps series configuration is categorised into two sections per area of installation as provided below:

- Wash water transfer pumps located at the Unit 3 Chlorine Contact Chamber
- Wash water distribution pumps located at the Dewatering Building

The pump operational philosophy is duty and standby per area installation, the wash water's existing series configuration between the transfer and the distribution pumps by-passing the Wash water storage facility i.e. DAF tanks located close to the Dewatering Building. The entire wash water supply is filtered before the Unit 3

Employer:		Contractor:	
Witness:		Witness:	

Chlorine Contact transfer pumps and also filtered for the second time by a single automatic wash water strainer after the distribution pumps in the dewatering building before the installed filter Belt Presses.

The dewatered sludge is drawn from the sludge collection chamber and pumped to the dewatering filter Belt Presses in press duty/standby pump configuration.

PSX2.6.2 Scope of supply

The scope of work for the Wash Water equipment is design, fabrication, supply, delivery, transport, handling, storage, erection, installation, testing and commissioning of equipment. The Scope of Works shall include, but not be limited to, the following:

- Wash Water Transfer Pump Station at Unit 3 Contact Chamber:
 - o Replacement of two (2) transfer pump (duty and standby) on Unit 3 Chlorine Contact Chamber and addition of a new maintenance duty pump on the by-pass channel for transfer of wash water as per JW14060R-CI-012 during contact chamber cleaning. The maintenance transfer pump will only operate during the cleaning of the Unit 3 Contact Chamber. The pump sets shall include motors, couplings (flexible or closed coupling), baseplates, safety guards, hold-down bolts etc.
 - o Replacement of the suction and discharge pipework for transfer pumps as per drawing No. JW14060R-CI-012. Piping installation shall include all associated instrumentation as details in the relevant drawings. The pressure class shall be to 1000kPa; and
 - o Installation of new suction and discharge pipework for the maintenance transfer pump to interconnect with the existing discharge pipeline from the Unit 3 Chlorine Contact Chamber pipeline.
- Wash Water Distribution Pump Station in the Dewatering Building:
 - o Replacement of two (2) pumps for the Set A & B Belt Presses and installation of two (2) new distribution pumps for Set C Belt Presses. The pump's operational philosophy is duty/standby configuration per area of water as per drawing No. JW14060R-CI-012 with solids handling capabilities. The pump sets shall include motors, couplings (flexible or closed coupling), baseplates, safety guards, hold-down bolts etc,
 - o Replacement of the suction manifold for all the four (4) distribution pumps.
 - o Reconfiguration of the discharge pipework for the existing two (2) distribution pumps servicing Set A and B Belt Presses,
 - o Installation of discharge pipework for the wash water supply to Set C Belt Presses and interconnecting pipework between Set C and Set A discharge pipework as per drawing No. JW14060R-CI-012 and JW14060R-ME-008 (pipe schedule) and JW14060R-ME-009. The pressure class shall be to 1600kPa,
 - o Installation of new automatic self-cleaning strainers with a by-pass manual strainer for the Set C Belt Presses. Further replacement of the automatic self-cleaning strainer and reconfiguration of the pipework to accommodate the

Employer:		Contractor:	
Witness:		Witness:	

installation of the manual strainer with bypass pipework for the Set A and B Belt Presses. The strainer filters the wash water before the critical Belt Presses and ancillary equipment water usage,

- o Pressure reducing valves on the following streams:
 - Both of the return wash water lines to the DAF tanks with flow regulation functionality,
 - Feed to the Polyelectrolyte solution make-up tanks,
 - Feed to the each of the belt wash common line to the Belt Press set A and C,
 - Feed to common line to the Polyelectrolyte solution dilution line.
- Sludge Supply Pumps:
 - o Replacement of two (2) Centrifugal pump type (duty and standby) for the supply of sludge as per drawing No. JW14060R-CI-013 and JW14060R-ME-010. The pump sets shall include motors, couplings (flexible or closed coupling), baseplates, safety guards, hold-down bolts etc.
 - o Associated air valves and drainage pipework. The pressure class shall be to 1000kPa.
 - o Design, amendment, manufacture, testing and commissioning of bypass line with associated valves for the existing flow meter.

PSX2.6.3 Battery limits

The battery limits for the wash water and sludge pumps shall be as follows:

- Existing equipment which is not associated with described the scope of works above shall not be modified unless instructed so by the Employer's Agent or Representative,
- The sludge pipework from the suction of the pump until the delivery pipework just before the first branch of the sludge distribution to the dewatering Belt Press,
- The buried pipework from Unit 3 Chlorine Contact Chamber to the isolation valve at the west DAF tank.

PSX2.6.4 Specific design, performance and operational parameters

The pumps supplied under this Contract shall be progressive cavity pump type and shall comply with the requirements of Mechanical Particular Specification M18, M20, M21 and following project requirements.

Detailed performance curves and a complete datasheet for the pump unit type shall be provided at the time of tendering. The curves shall indicate the following:

- Head (meters) vs. flow (m^3/hr) – The curve shall extend from 0% to 120% of the selected best efficiency point (BEP) based on the duty flow,
- Power absorbed in kW - The curve shall extend from 0% to 120% of the selected BEP based on the of duty flow,

Employer:		Contractor:	
Witness:		Witness:	

- Pump efficiency – The curve shall extend from 0% to 120% of the selected best efficiency point (BEP) based on the duty flow,
- Net positive suction head curves required (NPSH_{required}) by the pumps at the specified flow rate range. NPSH_{Required} curves for both 0% and 3% cavitation shall be included with the pump characteristic curves. The selected pump NPSH_{available} shall always be greater (including the safety margins) than NPSH_{required} at all potential operating points,
- The impeller size shall be such that at least a 5% increase in head at the rated capacity can be obtained by installing a larger diameter impeller of the same pattern. Minimum allowable impeller diameter shall be 105% of the pump supplier's minimum catalogue diameter. No pump, with a constant speed driver, which requires a maximum or minimum diameter impeller to meet the rated pumping conditions, will be accepted,
- State the rated impeller diameter in millimetres to achieve the duty flow. The tenderer shall indicate the range of impellers that the selected pump can be installed with,
- The Contractor shall guarantee the output and efficiency of the offered pump sets, which guarantees shall be binding under the Contract,
- Where guaranteed performance is specified, certified test curves shall be drawn from the test data obtained from the offered pumps and shall include; head (m), quantity pumped (m³/hr), efficiency (%), power consumption (kW), speed in rpm and speed/torque (rpm/kNm). The performance with maximum and minimum impellers shall also be indicated, as well as tested NPSH available,
- State the rated pump rotational speed in rpm.

The selected pump shall operate effectively under prevailing site conditions in the transfer of the fluid medium with minimum properties as indicated below:

- **Wash water properties:**
 - o Generalised Newtonian fluid with constant viscosity,
 - o Expected suspended solids of 1% on average,
 - o Corrosion and Abrasive wear,
 - o Spherical, Fibrous or stringy solids.
- **Sludge properties:**
 - o The non-Newtonian fluid of shear-thinning characteristics,
 - o Solids concentration of between 2 and 6%,
 - o Corrosion and abrasive wear,
 - o The build-up of gas pockets, therefore, breather or vent cocks shall be installed on pump high points,
 - o Consideration for pump line flushing for longer intermittent operations,

Employer:		Contractor:	
Witness:		Witness:	

- o Spherical, Fibrous or stringy solids.

The arrangement of the impeller with back vanes shall reduce the residual axial thrust to a minimum in order to reduce the loads on shaft, seals, and bearings. Designs that incorporating a balanced, double suction arrangement are preferred. The selection of the impeller type shall be such that there is less abrasion when the fluid is being pumped and the impeller shall be able to handle the specified solids or rags without being stuck in the impeller. The free ball passage i.e. solid handling size of the pump shall be measured as the hard-sphere that will pass in the volute casing. The solids handling size shall take into consideration the characteristics of the inflow medium and application.

Impeller shrouds shall be of adequate thickness after they have been machined, the thickness depending on the impeller diameter. Impellers for similar pumps shall have the same outside diameter and shall be interchangeable.

Wash Water Transfer Pump

Pump function	: Transfer of wash water
Pumping capacity	: 540 m ³ /hr
Nominal discharge head	: 15 m
Speed control	: Fixed speed
Pressure gauges required	: YES (on each pump suction and discharge side)
Priming lift	: End-suction centrifugal pump
NPSH _{available}	: 4.17m to 8.59m
Nozzle flange rating	: SANS 1123 Table 1000/3

Wash Water Supply Pump

Pump function	: Supply of wash water
Pumping capacity	: 250 m ³ /hr
Nominal discharge head	: 85 m
Speed control	: Fixed speed with a soft starter
Pressure gauges required	: YES (on each pump suction and discharge side)
Priming lift	: End-suction centrifugal pump
NPSH _{available}	: 9.82m to 10.3m (varying water level)
Nozzle flange rating	: SANS 1123 Table 1600/3

Sludge pumps

Pump function	: Transfer of sludge for dewatering
Pumping capacity	: 396 m ³ /hr
Nominal discharge head	: 20 m
Speed control	: Fixed speed
Pressure gauges required	: YES (on each pump suction and discharge side)
Priming lift	: Self-priming suction lift suction

Employer:		Contractor:	
Witness:		Witness:	

NPSH_{available} : 4.04m to 8.59m
Nozzle flange rating : SANS 1123 Table 1000/3

An inline strainer shall be installed upstream of the wash water distribution pumps in the dewatering building. The main strainer shall be of the automatic backwash self-cleaning strainer installed with a manual (bucket or y strainer) on a by-pass line. The strainer shall be designed to handle 25% more of the specified flow and 50% higher than the working pressure as a minimum.

The cleaning process of the strainer shall be intermittent in order to keep the wasting of wash water to a minimum. The cleaning shall be regulated by a differential pressure across the strainer not exceeding 50kPa or by a set timer. The strainer serves as the critical component of the dewatering process equipment, as it is expected to be continuously in operation with minimum downtime. The backwash or draining valves shall be electrically operated with the power requirements of 220V at 50Hz. The backwash water pipework shall be provided to the designated disposal point.

Wash water Self-cleaning and Manual Strainers (where applicable)

Function : Filtration of solids from the wash water
Capacity : 250 m³/hr
Line working pressure : ± 800 kPa
Screen aperture size : 250 microns
Nozzle flange rating : SANS 1123 Table 1600/3
Inlet and Outlet size : 150NB for strainer in JW14060R-ME-009
& 200NB for strainer in JW14060R-ME-008
Power requirements : 220/3/50
Control System IP rating : IP65

PSX2.6.5 Material of Construction

Materials of construction shall be selected to handle the type of media being pumped as specified. It shall be noted that in all applications the media can contain grit carried over from the grit removal equipment and solids that are of a stringing substance in nature. The pump unit components shall be constructed of the material specified in Table 4.6-1 below.

Employer:		Contractor:	
Witness:		Witness:	

Table 4.6-1 Material Specifications - Pumps

COMPONENT	MATERIAL TYPE	
	Wash water pump	Sludge pump
Pump Casing	High material grade cast iron epoxy coated	CD4MCu Stainless steel
Pump impeller	Approved Cast steel in accordance with the EN standards	CD4MCu Stainless steel
Pump shaft	Approved stainless steel in accordance with the EN Standards	ANSI 1144 stress proof alloy steel
Shaft sleeve	420 SS heat treated min 400BHN	420 SS heat treated min 400BHN
Coupling guard	Mild steel epoxy coated	Mild steel epoxy coated
Bearing Housing	ASTM A48 Class 30 grey Cast iron	ASTM A48 Class 30 grey Cast iron
Mechanical Seals back plate and deflector vane	CD4MCu Stainless steel	CD4MCu Stainless steel
Mechanical seal faces	Silicon carbide or tungsten carbide	Silicon carbide or tungsten carbide
Wear disc/rings	ANSI 420 heat treated hardened SS	ANSI 420 heat treated hardened SS
O-rings	Approved synthetic rubber	Approved synthetic rubber
Baseplate	Hot dipped Galvanized mild steel	Hot dipped Galvanized Mild steel
Hold down bolts	316 stainless steel	316 stainless steel
Pipework	Hot dipped Galvanized mild steel	304L Stainless steel
All other accessories shall be of the manufacturer's standard, industry approved, and corrosion protected.		

Table 4.6-2 Material Specifications – Strainers

COMPONENT	MATERIAL TYPE
Housing and flanges	Epoxy coated Grey Cast iron
Screen	316 stainless steel
Seals	Approved synthetic rubber
Controls	Brass or 304 Stainless steel
All other accessories shall be of the manufacturer's standard, industry approved, and corrosion protected.	

Employer:		Contractor:	
Witness:		Witness:	

PSX2.7 Conveyor Belt Refurbishment and Supply of New

PSX2.7.1 General Plant Description

The Belt Presses sludge cake is discharge into a conveyor belt at $\pm 18\%$ solids. The conveyor belt layout for sludge cake conveyance from the dewatering building to the composite building is as indicated in drawing JW14060R-ME-001 & JW14060R-ME-0002.

PSX2.7.2 Scope of Supply

The Scope of Work for the Conveyor Belt equipment is the design, fabrication, strip & refurbish, supply, delivery, transport, handling, storage, erection, installation, testing and commissioning of spare equipment for refurbishment purpose. The Conveyor Belt Scope of Work shall include, but not be limited to, the following:

- Decommissioning the conveyor belt sequential in alignment with the decommissioned Belt Press for replacement of selected critical components such as replaced drive unit (motors, couplings and gearboxes,) and roller trough.
- Refurbishment of the conveyor belt associated with the Set A Belt Presses that is approximately 35m.
- Refurbishment of the conveyor belt associated with the Set B Belt Presses that is approximately 46m.
- Design, fabrication, and installation of NEW conveyor belt associated with Set C belt press with an approximate length of 20m.
- Replacement of individual Belt Press sideliners or skirt plates for containment of sludge cake within the conveyor belt.
- Removal and replacement conveyor belt accessories with new items for all the conveyor belts inside the Dewatering Building and the adjacent conveyor belt outside the building feeding into the main common conveyor belt to the drying beds.
- Design, fabrication, and installation of protective guard on all conveyors within the Dewatering Building.
- Refurbishment of the conveyor supporting structures by shot blasting and recoat for corrosion protection in accordance with Johannesburg Water (SOC) LTD specification for corrosion protection, G02.
- Design, fabrication and installation of cross direction chutes between the conveyors.

PSX2.7.3 Battery limits

The battery limits for the conveyor belt shall be as follows:

- Existing plant equipment associated dewatering plant operation,
- The conveyor belt and associated equipment within the Dewatering Building.

Employer:		Contractor:	
Witness:		Witness:	

PSX2.7.4 Specific design, performance and operational parameters

The conveyor components supplied under this Contract shall be compatible with interconnecting existing components and shall comply with the requirements of Mechanical Particular Specification M16 and the specified project requirements

All conveyors shall be designed for a surcharge angle of 0° with a capability of handling “lumped sizes of sludge cake” with a maximum inclination of 5° and a troughing angle of 35°. The conveyors shall be of a three (3)-roll troughing idler design as per the requirements of SANS 1313 with a minimum standard Belt width to be used for specific application shall be based on the properties of the material to be conveyed such as the maximum size of the pieces.

Design tonnage and maximum tonnage for belt conveyors shall be for a blended sludge of the Waste Activated Sludge and digested sludge cake of ±18% dewatered from a Belt Press process or screening process. The percentage of sludge shall be with reference to the maximum mass of dry sludge treated by the dewatering or screening equipment. No additional percentage shall be applied to the maximum feed tonnage to obtain a maximum design tonnage

Guards shall be constructed and supported off a heavy-duty mild steel angle iron and flat bar plates frame covered with a heavy-duty mild steel mesh subject to the approval by the Employer's Agent or Representative. The guard covers shall be removable from the frame structure to access equipment without the need to dismantle any other parts. The mesh size shall be such that no person shall insert a finger to reach the equipment with a defined size of 10x10mm. However, openings in the guard frame or anywhere else in the mess above the mesh size shall be defined as:

- Openings greater than 10mm but less than 80mm shall be moved away from the danger point with the following formula X (reasonable distance from the danger point) = $10 \times Y$ (size of the opening),
- Furthermore, the guards shall distance an operator from the danger point of the conveyor equipment with the minimum safe distance of 850mm when the whole hand can fit through an opening unless otherwise defined in-line to safety regulation.
- The guard covers shall be in sections of not more than 25kg with 16mm round bar handles at appropriate locations to be handled by an Operator. Larger guard covers shall be either designed with lifting hooks by lifting equipment or hinged for opening subject to the approval of the Employer's Agent or Representatives.
- The design of the cover guards shall be visible with the colour coding compliance to the Johannesburg Water Specification and shall have a reasonable access point to all equipment and ancillaries that require frequent access.

PSX2.7.5 Material of Construction

Materials of construction shall be selected to handle the type of material being conveyed. It shall be noted that in all applications the material can contain grit, rags, dust, moisture or a percentage of water and solids that are of a stringing substance

Employer:		Contractor:	
Witness:		Witness:	

in nature. The conveyor unit and components shall be constructed of the material specified in Table 4.7-1 below as a minimum.

Table 4.7-1 Material Specifications:

COMPONENT	MATERIAL TYPE
Skirt, hoppers, sideler	VRN 500
Belt	SANS 1173
Belt scrapper	Vulcanized EPDM
Gearboxes	Cast steel or Cast iron
Bearing housing	Cast steel
Baseplates and conveyor belt support	Hot dipped galvanized mild steel
Dust ducting	Hot dipped galvanized mild steel
Stairways and walkways	Hot dipped galvanized mild steel
Conveyor Belt Guards	Painted Mild Steel

PSX2.8 Heating, Ventilation and Air Conditioning (HVAC)

PSX2.8.1 General Plant Description

Part of the Dewatering Building section which houses the Set A & C belt presses have been using roof louvre installation as a means of ventilation. The existing Set B MCC and SCADA room has no HVAC installation. The two new MCC buildings and a solar battery room shall be constructed under this project and be provided with mechanical forced ventilation.

PSX2.8.2 Scope of Supply

The Scope of Work for HVAC is design, manufacturer, supply, installation and commissioning for dewatering building, MCC buildings, battery room and SCADA room.

The main Dewatering Building will be naturally ventilated using access doors and roof louvres. Forced ventilation and air-conditioning systems shall be installed in all MCC buildings (including the Solar Battery Room) and the SCADA Room respectively. The HVAC Scope of Work shall include, but not be limited to, the following:

- SCADA Room: The room shall be air-conditioned using split-type air conditioning units adequately sized for the heat loading conditions in the room;
- Set A, B & C MCC Building: The system in the MCC buildings shall consists of intake louvres, filter banks, sound attenuators, fans, ducting and discharge louvres, and other associated Plant items. Fresh air shall be drawn from outside, filtered and discharged into the building. The building shall be pressurised to prevent the ingress of unfiltered outside air; and

Employer:		Contractor:	
Witness:		Witness:	

- Solar Battery Room: The room shall be independently ventilated using a flame-proof plate-axial fan at a low level supplying air to the room. A pressure relief damper shall be installed at a high level to relieve pressure from the room.

The MCC and Battery Rooms ventilation design shall be based on the following air exchanges:

- Solar Battery Room shall achieve a minimum of four air changes per hour; and
- MCC shall achieve a minimum of ten air changes per hour.

PSX2.8.3 Specific design, performance, and operational parameters

PSX2.8.3.1 General

All equipment materials shall be suitable for the purpose for which they are to be used. All materials properties claimed for these materials shall, unless specified otherwise in this Section, comply with the requirements of the latest edition of the appropriate South African or other internationally recognised standard specification at the time of Tender.

For each type of equipment, the Contractor shall indicate the materials used for each of the proposed sub-assemblies.

The Contractor shall provide full references of suppliers and materials of the equipment supplied as well as all original copies of all the Certificates of Conformity regarding raw materials used to manufacture the equipment.

PSX2.8.3.2 Operating Conditions And Climate

Northern Wastewater Treatment Works is located on the south of Diepsloot in Gauteng Province of Republic of South Africa. The materials and equipment to be supplied and installed shall be selected appropriately and be fit for the purpose to operate under the following conditions:

Altitude : 1366 masl

Ambient Conditions:

- Summer DB : 35°C
WB : 22°C
- Winter DB : 0°C
WB : -1°C

Ambient Condensing Temperature : 35°C

Indoor Conditions:

- Summer Inside DB : 22°C ± 1°C
- Winter Inside WB : 24°C ± 1°C

Employer:		Contractor:	
Witness:		Witness:	

The HVAC systems installed shall be suitable in all respects for operation under the prevailing atmospheric, installation and electricity supply conditions as outlined in this Specification. The Contractor shall ascertain any other local conditions or peculiarities which might affect the working of the equipment and adjust the system accordingly without any additional payment or change in standards of materials and equipment supplied or workmanship in this respect. This also applies to the nature and construction of the building, details of which are indicated on the Drawings.

PSX2.8.3.3 Noise and Vibration Control

The Contractor shall be responsible for limiting noise and vibration transmission from the equipment to the building structure and adjacent rooms within the limits specified in SANS 10103: "The measurement and rating of environmental noise with respect to annoyance and speech communication":

- Noise levels in the SCADA Room shall not exceed 35 dB;
- Noise levels in the Solar Battery Room shall not exceed 45 dB; and
- Noise levels inside the MCC Rooms shall not exceed 45 dB.

The Contractor shall submit noise estimating sheets for all HVAC components as well as the insertion loss ratings of sound attenuators to the Employer's Agent for approval. Failure to do so will result in the replacement of equipment at the Contractor's cost should the noise levels in any area exceed the limits specified above

Noise generating HVAC equipment such as fans, motors, etc. shall be selected to operate as close to the point of maximum efficiency as possible.

PSX2.8.3.4 Split Type Air Conditioning Units

Split type air conditioning units shall be a self-contained, direct expansion air conditioning units each complete with an indoor evaporator and outdoor air-cooled condenser. Additionally, these units shall be in design using a heat pump reverse cycle type except if otherwise specified.

The indoor and outdoor units shall be mounted according to the manufacturer's recommendations. Hanging units shall have threaded rod of appropriate size fitted, which shall either hang from the structure above or from cantilever-type brackets, fixed to the wall.

Each unit shall be equipped with a condensate drain pan.

Temperature controls shall include a fan switch and a temperature adjustment facility and temperature scale as a minimum. Each unit shall be equipped with a time delay safety circuit which shall delay the restart of the compressor for approximately 3 minutes even if the air conditioner is manually restarted. The remote control shall be wireless and shall be supplied with a mounting bracket. These control units shall be installed inside the room at appropriate access heights.

PSX2.8.3.5 Axial Flow Fans

All axial flow fans shall be direct units and be housed and finished in hot dipped

Employer:		Contractor:	
Witness:		Witness:	

galvanised steel.

Impellers shall be aerofoil design which shall be die-cast in aluminium silicon alloy materials, assembled with high tensile zinc plated steel bolts and nuts. They shall also have non-overloading characteristics. Complete units shall be statically and dynamically balanced.

External terminal boxes shall be provided on the casings of fans fitted with standard totally protected enclosed motors. All casings shall incorporate access panels and lubrication points using grease nipples where applicable.

All fans shall be selected to handle at least the quantity of air specified against the relevant system static pressure. Motors and starters shall be suitable for local and remote starting and for a remote status indication as specified.

Where fans are required to be mounted outdoors, they shall be appropriately encased in weatherproof housings and shall be fitted with terminal boxes, etc., suitable for such operation.

Axial flow fans shall be mounted on anti-vibration mountings and shall be connected with flexible connections to ducts, silencers, etc.

PSX2.8.3.6 Supply Air Plenums and Filters

The supply air filter plenums shall accommodate 50 mm thick washable filters housed in galvanised steel frames. The plenums shall be constructed from 1.2 mm thick galvanised steel plate and be a minimum of 600 mm deep and feature access panels to the filters. The filters shall be of a standard proprietary type with pleated media bonded into galvanised steel channel surrounds. The filters shall have a minimum efficiency of 45% (EN779) and minimum arrestance of 98% (EN779). The filters shall be supported in galvanised steel holding frames fitted with sealing strips or gaskets and four galvanised clips per frame to prevent air bypass of the filter media.

A suitable, easily read manometer shall be permanently mounted against the filter plenum and shall be installed to show the differential pressure drop across the filters. The manometer shall be graduated in Pa and shall indicate when a filter change or wash is required. The manometer must have PVC tubes connected to the measuring points. The tubes are to be installed in Ega-tubing securely fixed along their route. Stickers shall be fitted onto the manometer to indicate the maximum pressure drop across each filter bank. An extra spare set of filters shall be supplied on completion.

PSX2.8.3.7 Sound Attenuators (Silencers)

Sound attenuators shall be supplied and installed in appropriate positions according to designs to ensure the attainment of the required noise level. The sound attenuators shall be procured and supplied from an approved and reputable specialist manufacturer. This shall be in accordance with the specifications and shall be selected and installed so that sufficient sound attenuation is obtained to limit the noise level created by the ventilation equipment to below the specified standard. The units shall generally be manufactured from galvanised mild steel with a woven glass cloth acoustic media retained behind a galvanized wire mesh. The acoustic

Employer:		Contractor:	
Witness:		Witness:	

media shall have a Class 1 fire rating to BS 476. The unit shall be compatible with the fan diameter and at least twice the length of the fan diameter unless calculated otherwise by the manufacturer.

The Contractor shall calculate the pressure rating requirements of fans at the specified airflow rate to take into account the pressure drop across sound attenuation equipment proposed. Sound attenuators in the ductwork before and after the fans shall be designed for an insertion loss large enough to limit the total sound pressure level of the noise at a distance of 1.5 meters directly in front of the first air outlet in the duct system to the noise level specified. The discharge noise from the attenuators shall not exceed 65 dB(A).

PSX2.8.3.8 Ductwork

All ductwork shall be manufactured according to SANS 1238: 2005 Standard Specification for Air Conditioning Ductwork. Unless otherwise specified or noted, ductwork casings and plenum chambers shall be made of galvanised sheet metal.

PSX2.8.3.9 Supply Air Louvres

Supply air louvres shall be manufactured of extruded aluminium unless otherwise noted on the drawings, finished in natural anodised and mounted on a duct collar or wooden frame. Supply air grilles shall be provided with double deflection aerofoil vanes adjustable from the front of the grille, with the front vanes vertical. Supply air grilles shall be provided with opposed blade volume control dampers adjustable from the front of the grille.

PSX2.8.3.10 Door Louvres

Door louvres shall be standard type manufactured of extruded aluminium unless otherwise noted on the drawings, with fixed blades and have a natural anodised finish. The blades shall be spaced tightly to ensure that the louvre is non-vision.

PSX2.8.3.11 Weather Louvres

The weather louvres shall be manufactured of extruded aluminium unless otherwise noted on the drawings and have a natural anodised finish. The fixed horizontal blades shall be held in place by screws or rivets. Blades shall be spaced 50 mm apart. Ingress by birds, leaves, etc. shall be prevented by a galvanised, small-aperture wire-mesh screen fitted to the back (inside) of the louvre. The louvres shall be neatly drilled on site for fixing and installed into a 25 mm thick industrial plywood frame.

PSX2.8.3.12 Burglar Bars

Burglar bars shall be installed at all external ventilation openings penetrating the wall or roof. Burglar bars must be manufactured from 16 mm round bar with 100 mm (max of 150mm) spacing's and welded into a 5mm flat steel frame. Burglar bars must be either built into the brickwork or welded into place. They are to be hot dipped galvanized after manufacture. In addition to the burglar bars, openings are

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to be protected with wire mesh screen.

PSX2.8.3.13 Corrosion Protection

Where not indicated otherwise in this Section, corrosion protection of cabinets, enclosures, materials and Plant shall be as specified in Particular Specification, G02: Corrosion Specification and Drawings.

All steelwork, piping, lagging, etc. supplied under this Contract shall be painted as follows except if galvanised:

All exposed metal parts, materials and Plant items such as pumps, belt guards, all piping, pipe lagging, fittings, dampers, fans, coils, motors, pumps, packaged units, control panels, steelwork, exposed ducts and lagging, expansion tanks, make-up tanks, cooling tower, unit shelters, etc. shall be cleaned, primed, and finished in a high quality two pack epoxy plus top coat of re-coatable polyurethane, except if specified to be anodised, galvanised or epoxy power coated.

PSX.3 Dewatering Plant Overview Operational Philosophy

The overview operation philosophy shall be read in conjunction with the Process flow diagrams drawing No. JW1460-CI-004 & JW1460-CI-005 in order to establish to the Contractor the expected operation and intended use of the collective equipment to be supplied under this scope.

- A predetermined volume is wasted from the biological reactors to the waste sludge tanks (WST) for thickening before the dewatering process from each of the three (3) Northern Wastewater Treatment Works i.e. Unit 3, 4 & 5 and additionally volume from the digesters is also fed into the Aeration Sludge Collection Chamber.
- The sludge in the aeration collection chamber is Blended and/or mixed then subsequently pump into sludge main pipeline, feeding sludge to the Dewatering Belt Presses.
- During the sludge feeding cycle, the Operator shall be locally, or PLC base via a PID controller determine a volume in m³/hr. of sludge to be fed to an individual Belt Press within its allowable operating region. Depending on the number of healthy and available Belt Presses, the sludge loading shall allow flexibility in the number of duty Belt Presses that can be put into operation.
- The flow to each Belt Press is monitored and controlled through a magnetic flowmeter with aid of a modulating valve located in the sludge valve bank. The control process shall prevent underloading and overloading of each Belt Press using this valve and flowmeter as a minimum.
- The sludge shall then be fed at the most appropriate location for the Belt Press to achieve the dewatering process and performances. The Belt Press shall achieve the dewatering process by a combination of gravity and pressure/compression dewatering regions.
- During the Dewatering process, there shall be continuous monitoring of the Belt speed, tension, alignment and cleaning of the belt in order to optimize the dewatering efficiency of the Belt Press.

Employer:		Contractor:	
Witness:		Witness:	

- A minimum of two output streams are expected from the Belt Press i.e. the dry sludge cake and the filtrate. The sludge cake shall be discharged at a common point which will allow ease of discharge into a conveyor belt and conveyed to the drying beds. The filtrate shall discharge under the Belt Press into a collection drainage channel feeding to a filtrate "liquor" pump station.
- To optimize the sludge dewatering, each sludge stream feeding into the Belt Press shall be sufficiently dose with polyelectrolyte solution and mixed to achieve the maximum flocculation.
- Each Belt Press shall have a dedicated Polyelectrolyte adjustable flowrate duty dosing pump and a standby pump.
- The dosing pump shall draw the Polyelectrolyte solution from a dedicated Belt Press Holding tank monitored by level instrumentation.
- The Dewatering Building Belt Presses is serviced by two (2) Polyelectrolyte solution Make-up tanks, the configuration of the tank is allowed for continuous operation to feed the Holding tanks via duty/standby transfer pumps.
- Dry Polyelectrolyte powder is delivered in a bulk tanker and stored in the Polyelectrolyte silo for an estimated period of 30 days as a minimum. The Silo shall continuously feed the Polyelectrolyte make-up tanks as and when required with appropriately sized handling equipment. An emergency bay (Dry powder Polyelectrolyte hopper) that is manually operated shall be used to feed each of the make-up tanks when the bulk silo is not available by fluidizing of the powder into the tanks.
- There shall be a continuous supply of wash water for the Polyelectrolyte solution make-up tanks, Polyelectrolyte solution dosing and transfer pumps for flushing, Polyelectrolyte solution dilution, dewatering belt cleaning, and plant wash down as a minimum.
- The operation and control of the Belt Presses shall ensure that each of the supply streams i.e. sludge, Polyelectrolyte, wash water and conveyor belt shall be available and operational healthy.

PSX.4 Process Data

The Contractor's plan, process streams compliance and the Health & safety practices are of great importance when designing or selecting or executing the required Scope of Works, therefore, the following process data shall be maintained as bases for the design;

- The dewatered sludge is a blend of waste activated and digested sludge with a nominal feed rate of 126 000 kg DS/day to the Aeration basin (sludge collection chamber).
- The dewatering plant sludge cake production is estimated at 75 ton/day on average and is transported by conveyor belt to the compost area.
- The blended sludge solids concentration range is 2% to 6%.
- The maximum polyelectrolyte consumption range is 3 to 5 kg/ ton DS at any given point in time during the dewatering process.

Employer:		Contractor:	
Witness:		Witness:	

- The sludge and wash water pH level range are 5.2 to 7.7.
- The dewatering process is a continuous operation, and the equipment shall be design for 24 hours per day for 365 days operation with a minimum of 99% availability over the 15 years design life cycle.
- The treated sludge is expected to have lumped and fibrous solids
- A general ambient and operating temperature between 0°C and 40°C.
- The equipment shall operate without undue vibration and excessive noise. Shall be limited to 75 dBA measured at 1 metre from operating equipment.

The Contractor shall offer a Belt Press with guaranteed performance parameters and all performance parameters on offer shall be based on sludge sample results taken from the Northern Wastewater Treatment Works sludge streams. The Contractor is required to conduct process testing more especially on the Sludge streams before selecting and procuring the required dewatering equipment.

Additional process stream testing will be required to be made during the commissioning and trial operation stages to validate the performance of the supplied equipment.

Employer:		Contractor:	
Witness:		Witness:	

PSX.5 General Mechanical specifications

Equipment shall be designed:

- To ensure reasonable standards of engineering in design, materials selection and construction processes;
- To facilitate manufacture, inspection, installation, maintenance, cleaning and repairs;
- To ensure safe and satisfactory operation for an acceptable life expectation of 15 years under the ambient conditions prevailing at the Site;
- The offered equipment shall be support in forms of spares by the original equipment manufacturer for at least 15 years in alignment with the specified life expectancy from project installation; To prevent undue stresses being produced by expansion due to temperature changes;
- To keep maintenance costs to a minimum that represent the value for money in both the initial purchase and subsequent running costs;
- To facilitate inter-changeability of units and/or sub-parts throughout the Contract works with regard to new equipment and equipment and/or sub-parts currently being used on the existing JW Wastewater Treatment Works;
- To operate without undue vibration and excessive noise. Maximum of 75dBA measured at 1 metre from operating equipment;
- To comply with the legal requirements in respect of safety such as the Occupational Health & Safety Act, 1993 and Regulations as well as the prevention of water and air pollution;
- To satisfy any specific requirement contained in the statutory codes and legislation;
- To be suitable for operation 365 days per year, 24 hours per day under specified design conditions; and
- The minimum availability of the equipment shall be 99 %.

PSX 5.1 Quality Management (QM) and Testing. Commissioning and Trial Operation

QM shall be categorised as 'critical and major' for this Project. The Contractor's Quality Management System shall be in accordance with industry standards. The Contractor shall implement a comprehensive Quality Control programme and accept full responsibility for the quality of his workmanship and material used, irrespective of any quality surveillance that may be carried out by the Employer's Agent / Employer' Representative. In keeping with the basic principles Quality Management System, the Contractor, and Subcontractor(s) shall:

- Be responsible for compliance with all the requirements of the Specification in every respect;
- Carry out all inspections and tests called for in the Specification in the presence of the Employer's Agent / Employer' Representative. The cost of these inspections and tests shall be carried out at the sole expense and under the responsibility of the Contractor;

Employer:		Contractor:	
Witness:		Witness:	

- Draft a Quality Control Plan for manufacture for approval by the Employer's Agent / Employer' Representative and comply with the approved Quality Plan during the manufacturing process of all components indicating all the intended stages of testing during manufacture, cleaning, and preparation for application as well as necessary hold points for independent quality surveillance;
- Draft a Quality Control Plan for corrosion protection for approval by the Employer's Agent / Employer' Representative and comply with the approved Quality Plan during corrosion protection process of all components indicating all the intended stages of testing during corrosion protection as well as necessary hold points for independent quality surveillance;
- Draft a Quality Control Plan for installation for approval by the Employer's Agent / Employer' Representative and comply with the approved Quality Plan during the installation process of all components indicating all the intended stages of testing during installation as well as necessary hold points for independent quality surveillance; and
- Draft Quality Control Plans for any other construction process as may be required for approval by the Employer's Agent / Employer' Representative and comply with the approved Quality Plan during the execution of the process indicating all the intended stages of testing as well as necessary hold points for independent quality surveillance.

The Quality Control Plans will not be compromised once approved and shall always be adhered to. The Contractor shall operate approved quality assurance and control programmes in the Supplier's and Manufacturer's premises and on Site to verify that the Works comply with this Section. Before the commencement of any work, the Contractor shall prepare and submit to the Employer's Agent / Employer' Representative for approval, quality plans describing the procedures, standards of acceptance, hold point inspections, routine and type tests to be carried out for each component both during manufacture and on Site.

Although it shall remain the responsibility of the Contractor to ensure that the Works conform to the Specification, the Employer's Agent / Employer' Representative shall be entitled to inspect, examine and test the materials, workmanship and performance of every item of Plant. The Employer's Agent / Employer' Representative will notify the Contractor which tests or inspections, detailed in the quality plan, he will attend.

Approval by the Employer's Agent / Employer' Representative of materials, workmanship, etc., during manufacture or at Site will not relieve the Contractor of his obligations to comply with all the requirements of the Contract.

All instruments and appliances necessary for the complete inspection and testing shall be provided by the Contractor. Calibration certificates for instruments shall be produced to the Employer's Agent or Employer's Representative for review prior to the commencement of any tests and, if required by the Employer's Agent / Employer Representative, instruments shall be re-calibrated at the Contractor's own account before commencement of the tests.

In general, Quality Management System should be benchmarked in accordance with the relevant ISO 9000 and associated requirements.

Employer:		Contractor:	
Witness:		Witness:	

PSX 5.2 Material Tests

The Manufacturer's material test data and the Contractor's quality records shall be subject to examination by the Employer's Agent / Employer' Representative. Reasonable samples of the cleaning and coating materials to be used may be taken for testing.

Rejection of the samples shall place a hold on the use of the materials of the same batch number and any components that have already been cleaned/coated with rejected material shall be re-cleaned and coated.

PSX 5.3 Type Tests

Where the Contractor offers Plant selected from the standard range of products from a specialist manufacturer, type tests in accordance with a recognised international standard are required on one unit of each type to prove satisfactory design and quality of manufacture of that Plant.

The Employer's Agent / Employer' Representative may waive the requirement for type tests if he is satisfied that tests have previously been performed on identical Plant. The Contractor shall submit the data and results with his Quality Plan in sufficient time to allow for repeat tests without delaying the Works should the Employer's Agent / Employer' Representative not approve the evidence submitted.

PSX 5.4 Substandard Quality Control

All material, certification and records of the Contractor shall be subject to examination by the Employer's Agent / Employer' Representative.

This shall include the checking and testing of the Plant at the Works and on Site, installation and pre-acceptance testing. If any deviation is found, additional testing and quality surveillance shall be carried out at the Contractor's own costs until approved by the Employer's Agent / Employer' Representative.

If the additional testing confirms inaccurate quality control by the Contractor on an item of Plant, all work shall be stopped on that item of Plant and shall only proceed after remedial action in the quality control system has been implemented.

PSX 5.5 Access for Surveillance

For the purpose of carrying out quality surveillance, the Employer's Agent / Employer' Representative shall be granted access to any part of the Contractor's premises relevant to the work being carried out, at any reasonable time.

PSX 5.6 Installation

The equipment unit shall be aligned to within ± 0.025 mm full indicator movement on dial gauge, regardless of the coupling type. After the pump and motor unit mounting baseplate is tightened down, and the pipework erected and tightened, both angular and parallel alignment shall be checked, recorded and witnessed by the Employer's Agent or Representative at each quarter revolution. These readings shall be

Employer:		Contractor:	
Witness:		Witness:	

submitted to the Employer's Agent or Representative and is a prerequisite for handover.

Upon completion, dowel pins shall be fitted to facilitate relocation at any future time.

PSX 5.7 Testing by Manufacturer

The Manufacturer will carry out all tests on materials, quality control tests, dimensional checking and routine tests on parts to ensure that the pumps and materials conform to the requirements of the relevant SANS or BS specifications referenced in this document or specified by the OEM and to this Specification. .

PSX 5.8 Witnessed Testing

All Equipment shall be subject to a Factory Acceptance Test (FAT) by the Manufacturer and witness by Employer's Agent or Representatives at the Manufacturer's premises before despatch to site. All performance test results shall be made available to the Employer's Agent or Representative for verification or when the QCP's requires intervention or hold points for inspection.

In addition to the above, a number of performance tests will also be carried out in the testing facility of the manufacturer/supplier before equipment is transported to Site. Equipment shall only be despatch from factory once all relevant "hold points" on QCP's have been signed off by the Employer's Agent or Representative and/or the Approved Inspection Authority (AIA) in accordance with approved quality control plan. These tests can be carried out in the workshop of the manufacturer/supplier if it is suitably equipped with the resources needed for the testing or another approved testing facility.

The Employer's Agent or Representatives may witness these tests and the Contractor will notify the Employer's Agent or Representatives at least 14 working days in advance of the date, time and place at which the equipment may be inspected and tested. When tests and inspections have met the satisfaction of the Employer's Agent or Representatives, a certificate of workshop acceptance will be issued. These certificates are a prerequisite before payment for "Materials on Site" can be passed. The Employer's Agent or Representatives acceptance will in no way relieve the Manufacturer of any of his obligations to design, manufacture and supply pumps strictly in accordance with the Specification.

PSX 5.9 Testing by an Independent Facility

If a performance test of the equipment and its driving unit is not possible at the manufacturer's works or approved facilities of the supplier, this shall be stated in the Tender Returnable Schedule with reasons to allow the Employer's Agent or Representatives opportunity to make alternative proposals.

The Employer's Agent or Representatives may require as an alternative proposal that an independent testing facility or institution such as the South African Bureau of Standards carry out the performance tests. A separate item for performance testing will be provided in the Schedule of Quantities to allow for this.

Employer:		Contractor:	
Witness:		Witness:	

PSX 5.10 Plant Performance

On completion of the installation the Contractor will check all items for satisfactory functioning. He will then inform the Employer's Agent or Employer's Representatives of his intention to commission the plant. The Employer's Agent or Representatives may request control measurements on pump alignment at this stage.

The Contractor is expected to submit for acceptance by the Employer's Agent a commissioning plan clearly addressing how each of the following stages of plant performance shall be planned and executed for the entire scope of supply;

Stage 1 – Post-installation inspection

Stage 2 – Dry or Cold Commissioning

Stage 3 – Wet or Hot Commissioning

Stage 4 – Trial Operation

A detailed programme of the Contractor's proposed commissioning procedures will be submitted not later than 14 working days prior to the commissioning date.

The Contractor shall further conduct the following and prepare a snag recording list to identify as a minimum the following;

- Check for correct lubrications levels in all rotating equipment including gearboxes and that motor bearings are greased properly.
- Ensure all HD bolts are torque down correctly.
- The alignment and levelling of each assembly shall be checked and witnessed by the Employer's Agent or Employer's representative.

The electrical functions and control shall be checked by a responsible inspector prior to attempting to start any motor on this Project.

PSX 5.11 During and After initial commissioning

Ensure all auxiliary components of the equipment and the peripheral instrumentation such as level, flow or pressure switches are functional

Should the Contractor fail to meet the performance requirements, the Employer may appoint others to undertake the necessary repair work at the Contractor's cost.

PSX 5.12 Tests at the Site of the Works

The Employer's Agent or Representatives may require that site tests are performed to verify performance figures guaranteed by the Contractor. Flow rate, total head and power input to the equipment units shall be determined, as accurate as Site conditions permit. The Contractor shall provide suitable instruments with recent calibration certificates.

Should the subsequent test results still fall outside the allowable tolerances, shall apply, and call costs shall be borne by the Contractor. In the event of the subsequent test being successful, costs shall be borne by the Employer.

Employer:		Contractor:	
Witness:		Witness:	

PSX 5.13 Trial Operation

The Contractor shall prove the performance guarantee of the offered equipment with one calendar month of commissioning and three (3) calendar months of trial operation. Trial Operation shall only commence once commissioning stage is complete and approved by the Employer's Agent or Representative.

Trial Operations Stage shall demonstrate that the equipment performs reliably within the performance parameters and in accordance with the Contract over the specific period. Once the Trial Operation has commenced, the equipment shall be operated successfully for a minimum period of four (4) weeks continuously, with interruptions only to alter equipment operational settings, effect final settings and optimization, test auto-functionality and train the Employer's operational staff in the final detail functioning of the equipment. During the Trial Operation Period, the Contractor shall record all operational data and on completion

submit to the Employer's Agent / Employer's Representative a report confirming final settings, calibration, auto control functions and approved tests, all to the satisfaction of the Employer's Agent or Representative.

Approval of the trial operation stage by the Employer's Agent or Representative shall indicate approval of equipment performance as guaranteed.

Disapproval of the trial operation stage by the Employer's Agent or Representative renders the correction and resetting of equipment. All costs involved in the correction and re-testing of equipment units will be borne by the Contractor.

Should the equipment unit fail to pass the trial operation with more than $\pm 15\%$ variation on the actual guaranteed figures that renders a negative impact in the plant's overall process, the Employer's Agent or Representatives will reject the equipment unit and request the Contractor to replace the unit.

Should the equipment until still fail to pass the trial operation, but the actual figures do not vary by more than $\pm 15\%$ from the actual guaranteed figures, the Employer's Agent or Representatives may:

- (a) Request the Contractor to carry out amendments to ensure the compliance of the unit with the Specification; or
- (b) Accept the equipment but impose a penalty for non-compliance on the Contractor. A sum will be calculated based on the additional energy and resources used over the life expectancy of the equipment and this will be deducted from the Contract price for each equipment for every kilowatt and operational cost by which the gross demand exceeds the guaranteed figure with permissible tolerances.

PSX 5.14 Fasteners

Nuts, bolts, studs and washers for incorporation in the Works shall conform to the requirement of the appropriate approved standard.

Bolts shall be of such standard length that a minimum of two to four complete threads shall protrude beyond the nut when in the fully tightened condition. The same shall applies to stud units. Mating surfaces shall be adequately protected against corrosion

Employer:		Contractor:	
Witness:		Witness:	

whilst awaiting assembly of the faces and bolting, all to the approval of the Employer's Agent or Employer's Representative.

All high tensile bolts and studs used in the Works shall bear the letter HTS stamped or engraved on the end.

Washers shall be provided under all bolt heads and nuts. The threads of bolts and studs shall be lubricated before assembly with a lubricating substance subject to the approval of the Employer's Agent or Employer's Representative. Washers, locking devices and anti-vibration arrangements shall be provided where necessary and shall be subject to the approval of the Employer's Agent or Employer's Representative. Multiple washers or shims shall not be used

Stainless steel bolts, nuts and washers shall be in accordance with SANS 1700 A70, and the grade of stainless steel shall be subject to the approval of the Employer's Agent or Employer's Representative.

Hot Dip Galvanized fasteners shall comply with the requirements of SANS 121. High strength friction grip (HSFG) bolts, nuts, load indicator washers and washers shall subject to the approval of the Employer's Agent or Employer's Representative and shall be hot dip galvanized.

High strength friction grip bolts shall be tightened in accordance with the manufacturer's recommendations and the tension shall be re-checked not less than 3 hours after first tightening and then the bolts shall be retightened to the initial load all to the approval of the Employer's Agent or Employer's Representative.

All stainless steel holding down bolts, nuts and washers in contact with a dissimilar material shall be provided with isolating washers and sleeves (insulating kit) where appropriate to prevent galvanic corrosion. The bed plates and machinery shall be provided with means of adjustment for line and level to maintain the items of Plant in correct alignment during grouting. Packers used for adjustment shall be of non-corrosive material to the approval of the Employer's Agent or Employer's Representative. Holding down bolts which are to be tightened after grouting shall be provided with bond breakers where they pass through the grout.

Where there is a risk of corrosion, bolts and studs shall be designed so that the maximum stress in the bolt and nut does not exceed half of the yield stress of the bolt material under all conditions. The shear value of high strength friction grip bolts shall be reduced in proportion to the reduced tensile stress compared with the normal design stress.

All anchor/hold-down fasteners shall be of grade 316 stainless steel and shall be no smaller than M16. All threads coated with compatible anti seize compound before assembly.

No tapped holes in mild steel shall be allowed. Where tapped holes are unavoidable, this shall be done into stainless steel.

Where bolts and nuts are required to be removed and re-assembled on a regular basis, these shall be of stainless steel.

Metal coatings and other treatments applied to fasteners shall be carried out in a manner which will not cause hydrogen embrittlement of the parent material.

Employer:		Contractor:	
Witness:		Witness:	

PSX 5.15 Equipment Training Procedure

Training shall be provided by the Contractor (or specialist equipment suppliers) based on the supplied and approved operation and maintenance (O&M) manuals for all supplied equipment. This training shall be provided to the Operations and Mechanical including other support discipline staff of the Employer along with the Employer's Agent and/or Representatives. The duration of the training period shall be a minimum of 128 hours with the training content or curriculum agreed with the Employer's Agent and/or Representatives.

The training structure for the equipment and/or system shall include both the theory and practical components centred around the equipment and derived from the O&M manuals.

The preparation of the O&M manuals shall be based on the Johannesburg Water (SOC) Particular specification for Commissioning and Operation.

PSX 5.16 Operation and Maintenance Manual summary

The Contractor shall hand over to the Employer's Agent or Employer's Representative four sets (x2 hard copies and x2 electronic copies on non-locked USB) of the Operation and Maintenance Manual compiled for each installation not later than at the time of commissioning of the installation. These manuals are a prerequisite for final takeover of the plant. A copy of the Operating and Maintenance Manual for each equipment type shall be bound in with the Operating and Maintenance Manual for the project. The manual shall be A4 size and properly bound. Drawings larger than A3 size shall be contained in separate plastic pockets.

The Operation and Maintenance Manual will contain the following:

Operations Instructions:

- Brief description of the plant and installation as a system with the method(s) of operation described.
- General System or Process Safety Instructions indicating the following;
- Minimum PPE requirements
- Risk, Health and Safety Assessment with proposed control measures Concise operating instructions indicating the following;
- Start up and Shut down modes
- Alarm and protection interlock condition and the associated settings
- Routing attention during operation
- Description of adjustable settings for the mode(s) of control i.e. operating envelopes

Maintenance Instructions:

- The Contractor or the specialist vendor shall make allowances for Instructors to train the Client's O&M service personnel after the system has been commissioned and handed over.
- Routine for Preventative maintenance instructions with schedules for each unit

Employer:		Contractor:	
Witness:		Witness:	

or equipment

- Fault finding with detailed precautionary measures, elementary trouble location, rectifying measures and emergency actions this shall include failure mode analysis and preventative strategies.
- Detailed information and description on equipment installation, dismantling and handling.
- Lists of recommended spare parts including names and addresses of suppliers.
- Schematic Diagram and Drawings
- CoC's with calibration certificates, FAT, SAT, etc..

Employer:		Contractor:	
Witness:		Witness:	

PSX.6 MEASUREMENT AND PAYMENT

No separate payment will be made for required equipment unless otherwise specified in the detail/project specifications. All direct and indirect costs associated with such required equipment shall be deemed to be included in the rates tendered for the equipment.

Where separate payment is required for equipment and specified as such in the detail /project specifications, the following payment items shall be applicable:

PSX.6.1 General

The following items shall be included in the rates:

- (a) Supply of all design and pre-manufacture documentation and obtaining approval thereof;
- (b) Procurement and/or manufacture of required equipment with associated equipment items and delivery to Site;
- (c) Installation of complete required equipment with associated equipment items and testing;
- (d) Services required during period of initial use before handover to the Employer.
- (e) Payment under scheduled items shall be made per complete installation as specified, electrical connections, etc and grouting, etc. Measurement and payment will distinguish between supply / delivery; installation and testing; and commissioning and trial operation of the equipment. A further training requirement shall be allowed for as specified in the scheduled items.

PSX.6.2 Decommission, Dismantle, handle (loading & offloading) and transport to an on/offsite storage facility

<u>Item</u>	<u>Unit</u>
Decommission and Removal from site	No
.....	sum
.....	m
.....	ton/km

The tendered rates shall include for full compensation of all costs incurred in the required resources, e.g. lifting equipment, manpower, manual and power tools, cleaning including transportation costs and on/offloading of the equipment. No claims whatsoever for extras will be allowed on the grounds that a necessary piece of equipment or a part thereof is not specifically mentioned.

PSX.6.3 Supply and delivery to site with documentation

<u>Item</u>	<u>Unit</u>
Supply and delivery to site with documentation.....	No
.....	sum

Employer:		Contractor:	
Witness:		Witness:	

..... length

The tendered rates shall include for full compensation of all costs incurred in design, drawings, manufacture, supply, testing at the manufacturers works, inspections, quality control, quality assurance, factory acceptance testing, corrosion protection, packing, delivery to site including transportation costs and offloading on site including any crane requirements. No claims whatsoever for extras will be allowed on the grounds that a necessary piece of equipment or a part thereof is not specifically mentioned.

PSX.6.4 Installation (and/or Stripping for Refurbishment), Testing and Commissioning of the Equipment

<u>Item</u>	<u>Unit</u>
Installation, Testing and Commissioning of the Equipment	No
.....	sum

The tendered rates shall include for full compensation of all costs incurred in installation, site testing, setting into operation, the supply of O & M manuals, commissioning and maintenance during the warranty period of all equipment specified on Site including the provision of all labour, supervision, instruments, equipment, transport, on-site quality assurance and quality control, inspection and testing (including attendance at tests witnessed by the Employer's Agent or Representative), materials and Temporary Works necessary to completely install, test and commission and render fully operational surface aeration equipment.

The rate shall also include the cost of the installation of all auxiliary equipment not specifically mentioned but obviously required, (e.g. all ancillaries, including all bolts, fastenings and brackets, safety guards and any work or material required for the proper installation of such equipment) to enable the equipment to be installed and/or function safely and correctly as specified until taken over by the Employer; the putting into service of the complete installation; remedial work and any other work as specified and necessary.

The rate shall also include for all preliminary testing and the provision of testing equipment therefore including all disruptions to installation caused by such testing.

The rate shall also include for the attendance of a Belt Press OEM specialist for the full duration of the commissioning period.

Payment will only be effected after full compliance of the equipment items with this Section and associated documentation has been approved by the Employer's Agent or Representative.

For all refurbishment activities, the Contractor shall provide a detail inspection report of the accumulated findings from inspecting the equipment with proposed remedial actions and submit it to the Employer's Agent for review and acceptance before proceeding with the refurbishment. The Contractor shall invite the Employer and Employer's Agent to the workshop within 10 working days of complete stripping for a witnessed inspection.

Employer:		Contractor:	
Witness:		Witness:	

PSX.6.5 Trial Operations

<u>Item</u>	<u>Unit</u>
Trial Operations	sum
.....	months

The tenderer's rate include the number of calendar months specified for Trial Operation, resources required for trial operation, required safety equipment, day and night operation.. The Contractor shall programme and price for providing full technical and operational support during trial operation. The Contractor's Tendered rate shall include straining of the gearbox oil after 600 hours of initial operation/ the first initial gearbox oil filling as recommended by the original equipment manufacturer. The report shall also include reporting required during the trial operation period.

PSX.6.6 Employer's Operator Training

<u>Item</u>	<u>Unit</u>
Training	hrs
.....	sum

Payment for Training of the Employer's Operational Staff will be made under this Section as set out in project specification or agreed with the Employer's Agent / Employer' Representative. The lump sum shall be inclusive of all costs associated with the training programme and on-site training of personnel.

PSX.6.7 Spares Equipment

<u>Item</u>	<u>Unit</u>
Spares	No
.....	length
.....	sum

The cost of spares, considered to be necessary by the Contractor other than spares required by the Employer, delivered to Site and handed over will be paid as a lump sum. A Spare Part Schedule subject to approval by the Employer's Agent or representative shall be submitted before procurement of spares.

The actual lump sum to be paid shall be based on the unit rates priced in the Bill of Quantity for the actual spares ordered and supplied and the Employer is entitled to purchase all, some or none of the items listed. A provisional sum will be allocated in the Bill of Quantity for the complete list of spare parts as listed by the Contractor. The rate tendered shall provide for the manufacture, supply, delivery to Site and handing over of the spares ordered and shall include permanent packing for long term storage. The spares shall be manufactured at the same time as the installed items

Employer:		Contractor:	
Witness:		Witness:	

PORTION 4: PROJECT SPECIFICATION FOR ELECTRICAL WORKS

PSY 1. Introduction

This part contains the specific requirements for the project regarding work to be carried out at the Johannesburg Water's NWWTW for the electrical portion under Dewatering Building Belt Press Replacement and Associated Ancillaries Installation.

PSY 2. Scope of Work

The scope of work under this project will be executed on a live, operational site and the proposed tenders must therefore take cognisance of this fact when compiling construction programme.

Occupational Health and Safety Plans and shall accommodate appropriate working procedures. It is considered essential that the final effluent licenced quality shall take precedence over the Contractor's rate of progress when performing the work and the Contractor shall in the construction programme make adequate allowance, therefore.

The following electrical scope of work includes the detail design, manufacture, testing, supply, installation, commissioning and trial operation of all systems and equipment.

- Two (2) new motor control centres (MCC'S) for Belt Presses Set A and C.
- Replace existing star/delta starters for Washwater Pumps 1 and 2, supplied from MCC B, with electronic soft starters.
- Chassis / Bucket components for two (2) wash water transfer and two (2) sludge pumps.
- Low voltage switchboards and distribution boards
- Busbar connection between transformers and the new LV switchboard in Dewatering Substation
- Uninterruptible power supplies (UPS)
- Solar power installation
- Lighting and small power
- Field mounted control panels and isolators
- Earthing and lightning protection
- Programmable logic controllers (PLC)
- Sequential Control and Data Acquisition (SCADA)
- Instrumentation
- Access control
- Security cameras

Employer:		Contractor:	
Witness:		Witness:	

- Fire detection
- Cabling
- Cable racking

The project scope of works entails replacement and upgrade of existing installation which requires decommissioning, removal and disposal for redundant installation which include but not limited to the following:

- Decommissioning, removal and disposal of electrical installation for MCC servicing Set C Belt Presses and the MCC servicing Set B Belt Presses.
- Decommission, removal and disposal of supply cable and cable track associated with Set C and Set B Belt Presses; and
- Decommissioning, removal and disposal of all electrical installation associated with decommissioned mechanical installation such as manual hopper, dosing pumps associated with Set presses, transfer pumps and valve sludge banks.

PSY 3. Overview of the Works

The Dewatering Building Belt Press Replacement and Associated Ancillaries installation is supplied with low voltage power from the Dewatering Substation, which forms part of a 6.6kV ring feed from Unit 3 Main Substation.

The Dewatering Substation is old. Equipment will be replaced with new equipment and the power supply capability of the substation will be upgraded to a 2 x 630kVA transformers. This work will be performed as part of another project, the Infrastructure Renewal Plan (IRP) phase 1 project, which must be completed before this commencement of this project. The medium voltage installation at Northern WWTW will be upgraded to a 11kV power reticulation installation.

The battery limit for the IRP project will be the secondary terminals of the transformers. This project shall include the new external busbars¹ connection between the 2 x 630kVA transformers and the new LV switchboard, which shall be provided as part of the project scope of work. The new LV switchboard shall replace the old switchboard at the Dewatering Substation.

The new Dewatering Substation LV switchboard shall provide power to the following loads:

- New MCC A for Dewatering Building
- New MCC C for Dewatering Building
- Existing MCC B in Dewatering Building
- Existing DAF Pump MCC in DAF Pump Station

Employer:		Contractor:	
Witness:		Witness:	

The existing MCC "C", which supply power to the decommissioned Set C Belt Presses, shall be removed and replaced. A new MCC "C" shall be installed, with the associated PLC for new Belt Press installations, in a new MCC room.

The existing MCC "A", which supply power to Set A Belt Presses, shall be removed and replaced. A new MCC "A" shall be installed, with the associated PLC for new Belt Press installations, in a new MCC room.

The existing MCC "B", which supply power to Set B Belt Presses shall remain.

A solar power installation shall be installed on the roof of the Dewatering building to enhance power supply during the day and to provide back-up power to the Lighting DB.

PSY 4. Particular Generic Specifications

The following Johannesburg Water (SOC) LTD Particular Generic Specifications shall be read in conjunction with this Project Specification. This Project Specification shall take preference over the Johannesburg Water (SOC) LTD Particular Generic Specifications.

This Project Specification shall also be read in conjunction with the Technical Schedules and Data Sheets of the Contract. Any deviation from the agreed Technical Data Sheets shall be approved by the Employer's Agent. Any application for a concession or replacement shall be accompanied by a revised Data Sheet.

Table 4 -1 Johannesburg Water Particular Specifications:

Electrical Works	
Reference	Description
E01	Electrical Motor
E02	Electrical Cable Racking
E03	Electrical isolator pushbutton station equipment
E04	Electrical Low Voltage Switchboards and Motor Control Centres
E05	Electrical Low Voltage Power & Control Cables
E06	Electrical Medium and Low Voltage Cable Installation
E07	Electrical industrial welding plugs, couplers and socket outlets
E08	Electrical Wiring
E09	Electrical Building Installation
E10	Electrical Busbar Trunking
E11	General Electrical Earthing and Lightning Protection
E16	Uninterruptible Power Supplies (UPS)
E21	Electrical Lighting and Illumination
E26	Electrical colour coding of equipment

NB: The above listed specifications are bound in Volume 2B.

Employer:		Contractor:	
Witness:		Witness:	

PSY 5. Low Voltage Switchboards and Motor Control Centres (MCC)

LV Switchboards shall comply with Johannesburg Water (SOC) LTD Particular Specification E04 and project data sheets where applicable.

Switchboard shall be rated at 400V and fault rating shall be as indicated on the drawings and in data sheets.

Single line diagrams and typical Johannesburg Water (SOC) LTD motor control schematic drawings are issued with this tender. The contractor shall provide detail design and drawings of switchboards and MCCs and shall submit drawings for approval before any construction commence.

External busbars shall comply with Johannesburg Water (SOC) LTD Particular Specification E10. Drawings shall be submitted to the Employer's Agent for approval.

PSY 6. Uninterruptible Power Supplies (UPS)

UPS shall comply with Johannesburg Water (SOC) LTD Electrical Particular Specification E16 and Control Specification Volume 5 and project data sheets where applicable.

The UPS installations shall power suitable instrumentation DBs.

UPS status and alarms shall be connected to the local PLC and will be displayed on the SCADA.

PSY 7. Lighting and Small Power

Lighting and small power installations shall comply with Johannesburg Water (SOC) LTD Particular Specification E09 and layout drawings.

Lighting designs were done, based on the LED type luminaires as shown on the drawings. Alternatives may be offered but must be of the same quality and specification. The contractor shall submit revised lighting designs if alternatives are offered.

Flush mounted distribution boards and power outlets and concealed conduit shall be used for substation installations.

PSY 8. Earthing and Lightning Protection

Earthing and lightning protection installations shall comply with Johannesburg Water (SOC) LTD Particular Specification E11.

A specialist sub-contractor shall be used for design and installation of earthing and lightning protection. Designs, according to SABS standards, and drawings shall be submitted to the Employer's Agent for approval.

PSY 9. Electrical Motors

Electrical motors shall comply with Johannesburg Water (SOC) LTD Particular Specification E01.

Employer:		Contractor:	
Witness:		Witness:	

Electrical motors shall be coupled to the gearboxes in accordance with Johannesburg Water (SOC) LTD Particular Specification M08.

The motors shall have an IP rating of at least IP 66 to prevent dust and water ingress. There is use of high-pressure wash water in the area of installation.

The motors shall be so installed that the terminal boxes are facing downwards to prevent ingress of water.

Motors connected to variable speed drives shall be as specified in Johannesburg Water (SOC) LTD Particular Specification E01. Detail data sheets of these motors shall be provided with the tender document.

PSY 10. Variable Speed Drives (VSD)

VSDs shall comply with Johannesburg Water (SOC) LTD Particular Specification E17.

VSDs shall be mounted inside starter cubicles in the MCC. Sufficient ventilation and dust control shall be provided, and keypad control shall be installed on the doors of cubicles for easy access, without opening the cubicle door.

VSDs shall be rated for a harsh corrosive environment and protective coatings shall be provided to electronic circuits.

PSY 11. Electronic Soft Starters

Electronic soft starters shall be provided for the wash water Distribution Pumps installed at the Dewatering Building and shall be built into the MCC.

Sufficient ventilation and dust control shall be provided, and keypad control shall be installed on the doors of cubicles for easy access, without opening the cubicle door.

Soft Starters shall be rated for a harsh corrosive environment and protective coatings shall be provided to electronic circuits.

Soft starters shall be equipped with built-in bypass contactors and shall comply with Johannesburg Water (SOC) LTD VSD Particular Specification E17 where applicable.

PSY 12. Cable Rack Installations

Cable Rack installations shall comply with Johannesburg Water (SOC) LTD Particular Specification E02.

Cable rack shall be manufactured from corrosion resistant, powder coated, 3CR12 grade stainless steel.

Cables shall be installed on cable racks in accordance with Johannesburg Water (SOC) LTD Particular Specification E06.

Major cable rack routes are shown on drawings. This is for tender purposes only. The contractor shall submit detail cable rack layout drawing for approval before construction starts. This shall also include all minor cable rack routes. This shall be coordinated with other services.

Employer:		Contractor:	
Witness:		Witness:	

PSY 13. Solar Power Installation

A solar power installation shall be installed on the roof of the Dewatering Building to enhance power supply during the day and to provide back-up power to the lighting installation.

The solar installation shall generate 40kW peak power during the day and will provide 10kW back-up power for 6 hours.

Lithium Ion Batteries shall be installed in a battery room in suitable battery cabinets. The battery room shall be provided with access control and a CCTV camera security system.

The modular bidirectional inverter shall provide power to a distribution board inside the MCC room.

The PV panels shall be mounted on the steel sheet roof using mounting rails, which are suitable for the application. Spacing shall be allowed between panels for cleaning and maintenance access. The available roof space is 60m²

Earthing and lightning protection shall be included in this solar power installation.

PSY 20. MEASUREMENT AND PAYMENT

PSY 20.1 Supply and Delivery to Site

Unit: Lump Sum (Sum)

The rates tendered shall include full compensation for the design, supply and delivery including supply of raw materials and bought-out items, fabrication/manufacture/assembly, quality inspection/tests witnessed by the Employer's Agent or Representative, type and routine tests, application of finishes (paint or corrosion protection), trial erection and dismantling, preparation and packing for transport, transport from place of manufacture to the Site, insurance, harbour dues etc., during transport, loading and unloading, storage under appropriate conditions from date of delivery until commencement of erection and any other work as specified.

PSY 20.2 Installation

Unit: Lump Sum (Sum)

The rates tendered shall include full compensation for the installation including the provision of all labour, equipment, transport, materials and temporary works necessary to install the complete works, on-site quality assurance and quality control, inspection and testing (including attendance at tests witnessed by the Employer's Agent or Representative, the installation, supply of all consumables (electricity, fuel, oil and lubricants etc.) necessary for the operation of the installation until taken over by the Employer's Agent or Representative, the putting into service of the complete installation and any other work as specified.

Employer:		Contractor:	
Witness:		Witness:	

PSY 20.3 Design, Drawings and Other Documentation

Unit: Lump Sum (Sum)

Payment for Design, Drawings, Operation and Maintenance manuals and other documentation will be made under the relevant Chapters for the different portions of the work. Pro-rata payment will only be affected after the design and drawings have been approved by the Employer's Agent.

PSY 20.4 Supply and Installation of Cables and Wires

Unit: length (m)

Cable and wire lengths are approximate lengths. Installed cable and wire lengths will be measured on Site.

Installation rates shall include for all clamping, strapping and cable tag marking. Trenching is priced separately.

PSY 20.5 Supply and Installation of Cable Terminations

Unit: number (No)

The rates for cable terminations shall include for cable glands/termination kits, shrouds, crimped lugs, connection to terminals, core ferrule numbers and cable tag number inside the compartment or motor connection box.

PSY 20.6 Supply and Installation of Cable Ladders

Unit: Lump Sum (Sum)

The Supply and Installation rate shall include for covered heavy duty cable ladders, complete with covers, bends, elbows, tee-pieces, Unistrut mountings, fixings and splices.

PSY 20.7 Supply and Installation of Conduit and Support steel

Unit: length (m)

The Supply and Installation rate shall include for all fixing material and shall be as measured on site.

PSY 20.8 Supply and Installation of Lighting and Small Power in Buildings

Unit: number (No)

Unit: length (m)

Unit: lump sum (Sum)

Employer:		Contractor:	
Witness:		Witness:	

The installation shall be complete with distribution board, conduit, wiring, luminaires, light switches, power outlets as shown on drawings, in BOQ and specified and shall include all fixing material, terminations and covers.

The Supply and Installation rate of luminaires shall include for all lamps, control gear and support brackets.

PSY 20.9 Supply and Installation of MV and LV Switchboards and MCC

Unit: number (No)

The rates shall include full compensation for the design, supply, delivery, installation, protection relay settings and commissioning of switchboards and MCC. The price shall include all relays and control plant as shown on Drawings and as specified and all factory and site testing.

PSY 20.10 Cable Trenches

Unit: length (m)

The rates shall include full compensation for excavation, top and bottom layer of soft sifted soil, cable marker tape and backfill as specified.

PSY 20.11 Substation Safety

Unit: lump sum (Sum)

The rates shall include full compensation for all safety equipment and warning signs as per OHS ACT, including fire extinguishers, notice boards and padlocks.

PSY 20.12 Supply and Install Earthing and Lightning Protection

Unit: number (No)

Unit: length (m)

Unit: lump sum (Sum)

The rates shall include full compensation for the design, supply, delivery, installation and commissioning of an earthing and lightning protection system complete with all conductors, earth rods, isolators, bolts, nuts, welding, copper, trenching and other usable materials to complete the installation, true earth conductivity and earth mat resistance tests.

PSY 20.13 Supply and Installation of UPS

Unit: number (No)

The rates shall include full compensation for the design, supply, delivery, installation and commissioning of UPS units. The price shall include all relays,

Employer:		Contractor:	
Witness:		Witness:	

control plant and batteries as shown on Drawings and as specified and all factory and site testing.

PSY 20.14 Supply and Installation of E/Stop, Isolators and Local Control Panels

Unit: number (No)

The Supply and Installation rate shall include for E/Stop, Isolators and Local Control Panels mounted on pedestals and all associated fixing material.

PSY 20.15 Removal of redundant equipment and cabling

Unit: Lump Sum (Sum)

The rates shall include full compensation for the removal of redundant equipment, transport to client warehouse, loading and unloading using contractor's equipment.

PSY 20.16 Solar installation

Unit: Lump Sum (Sum)

The rates shall include full compensation for the design, supply, delivery, installation and commissioning of a complete solar power installation. The price shall include all solar panels including frames, inverter installations, cubicles, batteries, distribution boards as specified and all factory and site testing.

Employer:		Contractor:	
Witness:		Witness:	

PORTION 5: PROJECT SPECIFICATION FOR CONTROL AND INSTRUMENTATION WORK

PSYC 1. Scope of Work

The scope of supply of the control part of this contract shall be the design, manufacturing, supply, delivery, safe storage on site before installation, installation and commissioning of the control and instrumentation installation listed in this tender document and on the relevant drawings.

This shall include the following:

- The PLC and SCADA installation as specified.
- Dewatering Building Belt Press local control panels
- Network communication equipment.
- CCTV cameras and an access control system
- Fire detection and fire suppression installation
- Instrumentation

PSYC 2. Particular Generic Specification

The following Johannesburg Water (SOC) LTD Particular Generic Specifications shall be read in conjunction with this Project Specification. This Project Specification shall take preference over the Johannesburg Water (SOC) LTD Particular Generic Specifications.

This Project Specification shall also be read in conjunction with the Technical Schedules and Data Sheets of the Contract. Any deviation from the agreed Technical Data Sheets shall be approved by the Employer's Agent. Any application for a concession or replacement shall be accompanied by a revised Data Sheet.

Automation and Control	
Reference	Description
Volume 3	PLC Panels
Volume 5	Clean Power and Surge Protection
Volume 6	Cabling
Volume 7	Networking
Volume 8	Flow Measurement
Volume 9	Level Measurement
Volume 14	Turbidity & Suspended Solids Measurement
Volume 19	Field Junction Boxes and Panels
Volume 25	Labelling

NB: The above listed specifications are bound in Volume 2.

Employer:		Contractor:	
Witness:		Witness:	

PSYC 3. General

The Scada network shall consist of new PLCs for each set of Belt Press installation, local control stations and Adroit SCADA software in Control Room for the Belt Press installations.

Programmable Logic Controllers (PLC) and Supervisory Control and Data Acquisition (SCADA) interface shall be in accordance with NWWTW General Principal document, which will be issued to the successful contractor.

The Belt Press control installation is divided into the 3 MCC control areas as follows:

- New Set C Belt Presses control installations for MCC “C” ,
- New Set A Belt Presses control installations for MCC “A”,
- Existing Set B Belt Presses control installations for existing MCC “B”,

The new installations shall be similar to the PLC installation for the existing Set B Belt Presses (MCC “B”).

The existing PLC installation for Set B Belt Presses consists of an individual PLC for each Belt Press and a master (ancillary) PLC for common services to these Belt Press installations. PLCs are Modicon type Premium TSX series. Individual Belt Press PLCs are connected via an ethernet network to the master PLC.

PSYC 4. Belt Press Control

Belt Press motor starters shall be mounted in the applicable MCC for that press, with I/O hardwired to the PLC for that press.

A dedicated Belt Press control panel shall be installed for each Belt Press. Each control panel shall be linked to a dedicated PLC, installed inside the MCC room.

The control panel shall only be used for maintenance purposes and not to control the belt, all controls shall be done via the SCADA. All adjustments of set points etc shall be done on the SCADA screen.

All limit switches supplied and installed with the Belt Press shall be wired to a junction box on the Belt Press and connected to the PLC for that Belt Press.

Level meters, flow meters, control valves and isolation valves, associated with a Belt Press shall be hardwired to the PLC for that Belt Press.

The Belt Press shall have an electro-magnetic flow meter (mag flow) for measurement of instantaneous and totalised sludge, Poly and dilution water flows to the Belt Press.

These flow meters shall comply with the Automation and Control Design Standards Volume 8: Flow measurement.

The flow data (instantaneous flow and totalising pluses) from the flow meters shall be made available to the SCADA or the master PLC for ratio calculation and reporting purposes.

Refer to typical I/O schedule in this document.

Employer:		Contractor:	
Witness:		Witness:	

PSYC 5. Belt Press Control Panel

Each filter Belt Press shall be supplied complete with an integral control panel, mounted on the top walkway of a belt. The control panel shall provide electrical interlocks and indications as follows:

- Belt track condition
- Belt misalignment protection system to prevent belts from being damaged.
- Broken belt detection
- Low flow or low pressure of wash water
- Low or no flocculent supply
- Low or no sludge flow
- Manual stop/start
- Forward and reverse control facility on the belt drive to assist mechanical maintenance to replace belts. (This facility shall be available on the control panel)
- All of the necessary fault conditions within the belt filter press that will cause damage, system failure or injury.
- An hour running meter.

The control panel shall have easy access in the front and back and have adequate lighting for maintenance purposes.

All equipment supplied on the panel shall have a very high protection rating of IP66 for protection against ingress of water.

The indication lamps shall be the multi cluster LED type for longer life.

All protection systems and devices shall be clearly displayed on the SCADA in order to alert the relevant maintenance or process staff to the problems with a belt.

A comprehensive list of alarms shall be displayed on the SCADA to alert process or maintenance personnel when a belt goes into a shutdown condition.

PSYC 6. Programmable Logic Controller (PLC)

The UPS and surge protection shall comply with specification "Automation and Control Standards, Volume 5, Clean Power and Surge Protection".

The panels shall comply with all the requirements of Automation and Control Standards, Volume 3, PLC Panels.

The PLC shall be supplied, installed and programmed in accordance with the JHB Water Standards for PLC hardware, PLC software and PLC panels.

The PLC shall be interfaced with the master PLC in the MCC room, which in turn shall be interfaced with the existing plant SCADA in the Belt Press Control Room.

Employer:		Contractor:	
Witness:		Witness:	

PLC/SCADA interfacing shall be done via the existing network or by extending the existing network if required.

The PLC shall be able to interface directly with the rest of the PLC Network using Ethernet protocol and not use converters installed on the network.

The PLC's shall be complete with a bottom-entry enclosure, 24V DC power supply, circuit breakers, surge protection, UPS, etc. and wired it to the relevant I/O.

The Contractor shall ensure that there is sufficient space for all terminals, fused terminals, circuit breakers, surge protection, etc.

There shall also be sufficient space to ensure that all spare slots in the PLC racks can be equipped and wired in future if required. The PLC panels shall be equipped with a true online UPS.

The applicable PLC circuits shall also be equipped with proper surge protection.

PLC shall be Schneider Modicon Premium type with I/O modules as required. Allowance shall be made for at least 30% spare I/O and terminal space.²

PSYC 7. Instrumentation Cabling

All cabling shall be supplied and installed in accordance with "Automation and Control Standards, Volume 6, Cabling".

Fibre-optic cables between MCC buildings shall be buried in 110mm sleeves.

All fibre-optic cables shall be single mode fibre (SM) for use with 1000BASE-LX gigabit Ethernet for distances up to 10km.

A length of free cable shall be provided at each end of a cable pull. Loops of cable (commonly called service loops) shall be provided at all intermediate pulling points, such as in manholes and pull boxes where manholes and pull boxes are required to be installed by the Employer's Agent.

Service loops of 3 m length that are easily accessible and clearly marked with the prescribed cable number shall be provided at all fibre cable patch panels. The cables' minimum bending radii shall not be exceeded.

Intermediate patch and splice panels shall not be allowed unless approved by the Employer's Agent. Cables that are found to be damaged either due to defective manufacturing, delivery or installation practice shall be replaced in their entirety at the cost of the Contractor.

All fibre-optic cables shall contain at least 12-cores. All cable installations shall be re-measured for payment after installation.

² The Employer's intention with the PLC Infrastructure is to maintain uniformity throughout the plant. This is mainly because of the available skills and competency of the staff. Therefore, this means that the scope relating to replacement or refurbishment and supply of new items, the Contractor shall offer a modernised system. The Tenderer is to procure services relating to migration from the current system model as specified to the latest available model from the same manufacturer.

Employer:		Contractor:	
Witness:		Witness:	

All fibre-optic cable shall be terminated on patch panels at each end. Eight cores (4 pairs) shall be terminated on a patch panel. The remaining fibres shall be neatly coiled in the patch panel as spares.

PSYC 8. Data Communication and Networking

Data Communication and Networking shall be in accordance with "Automation and Control Standards, Volume 7, Networking".

Fibre-Optic Area Switches shall be provided in each PLC cubicle.

The area switch shall consist of a switch, 2 x 1000BASE-LX SFP modules, 2 x 3m single mode fibre patch leads, at least 2 x 10BASE-T/100BASE-TX RJ45 copper ports, 1 x 3m certified Cat-6 patch lead and a power supply.

The Contractor is primarily responsible for all fiber-optic and data communication testing and commissioning work. All testing and commissioning work shall be documented in detail in the prescribed formats and the results shall be verified and approved by the Employer's Agent.

The fibre-optic cables shall be tested and commissioned after installation. The commissioning of the data network can commence after the fibre-optic cables are commissioned.

PSYC 9. Instrumentation

Instrumentation equipment shall comply with Johannesburg Water (SOC) LTD Particular Specifications and instrument data sheet, as applicable.

Completed instrument data sheets shall be submitted at tender stage. Any changes or deviations from the tender data sheets shall be approved by the Employer's Agent.

Hardwired instrument I/O connections shall be as indicated in the typical I/O schedules. Network connections to instrumentation may be offered as an alternative at tender stage. This alternative offer shall include detail of the total cost for cabling, PLC cards and programming.

PSYC 10 Security Installation

PSYC 10.1 General

Access control and Closed-Circuit Television (CCTV) installations shall be provided to all 3 MCC rooms, to the solar battery room and local control room.

Access control shall consist of keypad readers and an access logging installation in the Northern WWTW control room.

CCTV cameras shall be provided at all entrance doors and inside rooms.

This new security installation shall be connected to the existing system at Northern Wastewater Treatment Works. The complete security system shall communicate via a wireless IP network back to the WWTW main control room.

Employer:		Contractor:	
Witness:		Witness:	

All security installations shall be connected to instrumentation distribution boards, which are powered from UPS.

PSYC 10.2 Access Control

An access control system shall be provided at MCC and battery room doors and shall consist of door electromagnets and access keypads. The complete access control system shall be supplied with power from a local UPS.

The security system shall include a controller that shall be able to function on its own.

There shall be a keypad access reader on the outside and exit pushbutton on the inside next to the door. Access shall be granted by means of a unique code to each person and shall be logged, with a date stamp, on the registration software.

PSYC 10.3 CCTV

CCTV installations shall be provided as follows:

- 1 fixed camera inside MCC "C" , MCC "A" , MCC "B" and control room, which will aim at door but also cover most of the room by means of a wide-angle lens.
- 1 fixed camera outside MCC "C" , MCC "A" , MCC "B" and control room, which will aim at door and access control keypad.

The contractor design shall make provision for all WI-FI equipment as required.

CCTV installations shall comply with the following:

- Lightning/surge protection shall be provided to the all antennas, cameras and power supplies. This surge protection shall be on both field and control side.
- All cameras shall be IP-based.
- Colour cameras shall be installed at all locations. Colour images shall be provided above 0.5 lux, the cameras shall have IR, and shall be able to switch to grey below this level.
- Cameras shall have automatic sensitivity (AGC) capable of compensating for varying light conditions in the range 2 to 30000 lux
- Lens shall be vari-focal, auto iris with minimum distance of 500mm.
- Colour cameras shall incorporate technology which provides the capability of correcting colour differences due to variations in light sources.
- The lens shall have anti-condensation and lens cleaning facilities.
- Cameras shall be fitted with suitable industrialised housings and hoods, being a minimum of IP65 rated enclosures.
- Ethernet Switches shall be provided to enable connection of signal concentrators /servers / workstations to the CCTV backbone.
- All cameras to include a bracket for pole or wall mounting as determined by the various locations.

Employer:		Contractor:	
Witness:		Witness:	

The existing overall video network consists of a wireless backbone, using a TCP/IP WI-FI local area network with its own ethernet switches.

The distances between the cameras and the signal concentrators will vary from 50m to 1000m. The Contractor shall supply the equipment necessary to interface all the components of the system. A block diagram showing the main components of the system shall be supplied.

The Contractor shall list all cables required for the system. Any special cables shall be supplied by the Contractor.

All outdoor ethernet cables (CAT6) shall be of the reinforced type with proper shielding to minimise ESD and surge voltages. The industrial type shall be used.

An equipment data sheet shall be submitted by the contractor for each item and returned with the tender documents. Where alternative selections are proposed, the Contractor shall submit a data sheet for each item.

PSYC 11. FIRE DETECTION

PSYC 11.1 General

The scope of this Section includes the design, manufacture, testing at works, supply, installation and commissioning of a fire detection system in accordance with the requirements of this Section.

Fire detection shall be provided in all 3 MCC rooms, to the solar battery room and local control room.

Alarm and status indication shall be displayed remotely in the WWTW main control room.

PSYC 11.2 Standards

Fire detection and suppression shall comply with the following standards and code of practice.

SANS 10139 Code of Practice "Fire detection and alarm systems for buildings - System design, installation and servicing"

SANS 50054 "Fire Detection and Fire Alarm Systems"

Note: Compliance with the latest amendments of the above codes, standards and specifications shall be minimum requirement. In the event of different requirements between the codes and/or standards, the most stringent code shall apply.

PSYC 11.3 Scope

The system shall include all detectors and master control/alarm stations, as required.

The system shall be designed to detect the presence of fire, smoke or ionised gas in any of the specified locations and to initiate alarms.

Employer:		Contractor:	
Witness:		Witness:	

The sensing system in each area shall have a minimum of two (2) detecting circuits with a minimum of two detectors in each circuit. There shall be an equal number of optical and ionisation detectors in each area. Large areas shall be divided into zones with a maximum of 20 detectors per zone.

The detectors shall be of the plug in type on fixed bases. This feature is required to facilitate interchanging between optical and ionisation type detectors.

The detectors shall be capable of repeated detection operations and shall have integral LED indication providing status and condition of the unit.

The operation of any one detector in an area shall initiate the alarm circuit and the operation of any two detectors in an area shall initiate the control circuits, i.e. the tripping of switchgear, ventilation fans and the release of gas.

The detectors shall be connected in a closed loop circuit and shall be continuously monitored by a monitoring current.

PSYC 11.4 Control Panels

The control panels for each area shall be suitable for outdoor wall mounting adjacent to the respective room's access door. The control panel shall be manufactured from 2mm thick mild steel, to IP55 enclosure classification.

The control panel shall incorporate all relays, batteries, power supplies, circuits, etc. for the proper operation of the system.

Each area shall have a separate control panel. Only where common entrances to various rooms are provided may control panels be combined to include one or more areas. Transformer bays may be combined with LV room or MCC room areas. Where areas are combined suitable allowance shall be made for alarm and control circuits.

The control panel shall be suitable for 220V AC operation and shall be equipped with a battery back-up to enable system operation for 4 hours after a primary power failure.

Perspex or Macrolon inserts shall be provided in the door of the control panel to facilitate the monitoring of the respective functions without having to open the door.

The following shall be accessible on the panel without opening the main door:

- A graphic panel showing the area and its components.
- External "Silence" and "Reset" buttons.
- Zone isolation facility.
- Lamp/LED test facility.
- Continuous monitoring of the detectors in the close loop circuits to indicate and display faults.

Employer:		Contractor:	
Witness:		Witness:	

PSYC 11.5 Alarm Functions

The control panel shall be equipped with relays to provide potential free, change over contacts rated 10 A/220V for alarm functions and to interface with other plant. Two potential-free normally open and two potential-free normally closed contacts shall be provided.

The following alarms shall be displayed on the panel:

- Two fire indicator lights per area i.e. one per circuit.
- Two fault indicator lights per area i.e. one per circuit.
- Power On" indication
- Power Failure" indication
- System On" indication

A central alarm annunciator shall be installed for a substation. The system shall provide an audible alarm on the outside of the buildings for each area. The alarm shall sound in the event of the following occurrences:

- One detector operated
- Two detectors operated (pre-gas release warning)
- Power supply failure
- Area fault (detector or cabling fault)

PSYC 11.6 Electrical Drawings

Electrical Drawings shall be provided for the following:

- Cable interconnection diagram for all cabling from the fire panel to all fire detection system field devices, with cable numbers; and
- Cable termination details for all field devices.

Electrical Drawings for the fire panel shall be provided as follows:

- Functional logic charts or diagrams;
- Schematic wiring diagrams;
- Termination diagrams;
- General arrangement Drawings;
- Construction detail Drawings and plant list; and
- Label details.

PSYC 11.7 Testing and Tests on Completion

All factory testing certificates, including routine and type testing, shall be submitted to the Employer's Agent before delivering to Site.

Tests on Completion and site testing shall be performed by the Contractor. A testing plan shall be submitted for approval before the start of testing.

Employer:		Contractor:	
Witness:		Witness:	

PSYC 12 TYPICAL I/O SCHEDULE

The following is a typical I/O schedule, to be used for tender purposes only, of a Belt Press and Master PLC. The contractor shall submit a I/O schedule for his complete installation, for approval, before construction starts.

TYPICAL BELT PRESS – I/O SCHEDULE

PLC tag	EQUIPMENT	EQUIP tag	I/O DESCRIPTION	I/O tag	DI	DO	AI	AO
	Poly dosing pump 1A		Field isolated		1			
			Running		1			
			VSD healthy		1			
			Not locked out		1			
			PLC selected		1			
			Start			1		
			Speed feedback				1	
			Speed reference					1
	Poly dosing pump 1B		Field isolated		1			
			Running		1			
			VSD healthy		1			
			Not locked out		1			
			PLC selected		1			
			Start			1		
			Speed feedback				1	
			Speed reference					1
	Top belt motor		E-Stop		1			
			Running		1			
			Not tripped		1			
			Not locked out		1			
			PLC selected		1			
			VSD healthy		1			
			Start			1		
			Speed feedback				1	
			Speed reference					1
	Bottom belt motor		E-Stop		1			
			Running		1			
			Not tripped		1			
			Not locked out		1			
			PLC selected		1			
			VSD healthy		1			
			Start			1		
			Speed feedback				1	
			Speed reference					1

Employer:		Contractor:	
Witness:		Witness:	

PLC tag	EQUIPMENT	EQUIP tag	I/O DESCRIPTION	I/O tag	DI	DO	AI	AO
	Flocculator mixer		Running		1			
			Not locked out		1			
			PLC selected		1			
			VSD healthy		1			
			Start			1		
			Speed feedback				1	
			Speed reference					1
	Top belt tracking motor		Running - For		1			
			Running - Rev		1			
			Not tripped		1			
			Not locked out		1			
			PLC selected		1			
			Start			1		
	Bottom belt tracking motor		Running - For		1			
			Running - Rev		1			
			Not tripped		1			
			Not locked out		1			
			PLC selected		1			
			Start			1		
	Floc tank drain valve 1		Opened		1			
			Closed		1			
	Inline drain valve 8		Opened		1			
			Closed		1			
	Poly dosing pump 1 discharge hand valve 2		Opened		1			
			Closed		1			
	Poly dosing pump 1 infeed hand valve 4		Opened		1			
			Closed		1			
	Poly dosing pump 1 wash water hand valve 5		Opened		1			
			Closed		1			
	Poly dosing pump 2 discharge hand valve 3		Opened		1			
			Closed		1			
	Poly dosing pump 2 infeed hand valve 6		Opened		1			

Employer:		Contractor:	
Witness:		Witness:	

PLC tag	EQUIPMENT	EQUIP tag	I/O DESCRIPTION	I/O tag	DI	DO	AI	AO
			Closed		1			
	Poly dosing pump 2 wash water hand valve 7		Opened		1			
			Closed		1			
	Wash water control valve		PLC selected		1			
			Remote		1			
			Opened		1			
			Closed		1			
			Open			1		
			Close			1		
	Sludge flow control valve		PLC selected		1			
			Remote		1			
			Opened		1			
			Closed		1			
			Position feedback				1	
			Position control					1
	Dilution water flow control valve		PLC selected		1			
			Remote		1			
			Opened		1			
			Closed		1			
			Position feedback				1	
			Position control					1
	Sludge Magflow meter		Totalizer pulse		1			
			Sludge flow				1	
	Dilution water Magflow meter		Totalizer pulse		1			
			Sludge flow				1	
	Poly Electrolyte Magflow meter		Totalizer pulse		1			
			Sludge flow				1	
	Top end of stroke inner limit switch		On		1			
	Top end of stroke outer limit switch		On		1			
	Bottom end of stroke inner limit switch		On		1			
	Bottom end of stroke outer limit switch		On		1			

Employer:		Contractor:	
Witness:		Witness:	

PLC tag	EQUIPMENT	EQUIP tag	I/O DESCRIPTION	I/O tag	DI	DO	AI	AO
	Gravity deck level		Low level		1			
	Press control panel		Start		1			
			Stop		1			
			Remote		1			
	PCP Sludge Flow		Flow increase		1			
			Flow decrease		1			
			PCP Sludge Flow					1
	PCP Sludge / Poly ratio		Ratio increase		1			
			Ratio decrease		1			
			PCP Sludge / Poly ratio					1
	PCP Poly / Dilution water ratio		Ratio increase		1			
			Ratio decrease		1			
			PCP Poly / Dilution water ratio					1
	PCP mixer speed		Speed increase		1			
			Speed decrease		1			
			PCP mixer speed					1
	PCP press drive speed		Speed increase		1			
			Speed decrease		1			
			PCP press drive speed					1
	Fault reset		On		1			
	Fault indication		On			1		
	Pre-wash		On		1			
	Wash water supply pressure switch		On		1			
	Bottom belt left hand side outer limit switch		On		1			
	Bottom belt left hand side inner limit switch		On		1			
	Bottom belt right hand side outer limit switch		On		1			
	Bottom belt right hand side inner limit switch		On		1			
	Top belt broken proximity switch		On		1			
	Bottom belt broken proximity switch		On		1			
	Top belt left hand side outer limit switch		On		1			

Employer:		Contractor:	
Witness:		Witness:	

PLC tag	EQUIPMENT	EQUIP tag	I/O DESCRIPTION	I/O tag	DI	DO	AI	AO
	Top belt left hand side inner limit switch		On		1			
	Top belt right hand side outer limit switch		On		1			
	Top belt right hand side inner limit switch		On		1			

TYPICAL MASTER PLC I/O

PLC tag	EQUIPMENT	EQUIP tag	I/O DESCRIPTION	I/O tag	DI	DO	AI	AO
	Poly make-up tank mixer		Running		1			
			Trip healthy		1			
			PLC selected		1			
			Lock out healthy		1			
			Isolator healthy		1			
			Start			1		
	Conveyor 1		Running		1			
			Trip healthy		1			
			PLC selected		1			
			Lock out healthy		1			
			Isolator healthy		1			
			Pull rope healthy		1			
			Alignment healthy		1			
			Belt break healthy		1			
			Start			1		
	Conveyor 2		Running		1			
			Trip healthy		1			
			PLC selected		1			
			Lock out healthy		1			
			Isolator healthy		1			
			Pull rope healthy		1			
			Alignment healthy		1			
			Belt break healthy		1			
			Start			1		
	Poly transfer pump 1		Running		1			
			Trip healthy		1			
			PLC selected		1			
			Lock out healthy		1			
			Isolator healthy		1			

Employer:		Contractor:	
Witness:		Witness:	

PLC tag	EQUIPMENT	EQUIP tag	I/O DESCRIPTION	I/O tag	DI	DO	AI	AO
			Start			1		
	Poly transfer pump 2		Running		1			
			Trip healthy		1			
			PLC selected		1			
			Lock out healthy		1			
			Isolator healthy		1			
			Start			1		
	Poly silo		Poly powder hopper low level		1			
			Poly powder hopper high level		1			
			Poly powder hopper low level		1			
			Fast fill solenoid manual switch		1			
			Poly outlet valve		1			
			Poly silo high level		1			
			Poly reverse jet filter		1			
			Silo poly inlet valve open		1			
			Silo poly inlet valve close		1			
			Poly filter fan running		1			
			Poly filter fan tripped		1			
			Reverse jet filter low pressure		1			
			Poly re-order level		1			
			Poly silo low level		1			
			Poly silo high pressure		1			
			Poly explosion panel relay healthy		1			
			Poly aeration blower running		1			
			Poly aeration blower not tripped		1			
			Poly de-humifier running		1			
			Poly de-humifier not tripped		1			
	Poly silo screw feeder		Running		1			
			Trip healthy		1			

Employer:		Contractor:	
Witness:		Witness:	

PLC tag	EQUIPMENT	EQUIP tag	I/O DESCRIPTION	I/O tag	DI	DO	AI	AO
			PLC selected		1			
			Lock out healthy		1			
			Isolator healthy		1			
			Start			1		
	Poly blower		Running		1			
			Trip healthy		1			
			PLC selected		1			
			Lock out healthy		1			
			Isolator healthy		1			
			Start			1		
	Sludge sump return flow control valve		PLC selected		1			
			Remote		1			
			Opened		1			
			Closed		1			
			Position feedback				1	
			Position control					1
	Sludge Magflow meter		Totalizer pulse		1			
			Sludge flow				1	
	Return Sludge to sump Magflow meter		Totalizer pulse		1			
			Sludge flow				1	
	Poly holding tank 1 inlet valve		Opened		1			
			Closed		1			
			PLC selected		1			
			Open			1		
			Close			1		
	Poly holding tank 2 inlet valve		Opened		1			
			Closed		1			
			PLC selected		1			
			Open			1		
			Close			1		
	Poly make-up tank jet wet solenoid		Open			1		
	Poly make-up tank fast fill solenoid 1		Open			1		
	Poly make-up tank fast fill solenoid 2		Open			1		
	Poly silo load cell		Mass				1	

Employer:		Contractor:	
Witness:		Witness:	

PLC tag	EQUIPMENT	EQUIP tag	I/O DESCRIPTION	I/O tag	DI	DO	AI	AO
	Return Sludge flow to sump pressure transmitter		Pressure				1	
	WAS sludge sump level transmitter		Level				1	
	Digested sludge sump level transmitter		Level				1	
	Poly dosing tank level transmitter		Level				1	
	Poly make-up tank level transmitter		Level				1	

Employer:		Contractor:	
Witness:		Witness:	

PSYC 20 MEASUREMENT AND PAYMENT

PSYC 20.1 Supply and install PLC Control Plant

Unit: Lump Sum (Sum)

The supply and installation of PLC control plant includes PLC hardware, software, all network switches to I/O and fibre optic cable network, fibre optic patch panels and all cabling to provide a complete system as specified.

The rate shall include full compensation for the approval of design including submission of design layouts and drawings, design, configuring, supply, manufacturing and installation of the specified PLC complete with all modules, expansion racks, interconnecting wiring mounting brackets, interface modules required for coupling to the network and all other material to give a fully operational PLC after loading of software and installation. The rate shall be all inclusive of all required material and labour.

The rate shall also include all programming and configuration of PLCs and SCADA.

PSYC 20.2 Supply and install CCTV

Unit: lump sum (Sum)

The supply and installation of CCTV installations shall include all hardware, software, cameras, mounting equipment, all network switches, Wi-Fi equipment and all cabling to provide a complete system as specified.

The rate shall include full compensation for the approval of design including submission of design layouts and drawings, design, configuring, supply, manufacturing and installation. The rate shall be all inclusive of all required material and labour.

PSYC 20.3 Supply and install Access Control

Unit: lump sum (Sum)

The supply and installation of access control installations shall include all hardware, software, mounting equipment, all network switches, control system equipment, servers, fingerprint registration facilities, access logging software and all cabling to provide a complete system as specified.

The rate shall include full compensation for the approval of design including submission of design layouts and drawings, design, configuring, supply, manufacturing and installation. The rate shall be all inclusive of all required material and labour.

PSYC 20.4 Supply and Installation of Fire Detection

Unit: lump sum (Sum)

The rates shall include full compensation for the design, supply, delivery, installation and commissioning of fire detection installation. The price shall

Employer:		Contractor:	
Witness:		Witness:	

include all relays, control plant, sensors, cabling and panels as shown on drawings and as specified and all factory and site testing.

PSYC 20.5 Supply and Installation of Junction Boxes

Unit: lump number (No)

The rates shall include Junction Boxes, complete with all required terminations and glands and suitable fixing and mounting steel structures.

Employer:		Contractor:	
Witness:		Witness:	

Johannesburg Water (SOC) Ltd



CONTRACT JW14060R

NORTHERN WASTEWATER TREATMENT WORKS

DEWATERING BUILDING BELT PRESS REPLACEMENT AND ASSOCIATED ANCILLARIES

VOLUME 2B

GENERIC PARTICULAR SPECIFICATIONS

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V1.0



Employer:		Contractor:	
Witness:		Witness:	

Volume 2B Tender and Contract
Particular Specification

The following Particular Generic Specifications forming part of the Contract have been written to cover phases or items of work involving a specialist type of operations or material to be encountered on this Contract and that are not adequately covered by the general specifications. The specifications listed below are bound in Volume 2B.

General	
Spec. No.	Description
G01	Colour Coding of Equipment
G02	Corrosion Specification

General Civil Engineering	
Spec. No.	Description
PQC	Carpentry, Joinery and Ironmongery
PQD	Steel Doors and Windows
PQH	Painting
PWB	Building Work
PWC	Subsurface Drains

Mechanical Works	
Spec. No.	Description
M05	Mechanical Mixing Equipment
M08	Gearboxes
M15	Filter Belt Press
M16	Belt Conveyor Equipment
M17	Mechanical Actuator Equipment
M18	Centrifugal pumps
M20	Mechanical Valves
M21	Pressure pipework
M26	Chemical Dosing and Transfer pumps
M30	Polyelectrolyte handling, Storage, Make-up and Dosing Equipment

Electrical Works	
Spec. No.	Description
E01	Electrical Motor
E02	Electrical Cable Racking
E03	Electrical isolator pushbutton station equipment
E04	Electrical Low Voltage Switchboards and Motor Control Centers
E05	Electrical Low Voltage Power & Control Cables
E06	Electrical Medium and Low Voltage Cable Installation
E07	Electrical industrial welding plugs, couplers and socket outlets
E08	Electrical Wiring

Volume 2B Tender and Contract
Particular Specification

Electrical Works	
Spec. No.	Description
E09	Electrical Building Installation
E10	Electrical Busbar Trunking
E11	General Electrical Earthing and Lightning Protection
E16	Uninterruptible Power Supplies (UPS)
E21	Electrical Lighting and Illumination
E26	Electrical colour coding of equipment

Automation and Control	
Spec. No.	Description
Volume 3	PLC Panels
Volume 5	Clean Power and Surge Protection
Volume 6	Cabling
Volume 7	Networking
Volume 8	Flow Measurement
Volume 9	Level Measurement
Volume 14	Turbidity & Suspended Solids Measurement
Volume 19	Field Junction Boxes and Panels
Volume 23	Pressure meters
Volume 25	Labelling



a world class African city



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PARTICULAR SPECIFICATION

G01 : COLOUR CODING OF EQUIPMENT

2	2013-10-23	Minor updates and re-issued	J Ritchie	
1	2009-05-12	Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance		
Rev	Date	Description	Signature: JW Wastewater Partnership	Signature: Approval from Johannesburg Water

PARTICULAR SPECIFICATION: VOLUME G01 : COLOUR CODING OF EQUIPMENT

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G01.1

SCOPE

This Specification has been adopted by Johannesburg Water to ensure the colour coding of electrical equipment, mechanical plant and pipework located on Johannesburg Water's Wastewater Treatment Works shall conform to the ruling Occupational Health and Safety Act.

The Specification comprises of **three** parts, namely:

- (a) SANS Code of Practice 10140-3, Identification colour marking – Part 3 : Contents of pipelines: 2003
- (b) A table (Table 1) which supplements SANS 10140-3, above, in order to provide greater detail or clarity on the colour marking of pipelines conveying fluids commonly found on the treatment works
- (c) A table (Table 2) which gives the colours adopted for certain electrical equipment and mechanical plant.

Throughout the Specification the colours used shall match the corresponding colours given in SANS Specification 1091, National Colour Standards for Paint: 2004 (as amended).

Where a colour code is not covered by this Specification, the matter shall be referred in writing to the Divisional Manager: Investment Delivery for ratification.

Table 1 : Colour Coding of Pipework on Johannesburg Water's Wastewater Treatment Works

Contents of Pipeline	Basic Colour	Colour Coding Indicator	
		Single Band	Second Band
<u>Water, non-drinkable</u>	Brilliant Green		
Cooling water		White	
Final treated effluent		Black	Dark Violet
Recycled effluent		Black	Dark Violet
Air saturated effluent		Black	Aquamarine
Filtrate		Black	
Wash Water		Black	
Scum water		Black	Dark violet
Dewatering Liquors		Black	Dark Violet
Overflow from P.S.T's		Black	Crimson
Overflow from Clarifier		Black	Dark Violet
D.A.F Underflow		Black	Crimson
Supernatant Liquor		Black	Avocado
Overflow Gravity Thickener		Black	Crimson
Fire Fighting			
Boiler feed		Cornflower	
Hydraulic power		Salmon Pink	-
Poly-electrolyte		Light Grey	-
Raw sewage		Middle Brown	-
Settled sewage		Mid-grey	-
<u>Thickener overflow from:</u>			
Primary sludge		Crimson	-
Activated sludge		Canary Yellow	-
Digested sludge		Maroon	-
DAF liquors		Canary Yellow	Turquoise Blue
Filtrate		Ultramarine	-
Washwater		Black	-
Scum water		Dark Violet	Crimson
Treated effluent		Dark Violet	-
Dewatering liquors		Black	Ultramarine
<u>Acids</u>	Jacaranda		
Ferric chloride		Crimson	
Ferric sulphuric		Artic Blue	

Contents of Pipeline	Basic Colour	Colour Coding Indicator	
		Single Band	Second Band
<u>Alkalis</u> Lime Slurry	Dove Grey		
<u>Gases</u> Sludge gas Steam Nitrogen Hydrogen Methane (digested) Carbon dioxide Chlorine/Hypochloride Oxygen Compressed Air Ventilated Air Vacuum Air Instrument Air	Light Stone Pastel grey Light Stone Light Stone Light Stone Light Stone Canary Yellow White Artic Blue Artic Blue Artic Blue Artic Blue	Jacaranda Aluminium Black Black Turquoise Blue Light Grey	Clad/lagging Light Grey Signal Red
<u>Sludges</u> Anaerobically digested Anaerobically digested: thickened Raw Sludge Lime treated Primary Primary thickened Digester supernatant liquor Activated : mixed liquor Activated : gravity thickened Activated : return sludge Activated : DAF overflow/float Activated : primary Activated : digested Activated : waste Pasteurised	Middle Brown Dark Violet Dark Brown Dark Brown Dark Brown Middle Brown Royal Blue Royal Blue Royal Blue Royal Blue Royal Blue Royal Blue Royal Blue Royal Blue Light Brown	Maroon Maroon Dove grey Crimson Crimson Salmon Pink Canary Yellow Canary Yellow Canary Yellow Canary Yellow Canary Yellow Canary Yellow Canary yellow	Light Grey Dark Violet Middle Brown Turquoise Blue Crimson Maroon
<u>Oil</u> Diesel oil Hydraulic oil Lubricating Transformer	Black Golden brown Golden brown Golden brown	White Salmon Pink Brilliant Green Crimson	
<u>Other Liquids</u> Polyelectrolyte Cooling liquid	Golden Yellow White	Jacaranda	

Notes: This table supplements SANS 10140-3: 2003

All codes are in relation to SANS 1091: 1975

Table 2: Colour Coding of Electrical Equipment and Mechanical Plant

Item	Colour	Remarks	Code to SANS 1091
Electrical panels : (external)	Light Orange	NOSA	B.26
Electrical panels : (external) emergency power on	Signal Red		A.11
Electrical panels : (Internal)	White		G.80
Coupling guards and motor guards	Golden Yellow	SANS 10140-2	B.4
Motor cowls	Light Orange	Historical	B.26
Electrical motors, pumps and compressors	Deep Pastel Green		H.28
Gearboxes	Navy Light Grey	NOSA: See also "Small Gearboxes"	G.35
Blower	Deep Pastel Green	NOSA	H.28
Baseplates	Olive Drab		
Cranes	Golden Yellow		B.4
Valve bodies		See SANS 10104-3, Clause 4.2	
Valve hand-wheels			
Small gearboxes	To be same colour as prime mover		

G01.1.1 Machined Components

All machined components shall be protected by "Tectyl" or similar proprietary coating after manufacture. The coating shall be sufficiently durable to prevent corrosion during storage and installation and shall be removed using the manufacturers recommended solvent after final adjustment of the equipment. Final painting shall be carried out in accordance with the system specified.

G01.1.2 Records

The contractor and sub-contractors shall maintain records of the application environment, dates of applications, conditions of surfaces before preparation, blast profiles, wet and dry film thicknesses, overcoating times, paint types and batch number, method of application, tests and type of instruments used, which shall be incorporated into the Component Quality Plan and be available to the Engineer or his Representative for review and surveillance. Two copies of the completed Component Quality Plan shall be provided within 2 weeks of completion of the corrosion protection system.

G01.2 **MEASUREMENT AND PAYMENT**

For the purpose of this Contract the electro-mechanical items shall be supplied and installed conforming to this specification. The cosmetic painting application shall be included for and the surface preparation, transporting of equipment to and from the applicator shall be included for. No separate measurement item shall be included for the application of these coatings.



PARTICULAR SPECIFICATION

G02: CORROSION SPECIFICATION

1	2009-05-12	Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance		
Rev	Date	Description	Signature: JW Wastewater Partnership	Signature: Approval from Johannesburg Water



Corrosion Protection Specification for Civil, Mechanical and Electrical Engineering Construction

2006 Edition

FOREWORD

Golder Associates Africa (Pty) Ltd require that the series of Code of Practice for Corrosion Protection (SANS 10120–HC) and Standardized Specifications for Corrosion Protection (SANS 1200 -HC) be applied in their designs and contracts

The series covers the following disciplines:

A. General	K. Brickwork and masonry work
B. Site investigation	L. Pipework
C. Site clearance	M. Road surfacing and paving
D. Earthworks	N. Railway track work
E. Geotechnical processes	R. Harbour and marine works
F. Piling, caissons and cylinders	S. Electrical works
G. Concrete	T. Mechanical work
H. Steel and other metalwork	U. Building work
J. Structural timber	V. Sundries

Each discipline has several sub-sections written or being written for it. The Corrosion Protection sub-section has so far been written for Structural Steelwork (10120-HC and 1200HC). These specifications, however, do not cover all the other disciplines adequately.

This document contains the supplementary requirements of **Golder Associates Africa (Pty) Ltd** to cover the Corrosion Protection of more disciplines of Civil Engineering Construction.

It is required to be used by

- Engineers commissioned by **Golder Associates Africa (Pty) Ltd** to design and provide particular specifications for Corrosion Protection and Painting of Civil Engineering Works, and / or
- Tenderers invited by **Golder Associates Africa (Pty) Ltd** to design or design and construct, amongst others, the Corrosion Protection and Painting of Civil Engineering Works

NOTE:

Where any clause in this document is in conflict with any of those in the SANS documents, the meaning and requirements of the clause in this document shall prevail

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Where conflict exists between this document and any National or International Standard, the requirements of this document shall take precedence, unless otherwise agreed by the Engineer.

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1 SCOPE

This specification covers materials and procedures used for corrosion protection of materials of construction in various environments. The specification is intended for use with mechanical, civil and electrical engineering contract documentation and provides specific information and instructions on how to optimise the corrosion resistance of the materials of construction.

NOTE: The standards referred to in the specification are listed in Appendix A

2 INTERPRETATIONS

2.1 REFERENCES

2.1.1 Code of Practice

The recommendations of SABS 0120, have been incorporated into this specification in so far as they are applicable

2.1.2 Supporting Specifications

Where this specification is required for a project, the following specifications shall, inter-alia, form part of the contract document:

- (i) Project specification
- (ii) SANS 1200 A, SANS 1200 AA or SANS 1200 AH, as applicable
- (iii) SANS 1200 H, SANS 1200 HA and/or SANS 1200 HB, as applicable
- (iv) SANS 1200 HC, as applicable

2.1.3 Date of issue of specifications and data sheets

The latest issue of specifications and data sheets shall be applicable

2.2 DEFINITIONS:

ACCEPTABLE - Acceptable to the Engineer

ACCEPTABLE QUALITY LEVEL (AQL) - The maximum percentage defective or the maximum number of defects per 100 items that, for the purpose of sampling inspection, can be considered satisfactory as a process average

COATING - A continuous material, which may be metallic or non metallic, applied and bonded to a surface for the purpose of protecting the surface from degradation by the environment or for the purpose of improved appearance or for identification

CONCESSION - A written authorisation from the Engineer to accept an item that is found to have departed from the specified requirements but nevertheless is considered suitable for use 'as is' or after rework by an approved method, in which case a re-inspection will be required

CONFORMANCE - the fulfilment by a product, process, or service of specified requirements

DEFECTIVE - a coating or lining that fails to meet one or more of the requirements of the specification

DELTA LAYER - the second layer of zinc-iron alloy growth from the base steel formed during the galvanizing process; the Delta layer's chemical composition is approximately 90% zinc and 10% iron; the Delta layer is 60% harder than the base steel it protects from abrasion and corrosion

DRY FILM THICKNESS (D.F.T.) - the thickness of a coating or lining after it is hard dry

ELECTRICAL INSULATION DEFECT (E.I.D.) - Defects in a coating or lining that impair the protective properties of the coating or lining and that are detected instrumentally by either:

- (i) a low-voltage, wet-sponge detector, or
- (ii) a high-voltage, sparking detector, operated in each case within the parameters specified

NOTE: E.I.D's include such defects as steel projections from the substrate, conductive particles embedded in the coatings or linings, voids and those defects commonly known as pinholes and holidays

ENGINEER - The Engineer responsible to the Purchaser for the execution of the contract

IDENTIFICATION - A means of identifying a specific item by means of a unique combination of numbers and/or letters that will enable subsequent traceability of the item

INDUCTION PERIOD - The period after the proper amounts of base and curing agent components of a two-pack coating material have been added together and thoroughly mixed, and then allowed to stand to enable the initiation of the chemical reaction, prior to any necessary thinning and the application of the coating material

INSPECTOR - A person authorised by the Engineer to act as his representative in examining the work and materials and in drawing such samples and carrying out such tests as may be necessary to ensure compliance with specification

LINING - A coating applied to the inside of a component such as a pipe, valve or pump body, for the purpose of protection of the inside surface. A lining may also be applied in order to reduce wall friction

LOT - A number of similar or related items submitted for inspection at one time by the contractor and of such size that the inspector can reasonably be expected to examine adequately in not more than one working day

PAINT - A liquid material that, when applied as a thin film to a suitably prepared surface by an appropriate method, undergoes a physical or chemical change (or both) that converts it to a solid coating or lining bonded to the surface to which it is applied

POT LIFE - The period, after the contents of the packs of a two-pack coating material have been mixed together, during which the paint remains suitable for use without the addition of further solvent

POWDER COATING - A material in the form of a dry, free flowing powder that, when applied to a suitably prepared steel surface by an appropriate method, can be fused by application of heat and subsequent cooling to form a continuous coating or lining that is bonded to the surface

QUALITY - Totality of features, properties and characteristics of a product, process or service that bear on its ability to satisfy the stated or implied needs

QUALITY ASSURANCE - All those planned and systematic actions necessary to provide adequate confidence that a product, process or service will satisfy given quality requirements

QUALITY AUDIT - A systematic and independent examination to determine whether quality activities and results comply with planned arrangements and whether these arrangements are effectively implemented and are suitable to achieve objectives. The intent of a Quality Audit is an independent review and evaluation so that needed corrective action can be obtained

QUALITY CONTROL - the operational techniques and activities that are employed by the contractor to ensure the required quality of a product, process or service

QUALITY PLAN - A document setting out the specific quality practices, resources and activities relevant to a particular contract or project

QUALITY PROGRAM - A documented set of activities, resources and events serving to implement the Quality System to a time schedule

QUALITY SURVEILLANCE - the continuing evaluation of procedures, methods, conditions, products, processes and services and analysis of records to assure that quality requirements will be met

ROCKGUARD OR ROCKSHIELD - Material intended to be wrapped around the outside of a coated pipe to prevent physical damage to the coating, but that otherwise plays no part in the corrosion protection of the pipe

- SOLVENT
- (i) That part of a liquid coating material that volatilises from the film during the drying process, or
 - (ii) a Volatile liquid compatible with a coating material and used for the purpose of cleaning equipment used in the application of a coating material
 - (iii) The active component of a degreasing material

NOTE - The coating manufacturer's recommended solvent for each application and for each product shall be strictly followed.

TAINT - The property of imparting or having an objectionable odour or taste, or both

TOTAL DRY FILM THICKNESS - the thickness of all the coats in a coating or lining system measured after the last coat is hard dry

TOXICITY - the ability of a substance to produce injury to a living being

TRACEABILITY - the ability to trace the history, application or location of an item or activity and like items or activities by means of recorded identification

WATER BREAK FREE - A surface which, when wetted all over with plain potable water, maintains a continuously wet surface and the water does not break up into islands of un-wetted surface

WEBER-RIELLY TEST – a test for water soluble salts remaining in pitted steel after abrasive blast cleaning. (Water soluble salts result in the formation of osmotic blistering of the coating after immersion). A white indicator paint is sprayed on the surface. If ferrous salts are present, the indicator turns pink or red, depending on the salt concentration. (This is a test for iron salts in the ferrous state and is not a test for chloride ions)

WET FILM THICKNESS (W.F.T.) - the thickness of a coating or lining immediately after application and before any volatile matter has evaporated

3 MATERIALS OF CONSTRUCTION

The engineer of the 21st Century has at his disposal a vast array of materials of construction and a great many ways of preserving these materials against deterioration.

Quality, availability and price will always dictate the extent of the use of any particular raw material.

The materials covered in this specification are those readily available in Southern Africa viz.

Stainless steel

Corrosion resistance steel

Aluminium

Galvanized mild steel

Painted mild steel

- and materials of civil construction, such as reinforced concrete, cement plaster finishes, fibre cement products and timber.

Materials not covered in this specification are polymers and plastics - e.g. rubbers, polycarbonates, glass reinforced plastics, high, medium and low density polyethylene(LDPE), polyvinylchloride (PVC), nylon, Teflon, Kynar® - etc, etc. which are generally corrosion resistant materials in their own right but it is nevertheless advisable to seek advice as to their exact use and suitability for any particular environment. For example PVCs and polyvinylidene chlorides are degraded by high heat conditions and can produce chlorine, which is itself a highly corrosive gas.

Mild steel is the metal most used for fabrication because of its relatively low price, easy availability and ease of fabrication. However mild steel corrodes (reverts to the oxide form in the presence of oxygen and water). There are two principal ways to prevent this, i.e. cathodic protection which reverses the electrochemical reaction (this only works if the metal is immersed or buried in a conductive medium) or coating (painting) which insulates the steel from the corrosive environment.

As there are many environments and very many coatings available, much of this specification is devoted to classifying the environments and detailing the use of the few reliable coating systems which are known to give good service in these environments. It is not easy to achieve good coating quality! The specification details quality control and testing procedures necessary to produce lasting performance.

It must be added that the original Specifications in this Document have been used for the last 20 years with excellent results.

4 DESIGN

4.1 THE EFFECT OF DESIGN ON CORROSION FREE LIFE

All items shall be designed to minimise corrosion in the environment to which they will be exposed. The following notes may be used as guidelines:

4.1.1 Water Retention Areas

Water retention areas shall be avoided wherever possible. For example, angle or U section steel should be used with the toes pointing downwards. The concrete base of steel columns should be sloped away from the steel and the sloping edge should be painted (sealed) to avoid water ingress at the steel/concrete interface

4.1.2 Crevices

Crevice give rise to accelerated corrosion by forming an oxygen concentration cell. Crevice shall be avoided by using:

- (i) Continuous welding should preferably be used. Where discontinuous welding (space welding) is used the gap should be wide enough to allow abrasive blast cleaning and correct painting or, if the gap is too narrow it should be designed so that it may be effectively sealed with a mastic or sealant.
- (ii) Mastics or sealants to seal unavoidable crevices such as bolted connections
- (iii) Insertion rubber or suitable impermeable gasket material between mating surfaces

4.1.3 Bimetallic Couples

Electrical contact between dissimilar metals gives rise to a corrosion cell when an electrolyte such as water is present. Junctions between dissimilar metals shall be insulated or effectively sealed against water ingress. Where insulation is not possible cathodic protection should be employed.

4.1.4 Accessibility

Whenever possible, the surfaces of corrodible materials such as mild steel shall be accessible for maintenance. The use of back to back angles, partially open box sections or inaccessible stiffeners should be avoided

4.1.5 Differential Aeration

Posts buried in soil are subject to accelerated corrosion due to differential aeration. Additional protection shall be given to that part which is buried and up to at least 800mm above ground. Similarly, tanks should not stand on the ground or on a concrete bed but shall be fitted with legs to ensure that there is no contact between the tank base and its bed. Where legs cannot be used, the tank shall stand on a concrete base, after coating the base of the tank with the full Corrosion Protection System. The edges of the concrete base shall be sloped away from the tank. The joint between tank and base shall be sealed with suitable mastic or sealant. As an additional precaution cathodic protection may be employed to protect the underside of the tank bottom.

4.1.6 Sharp edges and welds

The designer shall specify that all sharp edges shall be ground to a radius not less than 3mm or half the steel thickness and that all rough welds, undercuts, weld spatter and weld slag shall be removed by the Fabricator. (Refer also to Clause 5.2)

4.1.7 Cathodic Protection

Where cathodic protection is to be used on buried or immersed items or items imbedded in concrete, care shall be taken to ensure that the necessary bond continuity or insulation, as required, is included in the design. Provision must be made in the design stages to provide access for cables, reference electrodes and test point connections prior to construction. A qualified and experienced cathodic protection engineer should be employed at the design stage

4.1.8 Components to be galvanised

The design of components which have to be galvanised is very important to both the quality of the galvanising which will be achieved and to the integrity of the component i.e. with regard to distortion due to uneven expansion during dipping into molten zinc at 450°C - there is also a risk of explosion if the items are not vented or positioned correctly!

Design parameters are thoroughly covered by existing specifications which are mentioned in Section 6.2 below.

5 METAL FABRICATION

5.1 WELD QUALITY

All welding shall be carried out by coded welders to International Welding Standards. Weld quality shall comply with the requirements of the Engineer

5.2 WELDS SMOOTH

All welds shall be smooth, continuous and free from porosity, projections or undercuts. Rough welds shall be ground where necessary to achieve the required smooth profile. Undercuts or blowholes shall be re-welded and ground to a smooth surface.

5.3 CUT EDGES

All cut edges and drilled holes shall be de-burred and ground to a radius of not less than 3mm. If the steel thickness is less than 6mm, the radius of curvature of the edge shall be 50% of the thickness

5.4 WELD PICKLING AND PASSIVATION

All welds and heat affected areas of stainless and corrosion resistant steel shall be pickled and passivated as specified in Clause 7.2

5.5 COMPONENTS TO BE GALVANISED

If the component is required to be hot dip galvanized, refer to Clause 6

5.6 SAFETY PRECAUTIONS

The Contractor shall, at all times, observe all applicable legislation according to the **Occupational Health and Safety Act, No. 85 of 1993** and any relevant municipal bylaws and environmental legislation.

6 HOT DIP GALVANIZING

6.1 THE HOT DIP GALVANIZING PROCESS

6.1.1 Specifications

Hot dip galvanizing shall comply with SANS 121:2000/ISO 1461:1999 for fabricated articles and pipes, SANS 3575:1996/ISO 3575:1996 for strip galvanized sheet or SANS 675:1997 for fencing wire.

NOTE that the thickness of zinc coating varies according to the substrate galvanized:

Rolled steel sections – SANS 121:2000 / ISO 1461:1999 specifies minimum thickness according to the thickness of the substrate, e.g. steel of 5mm and greater thickness shall have a coating not less than 85 microns thick (normal grade) or minimum 105 microns if Heavy Duty is specified. Steel of less than 2 mm thickness is specified to have a minimum coating thickness of 45 microns (55 microns for Heavy Duty)

Sheet steel – SANS 3575:1996/ISO 3575:1996 or SANS 4998 :1996 / ISO 4998:1996 (structural quality) for strip coated sheet steel allows the purchaser to select the thickness required. For the purposes of this specification, only the following two grades need be considered:

- Z275 (Commercial grade) shall be used only when the galvanized steel is to be painted for aesthetic appearance or for colour coding. Average zinc coating thickness is 20 microns with the minimum being 17 microns
- Z600 (Heavy duty grade) may be used where galvanizing is the only specified method of protection. This is specified as average thickness of 43 microns with a minimum of 36 microns

Plain or barbed fencing wire - SANS 675:1997 specifies different galvanizing thicknesses for different wire thicknesses. The range of average thickness is 30 - 40 microns. NOTE: Galvanizing wire to SANS 935 is not acceptable for the purposes of this specification since the galvanizing thickness is too low for adequate corrosion protection in sewage and water purification works.

Tubing for structural purposes – SANS 32 :1997 / EN10240:1997– for plain ended round or square tubing up to 200mm diameter.

6.1.2 Thickness of galvanizing on steels of different metallurgical composition

The above specifications were written around galvanizing on aluminium killed steels which build up a relatively thin 'delta' layer. However silicon killed steels build up a thick delta layer very quickly when immersed in molten zinc. This results in relatively high thicknesses of galvanizing. Whereas these thicker layers result in additional protection against corrosion they are also relatively brittle and tend to delaminate on impact.

NOTE: It is the responsibility of the contractor to determine the metallurgical nature of the components prior to galvanizing. Poor quality of corrosion protection due to excessive thicknesses of galvanizing will result in rejection of the items.

6.1.3 Mating Surfaces

Mating surfaces on fabricated or cast iron components shall be wiped or centrifuged on removal from the galvanizing bath to remove blobs, runs or excess metal that may impair the air/gas/water tightness of the joint. This requirement must be specified to the galvaniser when ordering.

6.1.4 Fasteners

Bolts, nuts and washers used for fixing galvanized components shall be hot dip galvanized to SANS 121:2000/ISO 1461:1999. Electroplated fasteners will not be accepted unless otherwise agreed by the Engineer in writing

6.2 DESIGN AND FABRICATION

Components for hot dip galvanizing shall be designed and fabricated as recommended in SANS 14713:1999/ ISO 14713:1999 except that the use of lead plugs is not permitted

It is recommended that the manufacturer consults the galvaniser before design and fabrication to ensure that the fabrication will be suitable for galvanizing

The main requirements are as follows:

- (i) Overlap joints shall be avoided wherever possible. If essential, such overlap joints shall be thoroughly degreased before assembly and shall be vented by drilling holes through one or both overlapping materials
- (ii) Closed sections shall be suitably vented. If the inside of a closed section is not to be galvanized, a snorkel vent tube of suitable length and bore shall be attached

- (iii) Gussets and internal baffles in tanks shall be cropped to allow free flow of zinc and air
- (iv) Joints shall be continuously welded, using balanced welding techniques to avoid stresses. Welds shall be free from cavities, undercutting, weld slag and spatter
- (v) Symmetrical design shall be used whenever possible and the use of thin gauge steel adjacent to heavy section shall be avoided
- (vi) Openings and the flanges of manholes and bosses shall finish flush on the inside to ensure complete drainage
- (vii) Castings shall be designed to be of a uniform section as possible and shall be blast cleaned in accordance with Clause 10.5.3 before despatch to the galvaniser

6.3 REPAIR OF GALVANIZED ARTICLES

Welding, flame cutting, or other heat processes shall not be carried out on galvanized articles unless permission is granted by the Engineer

If such permission is given, or if mechanical damage has occurred, repairs shall be carried out as follows:

- (i) All scale, spatter and flux shall be removed by grinding and washing with clean water. Edges shall be ground to a radius not less than 2mm
- (ii) The preferred repair process is to blast clean to bare steel and apply zinc by the thermal spray process in accordance with SANS 1391, Part 1, Grade Zn150. On completion of metal spraying, burnish the surface by means of a mechanical wire brush to give a uniform appearance. Burnishing shall remove not more than 10 microns of zinc
- (iii) Where small areas are to be repaired, clean the surface thoroughly with fine abrasive paper, remove all debris with a damp cloth and allow to dry. Repair by application of an approved solvent free zinc rich repair coating. A sufficient number of coats shall be applied such that the repair coating thickness is not less than the average zinc thickness specified in the appropriate galvanizing specifications. The repair shall extend not less than 5mm beyond the damaged area. On completion of the repair and when the zinc rich primer is completely dry, one coat of acrylic resin based aluminium paint may be applied.

NOTE: Repair of galvanized surfaces by application of aluminium paint alone is not permitted

6.4 STORAGE OF GALVANIZED COMPONENTS

Galvanized components shall be stored to avoid the formation of 'white rust' or other forms of storage staining

Components shall be separated and supported on wooden battens to ensure adequate ventilation of all surfaces and in such a manner to avoid 'ponding' by rainwater

If storage staining does occur, remove the stains by scrubbing with detergent solution and bristle brush or nylon pad. The use of steel wool or other metallic abrasives is not permitted.

Rinse thoroughly and allow to dry. If the residual zinc thickness complies with the requirements of the appropriate grade in the relevant specification, no further action is required unless instructed by the Engineer

If the cleaned zinc thickness is below specification, the article shall be re-galvanized or repaired in accordance with Clause 6.3, as decided by the Engineer

7 STAINLESS STEEL FABRICATIONS

7.1 GRADE AND WELDING TECHNIQUES

The grade of stainless steel to be used shall be as specified in the appropriate section of the specification or drawings. Where welding is necessary, the appropriate "L" grade (low carbon content) shall be used. Plate used in fabrication shall be supplied as No.1 Finish in accordance with BS EN 10151

Welding procedures shall be only those recommended by the stainless steel manufacturer or by the South African Institute of Welding. Only welders coded to ASME IX, 2004 shall be employed

Welds shall be smooth and free from blowholes, undercuts, sharp projections and similar visual defects

Fabrication of stainless steel components shall be carried out in clean work places where there is no contamination by mild steel. Grinding and polishing equipment shall be dedicated and shall not be contaminated with iron or mild steel

Stainless steel shall be suitably handled to avoid scratching the surface

7.2 PICKLING AND PASSIVATION

Cut edges, welds and heat affected surfaces shall be pickled and passivated to remove all discolouration. Proprietary pickling and passivating pastes (as supplied by Duva Chemicals (Pty) Limited, or other approved supplier) shall be used in accordance with the manufacturer's recommendations. Care shall be taken not to exceed the maximum contact time recommended. No heat discolouration shall remain after completion of pickling and passivating

After passivation, surfaces shall be very thoroughly washed with clean potable water to remove all traces of acid. The surface shall be allowed to dry, then polished where necessary, using polishing compounds recommended by the stainless steel manufacturers or the South African Stainless Steel Development Association

7.3 SAFETY PRECAUTIONS

- (i) Operatives shall wear protective aprons, gloves and safety glasses during pickling and passivating
- (ii) Splashes on the skin shall be thoroughly washed with clean water immediately after contact. A weak solution of sodium bicarbonate shall be kept available for neutralization. Seek medical attention if in doubt
- (iii) Disposal of effluent shall be in accordance with the requirements of the local authority in whose area the work is being carried out

Note: these pickling chemicals are solutions of nitric and fluoric acid and must be treated with extreme care! The Material Safety Data Sheets (MSDS) shall be supplied by the manufacturers of the chemicals used, for reference in case of emergencies

8 CORROSION RESISTANT STEEL 3CR12 FABRICATIONS

8.1 ACCEPTABLE QUALITY OF PLATE

The 3CR12 plate shall be of an acceptable quality, free from inclusions from the rolling process or any other defects which may affect the long term corrosion resistance of the fabricated item. If necessary the plates shall be hand selected for fabrication by the Engineer's metallurgical inspector.

8.2 WELDING TECHNIQUES

Welds shall be full penetration welds, using 309 austenitic electrodes or filler wire, or special electrodes as recommended by Columbus (Pty) Limited

Welders shall be suitably coded for welding similar thickness of austenitic stainless steel, in accordance with ASME IX, 2004

Welding procedures shall comply with the recommendations of Columbus (Pty) Limited

Welds shall be smooth and free from blow-holes, undercuts, sharp projections and similar visual defects

8.3 PICKLING AND PASSIVATION

8.3.1 Areas to be cleaned

After completion of welding, both weld and heat affected zones shall be cleaned, pickled and passivated. Any heat scale, including that on the reverse side of the weld, shall be removed by pickling and passivation.

8.3.2 Procedure

- (i) Grind or wire brush, using dedicated grinders or stainless steel wire brushes to achieve the required smooth profile or remove scale
- (ii) Pickle with a proprietary thixotropic paste containing 15-20% nitric acid and 1-2% hydrofluoric acid, with a contact time of 10 to 15 minutes

- (iii) Rinse thoroughly with clean water until the pH of the washings is the same as that of the wash water
- (iv) Repeat the above process, if necessary, to remove all discolouration
- (v) Passivate with 10% nitric acid solution, or a proprietary passivating paste, for a contact time of 10 - 15 minutes, keeping the surface wet during this period
- (vi) Neutralise thoroughly with an approximate 10% solution of sodium bicarbonate in water, scrubbing the solution into the surface using 'Scotchbrite®' abrasive pads. Rinse thoroughly using clean potable water until washings are the same pH as the wash water.

8.3.3 Safety Precautions

- (i) Operatives shall wear protective aprons, gloves and safety glasses during pickling and passivating (it should be noted that these pickling chemicals are solutions of nitric and hydrofluoric acid and must be treated with extreme care!!)
- (ii) Splashes on the skin shall be thoroughly washed with clean water immediately after contact. A weak solution of sodium bicarbonate shall be kept available for neutralisation. Seek medical attention if in doubt
- (iii) Disposal of effluent shall be in accordance with the environmental requirements of the local authority in whose area the work is being carried out (See Clause 5.6)

9 ALUMINIUM FABRICATIONS

9.1 GRADE OF ALUMINIUM

The grade of aluminium or aluminium alloy shall be as specified by the Engineer or as recommended by the aluminium manufacturer for the specific application

9.2 ANODIZING

Aluminium components where specified as anodized shall be natural anodized and sealed in accordance with SANS 999 Grade 25. The corrosion resistance of the coating shall be not less than 8 when tested in accordance with 3.6 of specification SANS 999. Anodizing shall be carried out after completion of all welding

9.3 POWDER COATING

When specified by the Engineer, aluminium fabrications may be coated with exterior grade polyester powder. Such coating may only be carried out by contractors with the necessary plant, equipment and experience to pre-treat and powder coat aluminium effectively. The coating shall comply with SANS 1578 Part 1 and 2, or BS. 6496

9.4 CONTACT WITH CONCRETE

Whenever aluminium components, such as hand rail posts, come into contact with concrete or grout, the surface of the aluminium in contact with the concrete shall be coated with two coats of an approved epoxy tar composition, prior to the grouting.

9.5 CONTACT WITH MILD STEEL

When aluminium components are bolted to mild steel, plastic or rubber inserts shall be used to insulate the aluminium from mild steel. Fasteners shall be 304 stainless steel bolts, nuts and washers.

9.6 ALUMINIUM ROOF SHEETING

Aluminium roof sheeting should be used exactly according to the manufacturer's directions for use. Only approved contractors qualified to erect aluminium roofing shall be used. The fixing of the sheets is critical - far more so than the fixing of mild steel painted sheet because of the fact that aluminium is anodic to steel - i.e. it will sacrifice itself to protect the steel with which it is in contact. Therefore holes will get larger to the point where the roof/cladding sheets will detach from the fixings. This corrosion is accelerated by the accumulation of dust and dirt especially if the build-up is acid or alkaline or contains conductive ions e.g. salt

The manufacturers recommend the use of insulated stainless steel fixings and insulation tape separating the sheets from the supporting purlins/girts. Where this type of sheeting is used in corrosive environments it should be specified to be painted with PVF₂ on both sides and the sheeting should be designed to not allow accumulations of product or dirt to be in contact with the sheets. The sheets must not be in contact with the ground. This type of sheeting may only be used where high standards of cleanliness and maintenance are kept.

10 PAINTING AND APPLICATION OF ORGANIC COATINGS

10.1 MATERIALS

10.1.1 Paint Supplier

All materials in a paint system shall be purchased from one supplier. The contractor shall supply the paint supplier with a copy of the relevant sections of the specification. The paint supplier shall certify, by completion of the Form given in Appendix C, that the materials to be supplied comply with the relevant specification and are suitable for the intended purpose. The manufacturer shall preferably be a supplier of assessed capability listed under SANS ISO 9002 - 2000

10.1.2 Approval of paints

The Contractor shall submit with his tender, the appropriate form (See Appendix B) giving details of the paints he intends using and shall only proceed with the purchase of the paints upon receipt of written approval from the Engineer. Manufacturers' data sheets or legible copies thereof for each product shall be attached to the form

10.1.3 SABS compliance

Materials shall comply with the appropriate SANS specifications when relevant

10.1.4 Paint not changed without approval

No variation in brand or materials quoted in the tender documents and approved by the Engineer shall be permitted without the approval of the Engineer in writing

10.1.5 Containers

All coating materials shall be delivered in the manufacturer's original sealed containers, clearly marked with the following:

- (i) Manufacturer's name
- (ii) Product Brand and Reference Number
- (iii) Volume of contents
- (iv) Batch Number which may incorporate the date of manufacture
- (v) Date of manufacture, unless already incorporated in the batch number

- (vi) Abbreviated instructions for storage and use of the material, and/or reference to an appropriate data sheet which shall include mixing ratios of components of multi-component materials, minimum temperature of application, method of application, and minimum and maximum over coating times, where applicable
- (vii) The SANS mark where applicable

10.1.6 Manufacturer's instructions:

Recommendations supplied by the manufacturer in the form of the latest edition of printed data sheets, or given in writing on the manufacturer's letterhead, shall be followed. Any conflict between the manufacturer's data sheet and the specification shall be referred to the Engineer for adjudication

Verbal information by the manufacturer's representative will not be accepted unless confirmed in writing by the company, on their printed letterhead, and signed by an authorised officer of the company

10.2 STORAGE

10.2.1 Approved store

All coating materials shall be kept in an approved store, which shall be dry, enclosed and where the temperature will not exceed 40°C or drop below 0°C

10.2.2 Paint freshness

Usage of materials shall be on a first in, first out basis and no materials may be used which have exceeded the shelf life recommended by the manufacturer

10.2.3 No smoking

No smoking shall be permitted in or near a paint store

10.2.4 Combustibles separate

Solvent containers shall be kept sealed in the store with adequate air circulation and floor level vents. Solvent or paint soaked rags, cotton waste or other spontaneously combustible material shall not be kept in or near the store. Precautions shall be taken to prevent the discharge of static electricity in areas where flammable solvent is stored.

10.2.5 Further safety requirements

Stores shall be provided with adequate and suitable fire extinguishers placed outside the entrance in a prominent position. A separate store shall be provided for tools, equipment, protective clothing and personnel. The paint store shall not be used to accommodate personnel at any time

10.3 COATED MANUFACTURED ITEMS

When items are purchased already coated, the contractor shall supply to the Engineer full details of materials used, method and standard of surface preparation, method of application and curing, and total dry film thickness of the coating. Such items will be subject to inspection and approval by the Engineer before acceptance

10.4 GENERAL

- (i) The contractor shall ensure that he has available the latest edition of all the relevant National Specifications and Codes of Practice and the manufacturer's data sheets for materials to be used
- (ii) Requirements specified in Clause 3 shall be adhered to
- (iii) Strict attention shall be paid to fettling of surfaces by the Fabricator (see Clause 5 above) prior to coating. Should the painting contractor receive components not fettled in accordance with Clause 5, he shall arrange with the Fabricator to have the work carried out before commencement of painting. In case of dispute, the decision of the Engineer shall be final.
- (iv) Areas which are inaccessible after assembly shall be prepared and fully coated with the specified system and to the specified requirements before assembly. The coating shall be fully hard dry and every care shall be taken to avoid damage to the coating during assembly.
- (v) Mating surfaces (other than friction grip surfaces) shall be coated with primer or first coat only. The coating shall be uniform in thickness and shall not interfere with the mechanical tolerances. After assembly the joint shall be fully coated and if to be immersed, shall be totally sealed
- (vi) The painting sub-contractor shall provide evidence of his competence to apply the specified materials in the specified manner and to apply the necessary Quality Control procedures. The Engineer, at his discretion, may demand a Quality Audit of the Contractor's facilities by a technically competent and independent organization. The audit shall be carried out at the Contractor's cost

If consistent and satisfactory results are not achieved with the plant and equipment used by the Contractor, the Engineer may order the Contractor to obtain and use such plant and equipment as may be necessary to achieve the required results

All plant, equipment and temporary works which are supplied by the Contractor shall at all times be maintained in good working order

On completion of the Contract, all such plant, equipment and temporary works shall be removed from the site

- (vii) The Contractor shall provide a Quality Plan to show the stages at which Quality Control will be carried out. Further details are given in Section 13. The Quality Plan is subject to approval by the Engineer, who may require it to be revised if considered inadequate. The cost of revision shall be borne by the Contractor
- (viii) The Engineer will require a Program of Work so that Quality Surveillance inspection can be planned and executed at the appropriate time according to the Contractor's program

10.5 SURFACE PREPARATION OF MILD STEEL FOR PAINTING

10.5.1 Oil and Grease Contamination

Oil and grease shall be removed by a bio-degradable, water rinsable, emulsion solvent degreaser, followed by rinsing with clean potable water, after which the surface shall be allowed to dry

10.5.2 For Mild, Non-Corrosive Conditions

Manually or mechanically clean the surface to remove all loose millscale, rust and solid contaminants in accordance with SANS 10064, Section 4.4. The standard of cleaning shall be not less than St 2 of ISO Standard 8501:1

10.5.3 For Corrosive and Highly Corrosive (Underwater) Conditions

Mild steel shall be blast cleaned in accordance with Section 4.3 of SANS 10064 Code of Practice for "The Preparation of Steel Surfaces for Coating"

WARNING: Steel less than 2mm thick may distort if blasted incorrectly

Note: Compressed air used for blast cleaning shall be dry, clean and free from oil

An additional requirement is that water soluble salts present in the steel after blast cleaning shall not exceed the values given in Table 1. Should these values be exceeded, the steel shall be cleaned by washing with clean potable water or by water shrouded or water injected blast cleaning until the soluble salts are within the limits specified in Table 1.

The steel shall then be allowed to dry, after which it shall be dry flash blast cleaned to achieve the required degree of cleanliness

Immediately before painting, the steel surface shall comply with the appropriate requirements of Table 1

TABLE 1 - STANDARDS OF BLAST CLEANING REQUIRED

Property:	Above water	Immersed surfaces
Cleanliness -ISO 8501:1:	Sa 2½ min	Sa 3 min
Residual dust and debris -ISO 8502:3:	0.5%	0.3%
Oil, grease and perspiration:	Nil	Nil
Surface profile -ISO Method 8503:2 1992: Grit Comparator - Refer Table 2	Medium (G) 50 - 70µm	Course (G) 85 - 115µm
Water soluble iron salts Maximum at any point -Weber Rielly test:	500 mg/m ²	50 mg/m ²

The cleaned surface shall be coated as soon as possible and not later than the times given in Table 2

TABLE 2 - MAXIMUM TIME INTERVAL BETWEEN CLEANING AND COATING

Ambient relative humidity	Maximum time (hours)
Below 50%	6
50-70%	4
70-85%	2
Over 85%	Coating not permitted – Re-blast and coat when relative humidity is again below 85%

10.6 SURFACE PREPARATION OF CAST METALS FOR PAINTING

Surfaces of cast metals to be painted shall be blast cleaned with new iron slag, copper slag, or platinum slag abrasives designed for blast cleaning. THE ABRASIVE SHALL NOT BE RE-CYCLED OR RE-USED. Cast iron shall be blast cleaned until all sand particles, residual burnt on sand and casting skin have been completely removed.

When castings are required to be coated with organic materials, any blowholes exposed in blast cleaning shall be filled with engineering grade metal filled epoxy filler, finished flush with the surface, before coating. Polyester fillers are NOT PERMITTED

10.7 SURFACE PREPARATION OF GALVANIZED STEEL FOR PAINTING

Galvanized steel surfaces shall be thoroughly degreased prior to painting, using either a water rinsable solvent degreaser, or a mild acid-detergent degreasing solution, both used in accordance with the manufacturer's instructions. In both cases care shall be taken to avoid entrapment of cleaning agent in recesses or other retention areas. In both cases, the surface shall be thoroughly washed until a 'water break free' surface is achieved. If necessary, the process shall be repeated until a 'water break free' surface is obtained

After degreasing, the surface shall be lightly abraded by one of the following methods:

- (i) On small areas by the use of abrasive paper not coarser than 120 grade, or by using non-metallic abrasive pads
- (ii) On large areas by 'sweep blast cleaning', using a nozzle pressure not greater than 300kPa and ultra fine abrasive (particle size not exceeding 1,0mm). Cracking, flaking or any form of delamination of the zinc coating due to excessive blast cleaning shall not be permitted. Removal of zinc by blast cleaning shall not exceed 15 microns

Finally, all dust and debris shall be removed by vacuum cleaning, or by washing, and the surface shall be allowed to dry before coating. Coating shall take place within the time limits given in Table 2 of Clause 10.5

10.8 SURFACE PREPARATION OF ALUMINIUM FOR PAINTING

Generally, aluminium surfaces will be anodized or powder coated and will require no further treatment.

Where painting is required, the aluminium surface must be smooth, clean and free of corrosion product. If the surface is corroded (white/grey corrosion product very adherent to the surface) it must be cleaned using fine grade (200 - 400#) 'waterpaper' to expose bright metal. The surface shall then be thoroughly degreased using a water rinsable degreaser, then rinsed with clean potable water. If the surface is not water break free, repeat the degreasing process until a water break free surface is obtained. Allow to dry completely, then apply a thin coat (8 to 13 microns dry film thickness) of two-pack wash primer complying with SANS 723, mixed and applied in accordance with the manufacturer's instructions.

Note: Wash primer is an adhesion promoter and does not replace the primer specified in the paint system.

10.9 SURFACE PREPARATION OF STAINLESS STEEL FOR PAINTING

Components fabricated from stainless steel shall not be contaminated with iron or mild steel from contact with equipment which has already been used for mild steel fabrication. Sheared edges, welds or surfaces subjected to any form of heat treatment shall be pickled and passivated. Stainless steel surfaces shall not be scratched or stressed

When it is required to paint stainless steel, the surface shall be blast cleaned, when practical, with an approved non-metallic abrasive such as aluminium oxide or platinum slag. The use of steel shot, steel grit or cast iron grit is strictly prohibited

Where blasting is impractical, the surface shall be cleaned with and roughened manually to the use by 'Scotchbrite[®]' abrasive pads, followed by washing with clean potable water to a 'water break free' surface. If a 'water break free' surface is not obtained, detergent cleaning shall be repeated until the surface is 'water break free'. Allow the surface to dry before coating.

Note: It is not advisable to paint a highly polished stainless steel surface such as bright annealed finish without some sort of roughening.

10.10 SURFACE PREPARATION OF 3CR12 CORROSION RESISTANT STEEL

Black Mill Finish - Degrease and blast clean the whole surface using an approved abrasive if painting is required

No.1 Mill Finish - Pickle and passivate weld areas in accordance with Clause 8.3. Thoroughly degrease with a water rinsable detergent and allow to dry.

Cold Rolled - As for No.1 Mill Finish.

10.11 SURFACE PREPARATION OF PAINTED SURFACES

Fully Painted Surfaces to be repaired; - bare areas shall be cleaned with abrasive paper to bright metal surface. The surrounding paint, which must be intact, shall be feathered for a distance of 20mm beyond the damaged areas. Dust and debris shall be removed by the use of a clean rag dampened with water or clean solvent that will not attack the coating. Wetted areas shall be allowed to dry, after which spot repairs shall be carried out with all the coats previously applied and shall overlap the undamaged area by 20mm. However, for epoxies, etc. to be immersed, the abraded area must not be overlapped (Refer to Clause 20.1 – repair procedure). The requirements of the spot repair shall be not less than that specified for the undamaged coating

Fully painted Surfaces to be over-coated; - Where additional coats are required over the whole surface, the surface shall be degreased with a water rinsable detergent, rinsed with potable water and then abraded to a uniform matt finish.. The surface shall be washed to remove all contamination and then allowed to dry. Further coats shall then be applied as specified to give the required coating thickness and specified finish

Note: Abrasion is particularly important for pure epoxy, coal tar epoxy and polyurethane systems but is not necessary for vinyl systems or other recoatable finishes

Primed Surfaces; - Shop applied primers shall be thoroughly sanded with fine abrasive paper (220 - 320#) where necessary to achieve a uniform matt surface. The surface shall be scrubbed with a solution of suitable water based detergent-degreaser using a bristle brush, followed by potable water rinses to remove all grease and water soluble matter. The surface shall be allowed to dry completely before application of the specified coating system over the whole surface

10.12 SURFACE PREPARATION OF PLASTIC AND GRP SURFACES FOR PAINTING

Sand the surface thoroughly with 320-400# waterproof abrasive paper to achieve a uniform matt finish. Remove all debris, oil and grease by scrubbing with a solution of a suitable water based detergent. When the surface is well wetted, rinse off very thoroughly with clean potable water to remove all residues. Allow to dry completely before painting

11 APPLICATION OF PAINTS AND ORGANIC COATINGS

11.1 ENVIRONMENTAL CONDITIONS

Paint shall not be applied in high wind and/or dusty conditions that will cause dust to settle on the surface of the paint before it has dried, nor when the steel surface temperature is less than 3°C above dewpoint, nor higher than the maximum advised by the paint manufacturer, nor when humidity is greater than 85%*, nor when the ambient temperature is less than the minimum or greater than the maximum specified by the manufacturer of the coating material

11.2 MIXING

All coating materials shall be very thoroughly mixed until completely homogeneous preferably by power stirrer (care must be taken to not entrain air). With all paints the stirred paint should be left to diffuse for 5 minutes and then re-stirred.

In the case of two-pack materials, each component containing pigments shall be thoroughly mixed. The two components shall then be mixed together in the proportions supplied by the manufacturer until the mixture is completely homogeneous. In the case of solvent based epoxy materials, it is recommended that the mixed material be allowed to stand for an induction period of 20 to 30 minutes before use and then re-stirred prior to use.

For two-pack materials, the use of part of the contents (split packs) is strictly forbidden

The time and date must be noted at the time of mixing and at the time of applying the material so that:

- I. The usable potlife will not be exceeded and
- II. The maximum overcoating interval will not be exceeded.

Note: - There are services available to re-pack two component paints into small packs

11.3 METHOD OF APPLICATION

Application shall be by brush, roller, spray, airless spray or other suitable equipment as appropriate for the surfaces to be coated and in accordance with the recommendations of the manufacturer. Application equipment shall be maintained in clean condition and in good working order. The use of equipment not maintained in good clean condition may lead to rejection of the coating

11.4 OVER COATING

Over coating times shall be not less than the minimum nor greater than the maximum specified by the manufacturer, relevant to the ambient temperature. Where over coating times in the data sheet relates to 25°C, the contractors must acquaint themselves with the correct over coating times for lower and higher temperatures. Strict adherence to over coating times is particularly important for two pack coatings that are subsequently immersed. The Contractor will be held responsible for delamination or blistering of paint coatings on immersion.

11.5 MAINTENANCE OF CLEANLINESS

All surfaces to be coated shall be clean and free from dust, oil, moisture and perspiration before over-coating.

11.6 FILM THICKNESS

Whilst final assessment is determined by dry film thickness measurement, the use of wet film thickness gauges is recommended to ensure correct thickness during application. The wet film thickness required may be calculated by the formula $DFT = WFT / VS \times 100$, where VS = volume solids, corrected for added solvent where necessary. The manufacturer will supply the volume solids of the paint.

11.7 FILM THICKNESS TOLERANCE

- (i) Individual Coats - At least 90% of all thicknesses measured shall comply with the minimum requirements of the project specification. Up to 10% of all readings may be below the specified minimum thickness, but may not be less than 70% of the specified minimum thickness

- (ii) Total Dry Film Thickness - Not more than 10% of readings shall be less than the minimum specified and no reading shall be less than 90% of the specified minimum. The mean of 10 readings taken within any 1m² of the coated area shall not be less than the minimum DFT specified. No reading shall exceed the mean specified thickness by greater than 50%, unless a concession is granted by the Engineer
- (iii) Maximum Film Thickness - For solvent borne coatings to be immersed, the total DFT shall not exceed the mean specified thickness by greater than 50%, unless a concession is granted by the Engineer. For non-immersed coatings or for solvent free systems, the maximum film thickness measured may be greater than the maximum specified but any over thickness shall not be deleterious to the long-term performance of the coating and written support of this fact must be supplied by the paint manufacturer
- (iv) Multicoat applications – For solvent borne coatings to be immersed, further coats may applied only after the full curing period for the specified system has been achieved. This is a precaution to ensure that solvent retention does not occur.

Example: If a contractor has applied a system generally conforming with (i), (ii) & (iii) above but under-thickness areas are located at the time of inspection, additional coats may not be applied until the full curing time has been achieved.

12 HANDLING

12.1 DURING SURFACE PREPARATION AND COATING / PROTECTION OF NAME PLATES

All steel shall be supported not less than 100mm clear of the floor for coating prior to erection. The floor shall be clean concrete, brick or other non-dust producing material. Equipment name-plates and identification plates shall be protected from damage or obliteration. For service in corrosive environments, where complete protection of the substrate is required, the plates shall be removed prior to cleaning and shall be replaced after the complete coating is hard dry. For mildly corrosive conditions, name plates shall be protected by masking with suitable masking tape, which shall be removed and the name plate cleaned free of adhesive after completion of coating

12.2 AFTER COMPLETION OF COATING

Coated components shall not be handled earlier than the hard dry time recommended by the manufacturer, relevant to the ambient temperature. Coated components shall be handled with broad band fabric slings and shall be transported with suitable packing to minimise damage to the coating

All flanged pipes and components with projecting parts shall be stored and transported in such a manner that will prevent projecting parts such as flanges from contacting coated surfaces such as the body of the pipes

12.3 AFTER COMPLETION OF ERECTION OR INSTALLATION

All damage caused in handling, transportation and erection or installation shall be repaired in accordance with the requirements of the relevant system and to the satisfaction of the Engineer, at no extra cost

13 QUALITY ASSURANCE

13.1 CONTRACTOR QUALIFICATION

The Tenderer shall state on Form marked Appendix B in his tender the name of the painting sub-contractor that he proposes to use to carry out the painting or coating.

The Contractor shall ensure that all his sub-contractors have obtained a copy of this specification.

The Engineer may, at his discretion, require a Quality Audit of the painting sub-contractor to ensure that he has the management, facilities, skilled staff and quality control facilities and staff to carry out quality control during application of coatings to ensure compliance with specification

The contractor shall accept full responsibility for the quality of his work and of materials used, irrespective of any quality surveillance that may be carried out by the Engineer or his representative

The contractor shall obtain confirmation from the material supplier that materials to be used comply with the specification and are suitable for the intended purpose by having Form marked Appendix C completed by the material supplier

13.2 NOMINATED PERSON IN CHARGE OF QUALITY CONTROL

The painting sub-contractor shall appoint one member of staff to be in charge of all quality testing, recording and management. This person and all site records will be made available to the Engineer or his inspectorate at the time of inspections.

13.3 DATA SHEETS, SPECIFICATIONS AND CODES OF PRACTICE

The contractor shall have available the latest issues of each of the manufacturer's data sheets for the materials to be used, National Specifications and Codes of Practice relevant to the work to be carried out, as well as a copy of this Specification, all of which shall be available to the Contractor's Quality Control Manager

13.4 QUALITY CONTROL

The contractor shall have the necessary equipment and staff knowledgeable in test procedures to carry out all the quality control required to ensure compliance with the specification.

The contractor shall :

- (i) supply a Quality Plan and Quality Program at the time of tendering, both of which are subject to acceptance by the Engineer,
- (ii) maintain Quality Control records in accordance with the Quality Plan during execution of the contract. Such records shall be available to the Engineer or his representative at each Quality Surveillance visit,
- (iii) mark or securely label each component with a unique identification and
- (iv) carry out such tests as are required to ensure compliance with the specification

The cost of Quality Control shall be inclusive in the contractor's tender price

13.5 QUALITY SURVEILLANCE

13.5.1 Independent Surveillance

The Engineer may employ an independent, technically qualified organization to carry out quality surveillance of the work on his behalf. In the event of dispute, the Engineer's decision shall be final

13.5.2 Program

The contractor shall advise the Engineer timeously, in writing, when and where the following processes will be carried out

- (i) Completion of fettling or dressing prior to leaving the fabricator's works
- (ii) Blast cleaning and application of the first or primer coat
- (iii) After completion of all coats to be applied at the contractor's works
- (iv) At the commencement of repairs to be carried out on site

Failure of the contractor to advise the Engineer of his program may result in rejection of the work

13.5.3 Access for Surveillance

For the purpose of carrying out quality surveillance, the Engineer or his representative shall be granted access to any part of the contractor's premises relevant to the work being carried out, at any reasonable time. The contractor shall provide, at his own cost, any equipment or labour necessary to gain access to surfaces which are coated, to be coated or are in the process of being coated

13.5.4 Samples

The Engineer or his representative may remove any reasonable samples of materials to be used in the coating application. Rejection of the sample will place a hold on the use of material of the same batch number and may lead to rejection of all that batch of material and the reworking of any components that have already been coated with rejected material

13.5.5 Destructive Testing

The Engineer or his representative may carry out reasonable destructive tests to ascertain compliance with the specification. Areas thus damaged shall be repaired by the Contractor to the satisfaction of the Engineer at no additional cost

13.5.6 Cost of Quality Surveillance

Cost of Quality Surveillance will be borne by the Employer, except when surveillance results in rejection of the lot or when notice by the contractor results in a fruitless trip, in which cases the cost of surveillance shall be debited against the Contractor's account

13.5.7 Quality Surveillance Report

The inspector shall complete a report at each visit. A copy of the report will be given to the contractor on completion of each surveillance visit. A copy of the report approving the components shall be included with the delivery note. No payments will be authorised by the Engineer unless he has received a copy of an approval report. The Engineer may withhold payment until a final report has been issued, giving approval to the components after installation on site and repair of damage to the coating

13.5.8 Quality Control Records

The contractor shall maintain proper and adequate quality control records for all stages of the work. These records shall be available for inspection by the Engineer or his representative at the time of Quality Surveillance. Incomplete, inaccurate or inadequate records shall be regarded as non-compliance with the specification, and the cost of additional surveillance will be back charged to the contractor

13.5.9 Variation From Specification

No variation from specification, or change of sub-contractor or materials to be used from those stated in the tender documents, shall be permitted without written approval of the Engineer. Products equivalent to those specified may be submitted for approval. For the Engineer to assess the material, the manufacturer shall supply adequate technical data and case histories to support his claim to equivalence

13.5.10 Non-conformance and request for concession

The inspector may deem the corrosion protection acceptable or non-acceptable.

‘Non acceptable’ means that, in the view of the inspectorate, the work does not conform to specification. The inspector may reject the contractor’s work. Any non-conformance shall be immediately relayed to the Engineer.

If the contractor considers that the corrosion protection or non-conforming items will not be deleterious to the performance of the items in service the contractor may submit a concession request (form applicable on request to the Engineer) to the Engineer for consideration of the Engineer accepting the non-conforming quality.

14 TEST METHODS

Unless otherwise agreed in writing by the Engineer, the following test methods shall be used

14.1 Visual assessment of surface cleanliness: - ISO 8501-1:1988

14.2 Grading of surface profile - comparator procedure: - ISO 8503-2:1988

14.3 Assessment of dust on steel surfaces prepared for painting: - ISO 8502-3:1992

14.4 Field test for soluble iron corrosion products (soluble salts test used on ISO 8501-1 rust grades C or D):

I. ISO/TR 8502-1:1991

II. As the above method is not readily available the following proprietary test is acceptable: *Weber Rielly Soluble Salts Test* -as per the manufacturer's instructions.

14.5 Determination of chloride on cleaned surfaces.

I. Laboratory determination of chloride on cleaned surfaces: - ISO 8502-2:1992

(Note: The substances and procedures used in this method may be injurious to health if adequate precautions are not taken and these tests should be carried out by qualified personnel)

II. As the above method is not readily available the following proprietary test is acceptable: *Chlorid®* salt test

14.6 Measurement of wet film thickness:

I. ISO 2808:1991 - Method N°. 7a - Wheel gauge

II. ISO 2808:1991 - Method N°. 7b - Comb gauge

14.7 Measurement of dry film thickness:-

I. Magnetic metallic substances (iron, mild steel, ferritic stainless steel etc.): - ISO 2808:1991 - Method N^o. 6A(10.3.2) – Electro-magnetic instrument

II Non-magnetic metallic substances (aluminium, copper, austenitic stainless steel etc.): - ISO 2808:1991 - Method N^o. 6B (10.4.2.1) – Eddy current instrument

Note: - Instruments are to be calibrated and used according to the manufacturer's instructions. Instruments are to be re- calibrated at least every 6 months or when abnormalities are evident over a range of 500µm measurements on calibrated standard shims

III Non- metallic substances (concrete, timber, plastic etc.): - ISO 2808:1991 - Method N^o. 4

Note: -This is a destructive method and damage will be required to be repaired.

COATING SYSTEMS

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15 CATEGORIES

- A - ALKYD SYSTEMS for use in environments of low corrosivity. These oil based paints - (gloss enamels, eggshell enamels, polyurethane alkyds, alkyd undercoats and primers etc.) are easy to use, economical and have good weathering characteristics. They must not be applied directly to alkaline surfaces (cement and concrete) or to galvanized surfaces. They dry by solvent evaporation and then cure by reaction with atmospheric oxygen. They therefore do not re-dissolve in their original solvent and require abrasion prior to over-coating.
- B - TWO PACK SOLVENT BORNE CHEMICALLY CURED SYSTEMS, EPOXY, EPOXY PHENOLIC AND POLYURETHANE, for use under water and in corrosive environments. These systems have long maintenance free life when correctly applied. The pure systems for use underwater require strict control of over-coating times and preparation procedures.- Modified systems used above water are re-coatable and have improved resistance to chalking
- C - TWO PACK COAL TAR EPOXY. These systems have excellent resistance to water and mild acids but chalk severely on exposure to sunlight and are very difficult to re-coat. For use underwater they require strict control of over-coating times and preparation procedures.
- D - ONE PACK VINYL RESIN BASED SYSTEMS for use in corrosive environments, excluding immersion. These systems have good resistance to inorganic chemicals but are softened by fats and other organic materials (e.g. solvents). Due to their permanent solubility, they are easily re-coated with similar material for maintenance purposes. This characteristic causes the entire film to soften back on over-coating and hard dry times are extended when additional coats are applied.
- E - TWO PACK SOLVENT FREE CHEMICALLY CURED SYSTEMS, EPOXY, EPOXY PHENOLICS AND POLYURETHANE, for use primarily in immersion and abrasive conditions. Special equipment is required for the application of these materials and considerable experience is necessary for their correct application. Due to the absence of solvent, thick films can be applied, hence enabling good protection to be obtained in short time schedules. These systems have long maintenance free life when correctly applied but are difficult to re-coat in the maintenance situation

- F - **POWDER COATING.** These are free flowing powders applied by fluidised bed or electrostatic spray, then melted and cured by heat. They are therefore only suitable for application to metallic surfaces under factory conditions. Low build powder coatings for exterior use and application to galvanizing require a primer (Zinc-rich epoxy powder coating primers are now available as an alternative to galvanizing). For pipes, pumps and valves, only the high film thickness coatings are specified (FBE powder coatings). Application of powder may only be carried out by specialist contractors with the necessary heating and curing facilities and the required experience. No further cure time is required after completion of the full cure cycle; hence components can be handled immediately on completion. Care must be taken that the full cure cycle is completed to ensure that the powder coating develops its full properties. This is not easily discernable and requires special laboratory testing
- G - **TAPE WRAPPING SYSTEMS** Tape wrapping is a method of corrosion protection which utilises preformed strips of adhesive plastic, in the form of rolls, to wind around the item to be protected, with a suitable overlap, in order to 'blot out' the corrosive environment. It is used primarily for underground pipes and their ancillaries such as couplings, valves, etc. The method is used primarily on site although for certain types, wrapping can be carried out on individual pipes at a factory or site yard. There are many types of tape but for the purposes of this specification, only two types are given, namely petrolatum tape and rubber modified bitumen with polyethylene outer coating

16 CATEGORY A - ALKYD SYSTEMS

Preamble: Alkyd Systems are intended for use in environments of low corrosivity, where a good decorative finish is required. Materials shall therefore be applied with due cognisance of appearance and protection.

16.1 SYSTEM A1 ALKYD ON TO BARE METAL SURFACES

- (i) The surface to be coated shall be prepared by degreasing and manual or mechanical cleaning as specified in Clause 10.5.2
- (ii) Apply one coat of *alkyd metal primer* to a film thickness of not less than 40 microns. Allow to dry for a minimum of 8 hours
- (iii) Apply one coat *alkyd based enamel*, in the colour specified by the Engineer, to give a dry film thickness of not less than 25 or greater than 35 microns. Allow to dry for a minimum of 16 hours
- (iv) On exterior surfaces, apply a second coat of *alkyd enamel*, within 48 hours, to give a further dry film thickness of not less than 25 or greater than 35 microns in the final colour specified by the Engineer. Allow to dry for a minimum of 16 hours

Requirements

The finished system shall be smooth, glossy, free from excessive runs, sags, blisters, wrinkling, dirt, occlusions or other visual defects and shall be a commercial match to the colour specified by the Engineer. Runs, sags, curtaining, shrivelling, wrinkling or other visible defects will not be permitted

The dry film thickness of the finished system shall not be less than the following:

- Exterior surfaces - 80 microns
- Interior surfaces - 65 microns

16.2 SYSTEM A2 ALKYD ON SURFACES ALREADY CLEANED AND PRIMED

- (i) Clean and prepare the surface by degreasing, sanding and removal of dust as specified in Clause 10.11
- (ii) Touch up bare areas with a alkyd metal primer
- (iii) Apply one coat all over of alkyd metal primer
- (iv) Continue the system as given in System A1 (iii) to (v) inclusive

16.3 SYSTEM A3 ALKYD ON FACTORY FINISHED COMPONENTS

The contractor shall ensure that the system to be applied is compatible with the existing coating

- (i) Prepare the surface by degreasing, abrading and removal of dust as specified in Clause 10.5.1 or 10.11, as appropriate
- (ii) On interior surfaces apply one coat of alkyd enamel, in the colour specified by the Engineer, to give an applied dry film thickness of not less than 25 microns. Total dry film thickness to be not less than 65 microns
- (iii) On exterior surfaces, apply two coats alkyd enamel, with overnight drying between coats, to give an applied dry film thickness of not less than 50 microns. Total dry film thickness of the system shall not be less than 80 microns
- (iv) In both cases a further coat of enamel shall be applied after installation, to the final colour selected by the Engineer

16.4 SYSTEM A4 ALKYD ON GALVANIZED SURFACES ABOVE WATER

- (i) Prepare the surface by degreasing, abrading and removal of dust as specified in Clause 10.7
- (ii) Apply one coat of the paint manufacturer's recommended primer for galvanized surfaces Water based styrene acrylic emulsion primer, water based two pack epoxy, etch primer, epoxy holding primer can be used (The use of Calcium Plumbate Primer is excluded from these Specifications). Allow to dry for the over coating time recommended by the manufacturer.

NOTE: The purpose of the primer is to provide adhesion onto the substrate for the topcoat and to insulate the alkyd topcoat from direct contact with the galvanized surface to prevent saponification from occurring

- (ii) Continue the system as given in A1 (iv) (two enamel coats). The total dry film thickness shall be a minimum of 75 microns over the galvanizing

16.5 SYSTEM A5 ALKYD ON PLASTIC AND BITUMEN COATED SURFACES

- (i) Prepare the surface by degreasing, abrading and removal of dust as specified in Clause 10.12.
- (ii) Apply one coat of a water borne coating e.g. water based styrene acrylic emulsion primer, water based two pack epoxy or as recommended by the manufacturer. Allow to dry for a minimum of 16 hours at 25°C

NOTE: The good adhesion to substrate must be verified before continuing

- (iii) Apply one coat of alkyd enamel in the colour required by the Engineer

16.6 SITE REPAIR OF ALKYD SYSTEMS

Any site repair required by the Engineer shall be carried out in accordance with surface preparation method given in Clause 10.11, followed by all the coats required to restore the damaged area to the original system requirements. Since patch application of the final coat rarely gives an acceptable uniform finish, the whole area in which damage has occurred shall be cleaned, abraded with fine wet or dry abrasive paper (not coarser than 220 grit) and given one coat of enamel all over, unless otherwise accepted by the Engineer

17 CATEGORY B - TWO PACK, SOLVENT BORNE, EPOXY, EPOXY PHENOLIC AND POLYURETHANE SYSTEMS

Preamble: Two-component solvent borne chemically cured systems are the most commonly used coating system for corrosion protection of steel. EPOXIES are fast curing and adhere extremely well to clean surfaces. They are tough, durable, and water resistant but chalk badly on exposure to sunlight. The EPOXY PHENOLIC coatings are resistant to inorganic acids and many other chemicals. They have short overcoating times and discolour and chalk on exterior exposure. POLYURETHANES (aliphatic isocyanate cured) have excellent gloss and colour retention and are used as topcoats. All are supplied in two parts, which must be mixed together before use to allow the chemical reaction to take place

These materials can retain solvent if the material is applied too thickly in one application, if the time between coats is too short or if there is inadequate ventilation or low temperatures during curing. This solvent retention causes osmotic blistering on immersion

The applicator may not exceed the maximum film thickness per coat, or the maximum over coating time specified by the manufacturer. Since over coating are frequently quoted at 20° or 25°C, longer over coating times shall be allowed at lower temperatures. As a rough guide, increase time by 50% for a 5°C decrease or by 100% for a 10°C decrease in ambient temperature below the quoted temperature

Epoxy and epoxy phenolic materials shall not be applied when the ambient temperature is below 10°C

Solvent based epoxy materials shall be allowed 28 days to cure before immersion, or as recommended by the manufacturer. At temperatures below 20°C, longer periods shall be allowed, as for over coating times

Two pack solvent borne aliphatic polyurethane materials are similar in application and over coating properties to solvent based epoxies, but they have much improved gloss and colour retention. The curing agents are based on aliphatic isocyanates. The latter and their mixtures must not be mixed with water or with any solvent (especially epoxy solvents) other than that recommended by the supplier. The aliphatic polyurethanes are somewhat slower curing than epoxy enamels at 25°C but will cure at lower temperatures. They have outstanding weathering properties, and good dilute acid resistance. They are not recommended for immersion service.

Epoxy/polyurethane systems utilize primers for non-immersion corrosion protection use. These primers may contain a corrosion inhibitive or sacrificial pigment. Zinc metal powder is included in epoxy zinc rich primers and inorganic zinc primers to protect the mild steel substrate. MIO or Micaceous Iron Oxide is a flaky, lamellar pigment which provides a multi-layer tile like protection within the paint coating, thereby greatly increasing the waterproof properties of the system. The aluminium pigmented epoxy mastics utilise epoxy/amine components and modifiers which render the products tolerant to wire brushed surfaces. They are used where abrasive blasting is not possible or practical.

17.1 SYSTEM B1 PURE EPOXY COATINGS FOR IMMERSION SERVICE ON BARE STEEL AND CAST IRON SURFACES

Material to be used shall be a *two-component, high solids, solvent-based, epoxy coating* suitable for permanent immersion in water

- (i) Prepare surfaces as specified in Clause 10.5.1 or 10.5.2 as appropriate, to achieve a blast cleaned surface of cleanliness Sa3, a profile of 50-100 microns, dust quantity rating of no greater than 2 (Figure 1 - ISO 8502-3:1992) and soluble salts not more than 100mg/m² (Weber Rielly Test)
- (ii) Mix base and curing agent individually until homogeneous, then mix together in the proportions supplied or specified by the manufacturer and again mix until homogeneous. SPLIT PACKS, i.e. the use of part containers is not permitted.
- (iii) Apply two or three coats of the mixed material as required to give a total dry film thickness of not less than 300 microns nor greater than 450 microns

The coating shall be applied at the correct spraying viscosity and by the equipment recommended by the manufacturer to minimise the porosity of the applied film

Each coat shall differ in colour from the preceding coat

Each coat shall be applied to a thickness not less than the minimum nor greater than the maximum recommended by the manufacturer

The time interval between coats shall be not less than the minimum nor greater than the maximum recommended by the manufacturer for the prevailing ambient temperature. Should the overcoat time be exceeded, the surface shall be prepared as specified under REPAIR before over-coating

Requirements

The coating system shall be smooth, glossy, free from excess orange peel effect, bubbling, excessive runs and sags or other visible defects

The dry film thickness shall be minimum 300, maximum 450 microns

The coating shall be free from electrical insulation defects when tested with an approved wet sponge detector set to operate at 90 Volts, 2 Megohms. Repair of defects is permissible by the procedure given in 10.11, provided that the repaired area complies with all the requirements given above

The film examined in cross section shall not exceed the porosity of scale 2 as given in the Canadian Standards Association CAN/CSA-Z245.20-M86 Section 12.11

17.2 SYSTEM B1A RECOATABLE SYSTEM FOR ABOVE WATER USE IN CORROSIVE ENVIRONMENTS

Material used shall be a *high build two component epoxy coating*, followed by one or two coats of *recoatible, two component, aliphatic isocyanate cured polyurethane*

Surface preparation

As for System B1 except that surface preparation to Sa 2 ½ will be acceptable. All other requirements of System B1 shall be applicable, except that testing for electrical insulation defects is not required except when specifically called for by the Engineer.

Requirements

The coating system shall be smooth, glossy, free from excess orange peel effect, bubbling, excessive runs and sags or other visible defects

The dry film thickness shall be minimum 300, maximum 450 microns

17.3 SYSTEM B2A RECOATABLE SYSTEM FOR USE ABOVE WATER IN CORROSIVE ENVIRONMENTS ON GALVANISED SURFACES

Material used shall be a *two pack epoxy primer specifically designed for application to galvanized steel*, followed by one or two coats of *recoatible, two component, aliphatic isocyanate cured polyurethane*

- (i) Prepare the surface as specified in Clause 10.7, by degreasing and light abrading, or sweep blasting
- (ii) Apply an *epoxy primer* specifically designed by the manufacturer for use on galvanized steel to a dry film thickness of 40 to 80 microns
- (iii) Apply one coat of the a *recoatible two-pack polyurethane finish coat* to a dry film thickness minimum 40, maximum 60 microns

Requirements

The coating system shall be smooth, glossy, free from orange peel effect, bubbling, excessive runs and sags or other visible defects

The dry film thickness shall be minimum 80, maximum 140 microns over galvanizing. Electrical insulation testing is not required

17.4 SYSTEM B3 EPOXY PRIMER/ EPOXY MIO PRIMER/RECOATABLE POLYURETHANE –HIGH BUILD SYSTEM FOR EXTERIOR USE IN CORROSIVE ENVIRONMENTS

Material used shall be a *high build anti-corrosive epoxy primer*, followed by a coat of high build MIO containing epoxy intermediate coat, followed by a *recoatable two component aliphatic isocyanate cured polyurethane*.

- (i) Prepare surfaces as specified in Clause 10.5.1 or 10.5.3 as appropriate, to achieve a blast cleaned surface of cleanliness Sa2 ½ , a profile grade of medium (50 -70µm) as per ISO 8503-3, dust quantity rating of no greater than 2 (Figure 1 - ISO 8502-3:1992) and soluble salts not more than 100 mg/m² (Weber Rielly Test)
- (ii) Mix each base and curing agent individually until homogeneous, then mix together in the proportions supplied or specified by the manufacturer and again mix until homogeneous. SPLIT PACKS, i.e. the use of part containers is not permitted unless Engineer approved suitably accurate measuring equipment is available.
- (iv) Apply one coat of the *two component, high build epoxy primer* to give a minimum dry film thickness of 115µm, as per the manufacturer's instructions.
- (v) Apply one coat of the *two component, high build epoxy MIO intermediate coat* to give a minimum dry film thickness of 100µm, as per the manufacturer's instructions.
- (iv) After the prescribed interval for the environmental conditions, apply a single coat of two component, high gloss, high solids *recoatable two component aliphatic isocyanate cured polyurethane* to give a minimum dry film thickness of 40µm and a maximum dry film thickness of 60µm as per the manufacturer's instructions.

Requirements

The coating system shall be smooth, glossy, free from excess orange peel effect, bubbling, excessive runs and sags or other visible defects.

The dry film thickness shall be minimum 255, maximum 400 microns.

17.5 SYSTEM B4 - ZINC RICH PRIMER, EPOXY MIO PRIMER / RECOATABLE POLYURETHANE –HIGH BUILD SYSTEM FOR EXTERIOR USE IN NON ACIDIC ENVIRONMENTS

Material used shall be a *zinc rich epoxy primer containing a minimum 92% zinc metal (mass %), or alternatively an inorganic zinc primer containing a minimum 85% zinc metal (mass %)*, followed by a coat of *high build MIO containing epoxy intermediate coat*, followed by a *recoatable two component aliphatic isocyanate cured polyurethane*.

- (i) Prepare surfaces as specified in Clause 10.5.1 or 10.5.3 as appropriate, to achieve a blast cleaned surface of cleanliness Sa2 ½ , a profile grade of medium (50 -70µm) as per ISO 8503-3, dust quantity rating of no greater than 2 (Figure 1 - ISO 8502-3:1992) and soluble salts not more than 100 mg/m² (Weber Rielly Test)²
- (ii) Mix each base and curing agent individually until homogeneous, then mix together in the proportions supplied or specified by the manufacturer and again mix until homogeneous. SPLIT PACKS, i.e. the use of part containers is not permitted unless Engineer approved suitably accurate measuring equipment is available
- (vi) Apply one coat of the *two component, rich epoxy primer* to give a minimum dry film thickness of 50µm, as per the manufacturer's instructions.
- (vii) Alternatively, apply one coat of the *two component, inorganic zinc primer* to give a minimum dry film thickness of 50µm, as per the manufacturer's instructions.
- (viii) Apply one coat of the *two component, high build epoxy MIO intermediate coat* to give a minimum dry film thickness of 100µm, as per the manufacturer's instructions
- (iv) After the prescribed interval for the environmental conditions, apply a single coat of two component, high gloss, high solids *recoatable two component aliphatic isocyanate cured polyurethane* to give a minimum dry film thickness of 40µm and a maximum dry film thickness of 60µm as per the manufacturer's instructions.

Requirements

The coating system shall be smooth, glossy, free from excess orange peel effect, bubbling, excessive runs and sags or other visible defects

The dry film thickness shall be minimum 190, maximum 300 microns

17.6 SYSTEM B5 PHENOLIC MODIFIED EPOXY SYSTEM FOR STEELWORK AND EQUIPMENT IN CHEMICAL ENVIRONMENTS

Material used shall be a *solvent based epoxy-phenolic chemical resistant primer*, followed by a coat of *solvent based epoxy-phenolic chemical resistant intermediate coat*, followed by a *solvent based epoxy-phenolic chemical resistant topcoat*.

- (i) Prepare surfaces as specified in Clause 10.5.1 or 10.5.3 as appropriate, to achieve a blast cleaned surface of cleanliness Sa2 ½, a profile grade of medium (50 -70µm) as per ISO 8503-3, dust quantity rating of no greater than 2 (Figure 1 - ISO 8502-3:1992) and soluble salts not more than 100 mg/m² (Weber Rielly Test)
- (ii) Mix each base and curing agent individually until homogeneous, then mix together in the proportions supplied or specified by the manufacturer and again mix until homogeneous. SPLIT PACKS, i.e. the use of part containers is not permitted unless Engineer approved suitably accurate measuring equipment is available
- (ix) After the prescribed interval for the environmental conditions, apply one coat of the *solvent based epoxy-phenolic chemical resistant primer* to give a minimum dry film thickness of 100µm, as per the manufacturer's instructions.
- (x) Apply one coat of the *solvent based epoxy-phenolic chemical resistant intermediate coat* to give a minimum dry film thickness of 100µm, as per the manufacturer's instructions
- (iv) After the prescribed interval for the environmental conditions, apply a single coat of two component, high gloss, *solvent based epoxy-phenolic chemical resistant topcoat* to give a minimum dry film thickness of 100µm and a maximum dry film thickness of 60µm as per the manufacturer's instructions.

Requirements

The coating system shall be smooth, glossy, free from excess orange peel effect, bubbling, excessive runs and sags or other visible defects

The dry film thickness shall be minimum 300, maximum 400 microns

The coating shall be free from electrical insulation defects when tested with an approved wet sponge detector set to operate at 90 Volts, 2 Megohms. Repair of defects is permissible by the procedure given in 10.11, provided that the repaired area complies with all the requirements given above

17.7 SYSTEM B6 – ALUMINIUM PIGMENTED EPOXY MASTIC / RE-COATABLE POLYURETHANE FOR UPGRADING OF COATINGS ON ELECTRICAL EQUIPMENT, GEARBOXES, PUMPS, VALVES AND OTHER PROPRIETARY EQUIPMENT

Material used shall be *aluminium pigmented epoxy mastic*, followed by a *recoatable two component aliphatic isocyanate cured polyurethane*.

- (i) Prepare the surface by degreasing, abrading and removal of dust as specified in Clause 10.5.1 or 10.11, as appropriate
- (ii) Mix each base and curing agent individually until homogeneous, then mix together in the proportions supplied or specified by the manufacturer and again mix until homogeneous. SPLIT PACKS, i.e. the use of part containers is not permitted unless Engineer approved suitably accurate measuring equipment is available
- (xi) Apply one coat of the *aluminium pigmented epoxy mastic* to give a minimum dry film thickness of 125µm, as per the manufacturer's instructions.
- (iv) After the prescribed interval for the environmental conditions, apply a single coat of two component, high gloss, high solids *recoatable two component aliphatic isocyanate cured polyurethane* to give a minimum dry film thickness of 40µm and a maximum dry film thickness of 60µm as per the manufacturer's instructions.

Requirements

The coating system shall be smooth, glossy, free from excess orange peel effect, bubbling, excessive runs and sags or other visible defects

The dry film thickness shall be minimum 165, maximum 200 microns

17.8 REPAIR OF PURE EPOXY AND POLYURETHANE SYSTEMS

Unmodified epoxy or polyurethane coatings are difficult to repair when fully cured. Careful attention to the following repair procedure is required to ensure adequate adhesion of the material used for repair:

Prepare the surface by abrading to a uniform matt finish, followed by wiping the surface with methyl ethyl ketone (MEK) solvent, to give a contact time of 30 seconds. Allow to dry, then wipe off any residual dust with a clean rag. Apply as many coats of repair material as are necessary to achieve the specified film thickness. When using solvent borne materials, note the need for adequate time between coats as specified under System B1. Solvent borne coatings can be repaired using solvent free epoxy repair kits which are pre-measured and easy to use.

17.9 REPAIR OF RECOATABLE EPOXIES AND POLYURETHANES

These do not require abrading and solvent wiping but the surface must be cleaned as per Clause 10.5.1 before overcoating.

18 CATEGORY C - COAL TAR EPOXY BASED SYSTEMS

Preamble: Coal tar epoxy and urethanes are modified with selected grades of coal tar (imported source only) to reduce the costs and enhance certain properties such as waterproofing and chemical resistance characteristics. Some of the coal tar components react with the curing agent but some act as a diluent which imparts thermoplastic (softens with heat) properties to the coating

THE COAL TAR EPOXIES RECOMMENDED ARE SOLVENT BASED. They can therefore retain solvent if the materials are sprayed too thickly. The precautions given in Section 11.2 must be applied to these coatings. Due to their tendency to bloom within 24 hours, the surface preparation and over coating are all the more critical

As the coal tar is permanently soluble, 'bleeding' occurs when over coated with solvent based paints.

Coal tar epoxies have good water and dilute acid resistance and are very suitable for items such as rake arms in clarifiers. Coal tar repels root growth; hence these coatings are suitable for exterior buried pipe protection.

18.1 SYSTEM C1 SOLVENT BASED COAL TAR EPOXY ON METAL SURFACES

Material used shall be a *high build two component solvent based coal tar epoxy* composition using only selected imported coal tar.

The system

- (i) Prepare surfaces as specified in Clause 10.5.1 or 10.5.2 as appropriate
- (ii) Apply three to four coats of the *coal tar epoxy* material, mixed as recommended by the manufacturer and within his specified over coating times, as required to give a total dry film thickness not less than 300 microns. Should the overcoat time be exceeded, the surface shall be prepared as specified in Clause 10.11 before overcoating. Each coat shall be applied to a thickness not less than the minimum nor greater than the maximum recommended by the manufacturer

Requirements

The coating system shall be smooth, semi-glossy, free from orange peel effect, bubbling or excessive runs and sags or other visible defects

The dry film thickness shall be minimum 300, maximum 600 microns

The intercoat adhesion between layers shall be proven by a suitable adhesion test (ISO 2409)

The coating shall be free from electrical insulation defects when tested with an approved wet sponge detector set to operate at 90 Volts, 2 Megohms. Repair of defects is permissible provided that the repaired area complies with all the requirements given above

The film examined in cross section shall not exceed the porosity of scale 2 as given in the Canadian Standards Association CAN/CSA-Z245.20-M86 Section 12.11

19 CATEGORY D - VINYL BASED SYSTEMS

Vinyl resin based paints (the medium shall not contain alkyd resin or other saponifiable matter) are solvent based, single component materials with excellent resistance to water, dilute acids and hypochlorites. Their resistance to heat is poor and must never be used on surfaces continually operating at 70°C or higher. They are not resistant to solvents and should not be used where there may be contact with oils, fats, kerosene, petrol etc

The main advantage of vinyls is their easy maintainability. Vinyls may be recoated after any period of time, provided that the surface is cleaned, and is free from chalking, dust, grease and general grime. Because they are soluble in their own solvents, the under layers are quickly softened by over coating. Experienced operators using special techniques must be employed when brushing

Vinyls are therefore recommended for interior and exterior use where they are subject to chemical fumes, as in chlorination rooms. For exterior use the topcoat may be modified with acrylic resin for improved colour retention. Such modified types usually have a semi gloss finish rather than full gloss

19.1 SYSTEM D1 VINYL ON BARE STEEL OR CAST IRON SURFACES

Material shall be solvent containing, based on *polymerised vinyl chloride / vinyl acetate copolymer* or *vinyl chloride / iso-butyl ether resins*. The material shall not contain alkyd resin or other saponifiable matter. For exterior use, the final coat may be modified with acrylic resin to give improved gloss and colour retention

The system

- (i) Prepare surfaces by blast cleaning as specified in Clause 10.5 to achieve a surface not less clean than Sa 2 ½ and a profile of 25 to 50 microns (fine)
- (ii) Apply one coat of the manufacturer's recommended primer for vinyl systems to a dry film thickness not less than 40 and not greater than 80 microns. Allow 16 hours to dry, or longer in humid conditions
- (iii) Apply one coat of *high build vinyl intermediate coat* to a dry film thickness of not less than 60 or greater than 80 microns
- (iv) Apply one or two coats of *vinyl enamel* to a dry film thickness of not less than 25 or greater than 35 microns per coat
- (v) On completion of installation and all repairs on site, apply one additional coat of vinyl enamel

Requirements

The coating system shall be smooth, uniform, glossy or semi-glossy, free from excessive runs, sags, blisters, wrinkling or other visual defects. The total dry film thickness shall be not less than 125 nor greater than 195 microns

19.2 SYSTEM D2 VINYL ON PAINTED OR PLASTIC ITEMS IN CHLORINATION ROOMS

Material used as a primer/barrier coat shall be a *water based epoxy (two pack)* or *styrenated acrylic primer (single pack)*. Being water based, the drying time is extended in humid conditions. Care shall be taken to avoid excessive film thickness and to allow adequate drying time before overcoating. Full drying and coalescence throughout the thickness of the film is essential. Do not apply at temperatures below 5°C or where such temperatures are likely to be encountered before full cure. Do not apply to wet surfaces

The system

- (i) Prepare surface by abrasion and removal of oil, grease and dust as specified in Clause 10.11 or 10.12, as appropriate
- (ii) Apply one coat *water based primer* to give a dry film thickness not less than 25 and not greater than 50 microns
Allow a minimum of 16 hours to cure before overcoating. Since this material is water based, drying time will be extended under humid conditions
- (iii) Apply one coat *vinyl intermediate coat* to a dry film thickness of not less than 60 or greater than 80 microns
- (iv) On completion of installation and all repairs on site, apply one or two final coats of vinyl enamel to a dry film thickness of not less than 25 or greater than 35 microns per coat in the colour selected by the Engineer, complying with the requirements stated in Section 19 above.

Requirements

The total dry film thickness shall be not less than 110 or greater than 165 microns

When required for protection on pre-primed or painted components such as valves, the full system as above shall be applied, when the total coating thickness shall be not less than 100 microns.

(When required on plastic items such as pipes, for identification purposes only, the above system may be used but it is simpler to use an appropriate coloured self adhesive vinyl or polyurethane tape, as specified by the Engineer. In this case the tape shall be applied uniformly to the surface, with uniform width of overlaps.

19.3 SYSTEM D3 VINYL ON GALVANIZED STEEL

Material used as primer shall be a *solvent based two pack epoxy* based primer specifically designed for use on galvanized steel

The system

- (i) Prepare surface as specified in Clause 10.5.3
- (ii) Apply a *solvent based two pack epoxy primer* specifically designed for galvanised steel to the clean surface at a thickness within the range specified by the paint manufacturer. Correct overcoating time for the prevailing ambient conditions is important
- (iii) Apply one coat *vinyl high build intermediate coat* at a dry film thickness not less than 60 or greater than 80 microns. Allow not less than 16 hours before overcoating
- (iv) Apply one coat *vinyl enamel* at a dry film thickness not less than 25 or greater than 35 microns

Requirements

The finished system shall be smooth, glossy or semi- glossy, free from excessive runs, sags, blisters, wrinkling or other visual defects

The total dry film thickness over the galvanizing shall be not less than 125 or greater than 195 microns

19.4 REPAIR OF VINYL SYSTEMS

Since there is no chemical cure of vinyl systems, abrasion of exposed steel only is required for repair. Wash the old coating with detergent and water (do not use emulsion degreasers). Rinse with clean water. Abrasion and solvent wiping of the coating are unnecessary and shall not be carried out. Abrade any exposed metal and feather the edges. Remove all debris by brushing with a clean dry brush

Apply the specified primer to bare steel, followed by the number of coats to restore the damaged area to meet the requirements of the appropriate specification.

NOTE: the topcoat shall not be applied directly to the steel without the use of the primer!

20 CATEGORY E SOLVENT FREE EPOXY, EPOXY PHENOLIC AND POLYURETHANE SYSTEMS

These materials consist of two components, base and activator which must be mixed prior to application in the correct proportions as supplied by the manufacturer.

The rate of cure can be designed to be slow for hand application or fast for machine application, taking into consideration the ambient temperature. The faster the cure, the shorter the touch dry time but the potlife of the mixed material will also be shorter.

The slower the cure, the longer the touch dry time but the potlife of the mixed material will be longer. The potlife is designed for the mass of the material to be mixed at one time and the method of application.

The slower curing epoxies can be premixed and sprayed through airless spray equipment. The faster curing epoxies and polyurethanes can only be applied through specialized dual component equipment, by contractors with the necessary know-how.

Solvent free materials may be applied in thick coats, hence only one or two applications are necessary to achieve the specified coating thickness. The dangers of solvent entrapment described in Clause 11.2 are therefore eliminated.

An important difference between epoxies and polyurethanes is that the latter can cure at sub-zero temperatures whereas epoxies require temperatures above 0°C.

Both types can be formulated to produce varying degrees of hardness, flexibility and chemical resistance. Epoxies generally have excellent adhesion due to their highly polar nature. The bisphenol F/novolac phenolic epoxies cured with modified amines are available in solvent free form and provide outstanding resistance to many aggressive chemicals, including concentrated inorganic acids

Solvent free polyurethanes may be divided into two main classes although there may be wide variations depending on the particular formulation used. The two main classes are:

Elastomeric types, similar to rubber; these have very high flexibility and outstanding resistance to abrasion, but rather poor water resistance. When used on steel, the manufacturer's recommended primer must first be used. These are applied by casting, or, in the case of pipe lining, by spin casting

Semi rigid types, whose flexibility is much greater than epoxies but much less than the elastomeric polyurethanes,. However, their water resistance and chemical resistance is superior to the elastomeric types, hence they are used where corrosion protection is the primary consideration.

Specialized primers are recommended for polyurethane coatings applied to steel and mineral substrates.

Because solvent free materials require specialist application, only contractors with sophisticated equipment, facilities, quality control and experience, will be considered

20.1 SYSTEM E.1 SOLVENT FREE EPOXY

Material shall be based on *liquid epoxy resins* and shall comply with the requirements of SANS 1217 Type 1C. When used for potable water it shall also be non-toxic and non-tainting (See Clause 3.3 of SANS 1217). When required, the contractor shall obtain and submit to the Engineer acceptable certification of non- toxicity and non-tainting properties

The system

- (i) Prepare surfaces as specified in Clause 10.5.1 or 10.5.3 as appropriate, to achieve a blast cleaned surface of cleanliness Sa3, a profile of 50-100 microns, dust quantity rating of no greater than 2 (Figure 1 - ISO 8502-3:1992) and soluble salts not more than 100mg/m² (Weber Rielly Test)
- (ii) Apply one or two coats of *solvent free epoxy*, using appropriate equipment as described in Clause 27.5, as per the coating manufacturers prescribed method.

Requirements

The finished coating shall be smooth, uniform, glossy, free from orange peel effect, excessive runs and sags, blisters or other visual defects

The dry film thickness shall be not less than 300 or greater than 500 microns

The coating shall be free from electrical insulation defects when tested with a wet sponge detector, operated in accordance with Clause 8.12.1 of SANS 1217, using a potential of 90 volts and a sensitivity of 10 Megohms

The film examined in cross section shall not exceed the porosity of scale 2 as given in the Canadian Standards Association CAN/CSA-Z245.20-M86 Section 12.11

Repair procedure

The general procedure given in Clause 10.11 shall be followed, using a repair material recommended or supplied by the manufacturer of the solvent free epoxy material. The guidelines of the manufacturer's data sheet must be exactly followed. It is important that, for surfaces to be immersed, that the abraded, prepared area is not overlapped beyond the abraded area viz. a 'ring' of abraded coating must surround the repair.

20.2 SYSTEM E.3 SEMI-RIGID POLYURETHANE FOR UNDERWATER & MILDLY ABRASIVE CONDITIONS

Materials

The primer shall be suitable for steel and for the polyurethane material and be supplied by the manufacturer of the coating material. The coating material shall be a *solvent free, two component, semi-rigid polyurethane* based on polyether type polyol and aromatic isocyanate to reach the following requirements:

Tensile strength at 3mm thickness	(ASTM D 638)	> 15 MPa
Adhesion to correctly primed steel	(SABS Method 776)	> 10 MPa
Direct Impact resistance	(ASTM G 14)	> 9 Joules
Dielectric Strength	(SABS 1217)	> 20 kV/mm
Elongation at break	(ASTM D 638)	> 25%
Compressibility	(ASTM G-695)	> 25 MPa
Surface hardness of 5mm thick sample	(Shore 'D')	> 60 & < 80
Water Vapour Permeability	(ASTM E-96)	< 0,5g/24h/m ² /mm
Cathodic disbonded area after 30 days	(ASTM G-8 Method A)	< 500 mm ²

The adhesive shall be a low viscosity polyurethane adhesive designed to maximise adhesion between cured polyurethane and freshly mixed polyurethane. It is required for repair of cured solvent free polyurethane systems

The system

- (i) Prepare surfaces as specified in Clause 10.5.1 or 10.5.3 as appropriate, to achieve a blast cleaned surface of cleanliness Sa3, a profile of 50-100 microns, dust quantity rating of no greater than 2 (Figure 1 - ISO 8502-3:1992) and soluble salts not more than 100mg/m² (Weber Rielly Test)
- (ii) Apply the *metal primer* recommended by the manufacturer to his specified thickness
- (iii) Within the manufacturer's recommended over coating time, apply the specified thickness of *solvent free, semi-rigid polyurethane* by means of an airless spray machine fitted with metering pumps to ensure the correct mix ratio at the spray head. A qualified mechanic shall supervise the operation of the machine during spraying. The Contractor may be required to demonstrate to the Engineer that the machine is delivering components in the correct mixing ratio. Regular dismantling and cleaning of the machine is necessary to ensure correct volume ratios

Requirements

The coating shall be smooth, glossy, free from pinholes, excessive orange peel effect, bubbling, or excessive runs or sags. The coating shall be carefully examined after 24 hours cure for blisters and any uncured layers caused by blockages in the spray machine.

The dry film thickness shall be not less than 1,0mm

The coating shall be free from electrical insulation defects when tested with a high voltage holiday detector set at 5 kV and used in accordance with SANS 1217

The film examined in cross section shall not exceed the porosity of scale 2 as given in the Canadian Standards Association CAN/CSA-Z245.20-M86 Section 12.11

20.3 SYSTEM E.4 ELASTOPLASTIC POLYURETHANE, UNDERWATER; ABRASIVE CONDITIONS

Materials, system and requirements as for E.3, except that the coating thickness shall be not less than 2mm and there shall be no electrical insulation defects when tested with a high voltage holiday detector set at 10 kV

20.4 REPAIR PROCEDURE FOR POLYURETHANE SYSTEMS

Since polyurethane systems are chemically cured, very thorough abrasion of damaged or defective coating is required to ensure an adequate physical bond. If repair is carried out within 16h* of application of the last coat of polyurethane, abrade the surface with abrasive paper. Wipe free from dust and debris and then apply brush grade polyurethane, thoroughly mixed in the correct proportions, in as many coats as are required to achieve the specified thickness and freedom from holidays.

If repair is carried out later than 16h after application of the last coat, abrade the surface as above, remove debris, then apply the manufacturer's adhesive, thoroughly mixed in the correct proportions in a very thin layer, to the abraded surface only, NOT on any un-abraded area. Allow not less than 30* minutes nor more than 4h before application of brushing grade polyurethane, thoroughly mixed in the correct proportions, to the total thickness and freedom from electrical insulation defects as required by the relevant specification

*at 25°C and not more than 70%RH - as over-coating times are critical to achieve good adhesion, the manufacturer's advice must be sought on every application.

20.5 SYSTEM E.6 SOLVENT FREE CERAMIC FILLED HIGH ABRASIVE EPOXY LINING SYSTEM

Material shall be based on a high performance, solvent free, ceramic filled epoxy coating designed for use as a resurfacing and lining system to improve the efficiency in fluid flow environments

The system

- (i) Prepare surfaces as specified in Clause 10.5.1 or 10.5.3 as appropriate, to achieve a blast cleaned surface of cleanliness Sa3, a profile of 50-100 microns, dust quantity rating of no greater than 2 (Figure 1 - ISO 8502-3:1992) and soluble salts not more than 100mg/m² (Weber Rielly Test)
- (ii) Apply one or two coats of a *solvent free ceramic filled epoxy*, using appropriate equipment and methods as described in the manufacturers Technical Data Sheet

Requirements

The finished coating shall be smooth, uniform, glossy and free from orange peel effect, excessive runs and sags, blisters or other visual defects

The dry film thickness shall be not less than 500µm or greater than 2mm

The coating shall be free from electrical insulation defects when tested with a wet sponge detector, operated in accordance with Clause 8.12.1 of SABS 1217, using a potential of 90 Volts and a sensitivity of 10 Megohms

The film examined in cross section shall not exceed the porosity of scale 2 as given in the Canadian Standards Association CAN/CSA-Z245.20-M86 Section 12.11

20.6. SYSTEM E.7 SOLVENT FREE EPOXY PHENOLIC FOR STEELWORK AND EQUIPMENT IN CHEMICAL ENVIRONMENTS

Material shall be based on a high performance, solvent free, epoxy/phenolic coating designed for use in corrosive chemical environments

The system

- (i) Prepare surfaces as specified in Clause 10.5.1 or 10.5.3 as appropriate, to achieve a blast cleaned surface of cleanliness Sa3, a profile of 50-100 microns, dust quantity rating of no greater than 2 (Figure 1 - ISO 8502-3:1992) and soluble salts not more than 100mg/m² (Weber Rielly Test)
- (ii) Apply two or three coats of a *solvent free epoxy phenolic coating*, using appropriate equipment and methods as described in the manufacturers Technical Data Sheet.

NOTE: The overcoating times, as recommended, shall be strictly adhered to.

Requirements

The finished coating shall be smooth, uniform, glossy and free from orange peel effect, excessive runs and sags, blisters or other visual defects

The dry film thickness shall be not less than 300µm or greater than 500µm

The coating shall be free from electrical insulation defects when tested with a wet sponge detector, operated in accordance with Clause 8.12.1 of SABS 1217, using a potential of 90 Volts and a sensitivity of 10 Megohms

The film examined in cross section shall not exceed the porosity of scale 2 as given in the Canadian Standards Association CAN/CSA-Z245.20-M86 Section 12.11

21 CATEGORY F POWDER COATINGS

POWDER COATING may utilize a very wide range of materials, which may be broadly classified as follows :

Thermoplastic; such as Nylon, PVC, polyethylene, ethylene vinyl acetate, etc. These have the property of not changing their chemical composition during heating and cooling. They may therefore be reheated to become plastic or cooled to become solid as many times as may be necessary.

Generally the thermoplastic materials are applied in thicker coats than thermoset and have relatively poor adhesion; hence they are used primarily for articles that can be fully encapsulated.

Nylon (e.g. 'Rilsan') has good exterior exposure resistance and excellent resistance to wet abrasion. It is semi-flexible in nature and therefore has good impact resistance. A primer is required for all applications and adhesion with use of the primer is good. The dip application into a fluidized bed is ideal for small diameter pipes and ensures complete coverage at film thicknesses of 300 microns. Facilities for coating items up to 6 metre x 900mm are available in South Africa.

Thermoset; such as epoxy, polyurethane or polyester. On heating these powders melt, flow out to a thin film, then change chemically during the heating cycle so that, when cooled, they can no longer be melted by heat. It is therefore important that these materials go through the complete curing process during heating, otherwise they will not give the required performance

The thermoset materials are harder, are more resistant to impact damage and exhibit good adhesion but correct application is essential to ensure full cure

Incorrect curing time or temperatures are responsible for the largest proportion of defects in powder coating application. Articles of high mass, such as castings, are particularly susceptible and the surface temperature of the article to be coated should always be measured and controlled. Improper curing results in brittle, solvent sensitive coatings and may show up as pinholes and bubbles in the coating, or it may not be visually detectable but results in poor performance. Improper curing of thermoset materials can be confirmed by laboratory test procedures on flakes of coating

For exterior use in South African conditions, exterior grade polyester powders are preferred for their excellent gloss and colour retention on exposure.

For immersion service in water, epoxy powders are preferred

Design is important when items are to be protected by powder coatings. Corners are difficult to coat and sharp edges must be avoided. Powder coatings generally have very high cohesive properties and do suffer from weak spots at sharp edges, especially the thermoplastic materials. The Designer should aim for a 'cocoon effect' that encapsulates the item in an even thickness of the powder coating. Design of items to be coated by fluidised bed techniques must ensure no 'traps' that may cause build up of powder on horizontal surfaces.

The application of powder coatings shall only be carried out by specialist contractors with the necessary plant, facilities and experience to carry out such work. Full details of cleaning method, type of powder to be used, type of primer to be used, method of application, cure cycle and coating thickness shall be supplied to the Engineer

21.1 SYSTEM F.1 FUSION BONDED EPOXY (FBE) PIPE COATING

Material shall be based upon *thermosetting epoxy resin pipe coating powder* and shall comply with the requirements of SANS 1217 Type 2*. When used for potable water, it shall also be non-toxic and non-tainting (See Clause 3.3 of SANS 1217). When required, the contractor shall obtain and submit to the Engineer acceptable certification of non-toxicity and non-tainting properties.

*SABS 1217 Edition 1.3 is still in use.

The system

- (i) Prepare surfaces by blast cleaning as specified in Clauses 10.5 to Sa 3 finish
- (ii) Apply a *silico-chromate metal pre-treatment* to an approved method prior to heating the item
- (iii) Heat the component to the temperature recommended by the powder manufacturer (usually 220°C) and apply powder by electrostatic powder gun, by fluidised bed, or by electrostatic fluidised bed techniques to achieve adequate wetting of the surface and flow out to a smooth, uniform finish, complying with all the requirements given below

The applied powder shall be fully cured, either by residual heat, or by post curing (depending upon the powder formulation and heat capacity of the component), to meet the requirements given below

Requirements

The finished coating or lining shall be smooth, uniform, glossy or semi glossy, free from over spray, blisters or other visual defects

The dry film thickness shall be not less than 400 or greater than 600 microns

The coating or lining shall be free from electrical insulation defects when tested with a DC high voltage spark tester in accordance with SABS 1217, using a potential of 3.5 kV

The film shall be fully cured and shall show no softening or discolouration of the swab when tested for M.E.K. resistance in accordance with SANS 1217 Clause 8.9. In cases of dispute, degree of cure shall be determined by Differential Scanning Calorimetry, using the method described in British Gas Specification GBE/CW6, Part 1, Appendix B.2, when the difference in Glass Transition Temperature between the two runs shall not exceed 3°C

Impact Resistance of the applied coating or lining, when tested by ASTM G14 on a rigid substrate, shall be not less than 8 Joules. NOTE: large diameter and low wall thickness pipes must be supported internally at the point of impact to provide a rigid surface

Cathodic disbonding, when tested by ASTM G-8 Method B, for a period of 30 days, shall not exceed 500 mm², nor shall current flow at the end of test period, exceed 5 mA

The film examined in cross section shall not exceed the porosity of scale 2 as given in the Canadian Standards Association CAN/CSA-Z245.20-M86

21.2 SYSTEM F3 EXTERIOR DURABLE POLYESTER COATINGS ON PRIMED GALVANIZED STEEL FOR EXTERIOR USE

The system is intended for exterior use on galvanized sheet steel articles in corrosive environments. A primer designed for use on galvanized steel is required. *Exterior durable polyester powder* is preferred to give maximum gloss and colour retention on exposure to sunlight

Surface Preparation

The surface shall be chemically treated by a proprietary process to remove oil, grease and white rust and to leave a fine crystalline zinc phosphate surface layer

(If the surfaces to be coated are not going to be pre-treated by means of a chemical conversion, then the metal must be absolutely clean, and dry. If traces of white rust are present, it is recommended that these be removed by wire brushing prior to degreasing, to ensure the best possible corrosion protection and then, after degreasing, be lightly abraded with Scotchbrite®, to remove the oxide layer.)

Material shall be a *thermosetting exterior durable polyester powder* complying with SANS 1274 Part 6

Primer: A *twin pack Epoxy Strontium Chromate primer* shall be used on the prepared galvanized surfaces.

Apply by conventional liquid spraying equipment a mist coat of thinned *Epoxy Strontium Chromate Primer* to a dry film thickness of 10 - 20 microns.

Air dry for 60 -120 minutes to allow solvents to evaporate before over-coating with powder. Do not bake or allow the primer to cure for more than 4 hours.

The powder and the primer can then be baked together at the normal curing schedule for the powder coating in use.

Alternatively;

Use an approved 7 stage immersion tank pre-treatment process followed by application of an approved powder primer to a dry film thickness of 50 microns

Powder Application

The materials shall be applied and heated for the time and temperature cycle in accordance with the manufacturer's instructions

Requirements

The coating shall be smooth, glossy, free from over spray, blisters and other visual defects.

The dry film thickness shall be not less than 700 nor greater than 115 microns. The film shall be fully cured. It shall show no softening or discolouration, nor shall the swab show any significant discolouration, when tested with a cotton wool swab soaked in MEK for a contact time of 2 minutes. In cases of dispute, degree of cure shall be determined by Differential

Scanning Calorimetry, using the method described in British Gas Specification GBE/CW6 Part 1, Appendix B.2 when the difference in Glass Transition Temperature between the two runs shall not exceed 3°C

The coating system shall exhibit excellent adhesion when tested by the ISO 2409 method

21.3 SYSTEM F4 EXTERIOR DURABLE POWDER COATING ON EXTERIOR ARCHITECTURAL ALUMINIUM

The system is intended for use on architectural aluminium such as window frames, where colour and colour retention as well as chemical resistance are required

Material

Material shall be based on a *thermosetting polyester powder* complying with SANS 1578- Durable organic powder for coating of external architectural aluminium - Part 1 - Powder

The process

- (i) Prepare surfaces by a multi stage chemical spray pre-treatment as specified by the manufacturer
- (ii) Apply the powder by electrostatic powder gun to achieve adequate coverage of the surface
- (iii) Heat the coated component in a suitable oven to achieve the curing temperature and time recommended by the manufacturer

Requirements

The applied powder shall be fully cured to meet the requirements of the SANS 1796 – Coatings of durable organic powder for external architectural aluminium.

21.4 SYSTEM F5 *SINTACOTE* - SINTERED LOW OR MEDIUM DENSITY POLYURETHANE PIPECOATING

This system has been in use in South Africa for the last 15 years with good success. It consists of a low or medium density polyethylene powder that is applied to the preheated pipe by the fluidised bed process. The coating thickness is in the order of 2 - 3 mm; hence additional rock guard is only necessary in very rocky terrain. Due to the complexity of the application of the powder, it is only practical for fairly long pipelines and is not generally an off-the-shelf item

Material

Material shall be low (or medium when available) density *Polyethylene powder* complying with the requirements of ASTM D-1248, Type 1, Category 3, modified to give improved ultra violet light resistance

Surface Preparation

Blast clean to minimum Sa 2 ½, remove dust and debris

Primer

No primer is required

Powder Application

Powder shall be applied by rolling the pipe preheated to a surface temperature of 350°C by means of a special mandrel in a fluidised bed of powder. The contact time shall be sufficient to ensure adequate film build.

Requirements

The coating shall be smooth, uniform, semi-glossy and free from dry powder, blisters and other visual defects. The dry film thickness shall be not less than 1.5mm. The coating shall comply with all the requirements of Australian Specification AS 2518

When tested with a high voltage EID detector operated at a test voltage not less than 5 kV over 100% of the surface, there shall be no defects. Defects found during Quality Control may be repaired provided that such defects do not exceed 1 per m² and that the repaired area meets all the requirements of the specification.

The film examined in cross section shall not exceed the porosity of scale 2 as given in the Canadian Standards Association CAN/CSA-Z245.20-M86 Section 12.11

21.5 SYSTEM F6 TWO LAYER - EPOXY ZINC RICH POWDER PRIMER OVERCOATED WITH A POLYESTER POWDER DESIGNED FOR EXTERIOR USE

The system is intended for use on mild steel interior, mildly corrosive conditions or exterior conditions where additional corrosion resistance is required.

Material shall be double powder coating - firstly a *zinc rich epoxy powder primer* overcoated with a *polyester powder coating* designed for an exterior environment.

The process

Preparation - Steel > 2mm thickness: Prepare the surface as per Section 10.5 - abrasive blast to a low profile (Refer 10.7.2)

Steel < 2mm thickness: Degreasing and phosphating followed by passivation, rinsing with demineralised water and drying. Follow the procedural advice of the chemical pre-treatment suppliers.

Primer application

The steel prepared as above shall be primed using a *thermosetting epoxy*, rich in zinc - designed as an anti-corrosive primer undercoat for powder topcoats. The primer shall be applied and cured exactly according to the manufacturer's recommendations.

Topcoat application

Within 4 hours of applying the primer coat (refer manufacturer's instructions for delays exceeding 4 hours) the topcoat of *polyester powder coating* designed for exterior environments shall be applied. To ensure the integrity of the system the whole system must be cured in accordance with the recommended curing conditions for the topcoat*.

*Note: Failure to comply with the final curing conditions may cause variations in colour and gloss and cause degradation of the coating properties of the system.

Requirements

The coating shall be smooth (the primer layer is slightly granular), slightly stippled film, glossy, free from over-spray, blisters and other visual defects.

The combined film thickness shall be 120 - 150µm

The film shall be fully cured. It shall show no softening or discolouration, nor shall the swab show any significant discolouration when tested with a cotton wool swab soaked in MEK for a contact time of 2 minutes. In cases of dispute degree of cure shall be determined by Differential Scanning Calorimetry, using the method described in British Gas Specification GBE/CW6 Part 1, Appendix B.2 when the difference in Glass Transition Temperature between the two runs shall not exceed 3°C

Impact resistance according to ISO 6272-1 shall pass 0.5kg.m (the system).

Adhesion according to ISO 2409 - 2mm cross hatch on the system shall not exceed 0

22 CATEGORY G TAPE WRAPPING SYSTEMS

Tape wrapping is a method of corrosion protection used primarily for underground pipes and their ancillaries such as couplings, valves, etc. The method is used primarily on site although for certain types, wrapping can be carried out on individual pipes at a factory or site yard. There are many types of tape but for the purposes of this specification, only two types are given, namely petrolatum tape and rubber modified bitumen with polyethylene outer coating

General

Prior to the Contractor commencing work he shall obtain clearance in writing from the Engineer that all necessary investigations for soil resistivity and stray current electrolysis have been carried out and that, where required, continuity bonds and anode cables have been correctly installed

Surface Preparation

Items to be wrapped to this specification shall be cleaned manually or mechanically in accordance with Clauses 10.5.1 and 10.5.2 to achieve a cleanliness of minimum St 2 of ISO 8201-1

Primer

The primer shall be supplied by the tape manufacturer for the specific tape to be used. It shall be applied in a uniformly thin film, free of runs and sags. The pipe surface shall be entirely covered and shall be dry to the “tacky to touch” stage at the time of tape wrapping application. Uncoated, flooded, or areas primed over improperly cleaned pipe, shall be thoroughly cleaned to the satisfaction of the Engineer and re-primed

Application

Straight runs of pipe shall have the tape spirally wrapped with a manual or power driven wrapping machine. Short lengths, couplings and valves may be wrapped by hand. The tape shall overlap the preceding spiral by a minimum of 25 mm, more usually by an overlap of 55% of the tape width. The inner and outer tape layers, where applicable, shall be applied in such a manner that the overlaps of the layers do not coincide. The tape shall be kept under constant tension to ensure a uniform, tightly adhered coating, free of wrinkles, puckers, voids and bubbles. Care shall be taken to assure that the overlap is maintained.

Tape Joins and Repairs

When making a tape join during hand-wrapping or hand-operated wrapping machine operations, make a complete turn from the new roll over the wrapping previously applied. In the case of line-travel machines where reversing is difficult, pull sufficient tape off the roll to enable the new roll end to be so positioned as to allow at least one full turn over the previously applied wrapping

Ensure that all joins are free from wrinkles and folds and all old roll ends free from delaminated cardboard core material. Where damage to the wrapping on a pipeline has occurred and where there are creases, wrinkles and folds in the wrapping, proceed as follows:

- (i) If the width of the tape being used exceeds by at least 100mm the length of the section affected, cut the area of damaged wrapping away to bare metal leaving no raised edges or protrusions. Liberally prime the "window" thus exposed and apply a patch of tape, ensuring an overlap of the patch of at least 50mm on all sides onto the surrounding wrap. Apply primer (where applicable) over the patched area and, using a 55% overlap, apply by hand-wrapping a further layer of tape, commencing two turns before and continuing for two turns beyond the patch.
- (ii) Where the extent of damaged or faulty wrapping is such that the tape cannot span the affected area and provide a 50mm overlap on all sides, completely remove the wrapping from the pipe over the affected section, clean, re-prime and using a 55% overlap, re-wrap the pipe, commencing two complete turns before and finishing two turns beyond the bared section
- (iii) Where damage or a defect has occurred in a section that has been double wrapped and in the case of small holidays, use the appropriate procedure given in (i) or (ii) above
- (iv) Where damage extends through an outer wrap/rockshield, this should be carefully removed for a distance equal to three times the width of the tape of the inner wrap on each side of the holiday without damaging the pipe wrapping, the repair carried out by the appropriate method given in (i) or (ii) above, and the outer wrap or rockshield suitably reinstated

Rockshield

Suitable rockshield shall be applied in accordance with SANS 10129 Section 6, when required by the Engineer

Backfill

Backfill adjacent to the coated and wrapped pipe shall be free of scraps, sticks, rocks, or other hard debris that may damage the coating

22.1 SYSTEM G1 PETROLATUM TAPE

Petrolatum is a stiff, grease-like material derived from the distillation of crude oil. It has been used for many years for corrosion protection of both underground and above ground surfaces in severe environments. By impregnating this material into synthetic fabrics, various tapes have been produced. Because the material is soft, the completed corrosion protection must be protected from mechanical damage by a suitable outer wrap such as polyethylene tape or sheet

The system

Single wrap and HDPE outerwrap

- (i) Clean the pipe surface by manual or mechanical means as specified in Clause 10.5.1 and 10.5.2 to achieve a standard not less than St 2
- (ii) Prime with the tape manufacturer's recommended *petrolatum primer* at a coverage rate specified by the manufacturer
- (iii) All lengths of buried pipework are to be wrapped with *Petrolatum Impregnated Tape* of appropriate width. The tape shall be applied in a helical manner with a tape overlap of 25mm. The application shall be free of wrinkles, creases and air voids. Special care shall be taken to ensure that correct tension is used while applying the tape. All overlaps shall be suitably smoothed by hand to produce a smooth and continuous wrapping
- (iv) On completion of the tape inner wrap, the pipework shall receive an outer wrap of HDPE pressure sensitive wrapping of appropriate width. The HDPE shall be applied in a helical manner, with a tape overlap of 25mm, or 55% of the tape width if additional thickness is required for the backfill material. The application shall be free of wrinkles, creases and air voids. Special care shall be taken to ensure that correct tension is used while applying this tape. In addition, the outer wrap shall be secured at 5 metre centres with suitable fastening / strapping to prevent excessive unwrapping in the event of accidental damage

Requirements

The wrapped pipe shall have a uniform appearance, free from bubbles, wrinkles, lifting at the overlaps, and other visible defects

The total thickness will vary considerably. A single wrap of petrolatum-impregnated tape will contribute 1.2mm per layer. A single layer of rockshield HDPE tape will contribute 300µm, i.e. total 1.5mm - 55% overlap effectively doubles this thickness.

22.2 SYSTEM G2 BUTYL RUBBER MODIFIED BITUMEN WITH POLYETHYLENE OUTER TAPE

Bitumen has been used for very many years for pipe coating but suffers some major disadvantages, particularly due to its high temperature sensitivity in South African conditions. By the addition of butyl rubber the properties have been modified to make the blend very suitable for the coating of buried pipes and pipelines. In combination with high density polyethylene, tapes with high bond strength, low water absorption, good UV resistance and unique plastic flow properties have been produced

The system

- (i) Clean the pipe surface by manual or mechanical means as specified in Clause 10.5.1 and 10.5.2 to achieve a standard not less than St 2
- (ii) Prime all surfaces with the manufacturer's specified primer, at the manufacturer's recommended coverage rate
- (iii) Apply a *butyl rubber modified bitumen tape with polyethylene outer (butyl tape)* the tape in spiral fashion maintaining a minimum overlap of 25mm but may be up to 55%, according to the corrosivity of the soil. Care shall be taken to prevent air pockets and wrinkles. The tapes must be tensioned sufficiently to cause *slight* exudation of the bitumen mastic layer at the laps, *but not stretched*
- (iv) Apply the outer wrap of modified *polyethylene / laminated pressure sensitive 'rockshield tape'* in a similar fashion, making sure that the overlaps of the outer wrap do not coincide with the overlaps of the inner wrap

Requirements

The wrapped pipe shall have a uniform appearance, free from bubbles, wrinkles, lifting at the overlaps, and other visible defects

The total thickness will vary considerably. A single wrap of 1mm thickness butyl tape will contribute from 1 mm per layer. A single layer of 'rockshield' outer tape will contribute 300µm, 55% overlap effectively doubles this thickness. The actual tape thicknesses to be applied in any given environment will be specified by the engineer.

22.3 SYSTEM G4 PETROLATUM INHIBITIVE PRIMER, FOLLOWED BY PETROLATUM MASTIC OR PETROLATUM BLANKET FOR FLANGES & COUPLINGS

- (i) Clean the pipe surface by manual or mechanical means as specified in Clause 10.5.1 and 10.5.2 to achieve a standard not less than St 2
- (ii) Prime with the tape manufacturer's recommended *petrolatum primer* at a coverage rate specified by the manufacturer
- (iii) The entire item shall be packed using a *petrolatum mastic* to produce a smooth contour excluding all bubbles and voids
- (iv) The mastic shall be carefully over-wrapped (so as not to distort the soft surface) with *petrolatum impregnated tape* of appropriate width. The tape shall be applied in a helical manner with a tape overlap of 25mm. The application shall be free of wrinkles, creases and air voids. Special care shall be taken to ensure that correct tension is used while applying the tape. All overlaps shall be suitably smoothed by hand to produce a smooth and continuous wrapping
- (v). On completion of the petrolatum impregnated tape over-wrap apply a 'rockshield' HDPE tape or polyethylene layflat sheeting as recommended by SANS 10129 Section 5.3

Requirements of tape wrapped pipes and joints

Visual: The completed tape wrap system shall be smooth, uniform, with the specified overlap. It shall be free from bubbles, wrinkles, lifted edges and other visible defects

Thickness: The thickness of the tape wrap shall be not less than 80% of the specified number of layers multiplied by the manufacturer's specified thickness.

Holiday (E.I.D.) Detection: The whole surface of the pipe and couplings shall be tested with an approved high voltage holiday detector just prior to backfilling. The test voltage shall be not less than 50% nor greater than 80% of the breakdown voltage of the system. Breakdown voltage is given by the dielectric strength (kV/mm) of the tape, multiplied by the total thickness (mm). Generally, the test voltage will be not less than 18 kV

Holidays shall be marked out and repaired as specified. After repair, no holidays are permitted

23 SUMMARY OF COATING SYSTEMS

NOTE - These summaries are for ease of reference only. The contractor must comply with all the requirements given under SYSTEMS and in the GENERAL Clauses

CATEGORY A - ALKYD SYSTEMS FOR MILD ENVIRONMENTS

System	Substrate	Surface Prep	Coating System	Requirements
A1	bare steel	manual/ mechanical cleaning St 2 min.	1 coat high build primer for steel 1 coat alkyd enamel (interior) 2 coats alkyd enamel (exterior)	Smooth, glossy finish DFT interior - 65µm min DFT exterior - 80µm min
A2	primed steel	clean and touch-up	touch-up quick drying primer 1 coat high build primer all over 1 coat alkyd enamel (interior) 2 coats alkyd enamel (exterior)	Smooth, glossy finish DFT interior - 65µm min DFT exterior - 80µm min
A3	factory finished steel	abrade and clean	1 coat alkyd enamel (interior) 2 coats alkyd enamel (exterior)	Smooth, glossy finish DFT interior - 65µm min DFT exterior - 80 µm min
A4	galvanized steel	degrease and abrade	1 coat special primer 1 coat alkyd enamel	Smooth, glossy finish DFT over galv. - 75µm min
A5	plastic and bitumen coated	abrade and remove dust	1 coat water based primer 1 coat alkyd enamel	Alternative to tapes for colour coding

CATEGORY B - TWO PACK SOLVENT BORNE EPOXY AND POLYURETHANE SYSTEMS

System	Substrate	Surface Prep	Coating System	Requirements
B1	steel or cast iron	blast clean Sa 3, profile 50 - 100µm	2 -3 coats high build epoxy for underwater use	DFT min 300, max 450 µm no EIDs wet sponge 90v 2 Megohms
B1A	steel or cast iron	blast clean Sa 2½, profile 50 - 100µm	2 coats epoxy 2 coats recoatable polyurethane	DFT min 300, max 450 µm
B2A	galvanized steel	degrease and abrade	1 coat 2-pack special epoxy primer for galv steel 1 coat recoatable polyurethane	DFT min 150, max 250 µm over galvanizing
B3	steel or cast iron	blast clean Sa 2½, profile 50 - 100µm	1 coat HB epoxy primer 1 coat epoxy MIO int. coat 1 coat recoatable polyurethane	DFT min 255, max 400 µm
B4	steel or cast iron	blast clean Sa 2½, profile 50 -100µm	1 coat epoxy zinc rich primer (alt inorganic zinc) 1 coat epoxy MIO int. coat 1 coat recoatable polyurethane	DFT min 300, max 400 µm
B5	steel or cast iron	blast clean Sa 3, profile 50 - 100µm	1 coat epoxy phenolic primer 1 coat epoxy phenolic int. coat 1 coat epoxy phenolic topcoat	DFT min 250, max 400 µm no EIDs wet sponge 90v 2 Megohms
B6	factory finished steel	degrease and abrade	1 coat epoxy aluminium mastic 1 coat recoatable polyurethane	DFT min 165, max 200 µm

CATEGORY C - SOLVENT BORNE COAL TAR EPOXY SYSTEMS

System	Substrate	Surface Prep	Coating System	Requirements
C1	steel or cast iron	blast clean Sa 3	2 - 4 coats HB epoxy-tar	DFT 300, max 600 µm no EIDs wet sponge 90v 2 Megohms

CATEGORY D - VINYL SYSTEMS

System	Substrate	Surface Prep	Coating System	Requirements
D1	steel or cast iron	blast clean Sa 3	1 coat vinyl primer 1 coat HB vinyl intermediate 1 coat vinyl enamel	total DFT min 175, max 195 μm
D2	painted or plastic	degrease and abrade	1 coat water based primer 1 coat vinyl intermediate coat 1 coat vinyl enamel	DFT min 110 μm (on plastic pipes, coloured self adhesive tapes preferred)
D3	galvanized steel	degrease and abrade	1 coat 2-pack special epoxy primer 1 coat vinyl intermediate coat 1 coat vinyl enamel	DFT min 125 μm , max 195 μm

CATEGORY E - SOLVENT FREE EPOXY AND POLYURETHANE SYSTEMS

System	Substrate	Surface Prep	Coating System	Requirements
E1	steel or cast iron	blast clean Sa 3 profile 50 - 100 μm	1 -2 coats solvent free epoxy for underwater use	DFT min 300, max 450 μm no EIDs wet sponge 90v 10 Megaohms
E3	steel or cast iron	blast clean Sa 3 profile 50 - 100 μm	1 coat special primer solvent free hybrid aromatic polyurethane	DFT min 1mm no blistering or uncured material no EIDs spark test 5 kV
E4	steel or cast iron	blast clean Sa 3 profile 50 - 100 μm	1 coat special primer solvent free hybrid aromatic polyurethane	DFT min 2mm no blistering or uncured material no EIDs spark test 10 kV
E6	cast iron	blast clean Sa 3 profile 50 - 100 μm	2 coats solvent free, ceramic filled highly abrasive resistant epoxy lining	DFT min 500, max 2mm no EIDs wet sponge 90v 10 Megaohms
E7	steel or cast iron	blast clean Sa 3 profile 50 - 100 μm	2 -3 coats solvent free epoxy phenolic chemical resistant coating	DFT min 300, max 500 μm No EIDs wet sponge 90v 10 Megaohms

CATEGORY F - POWDER COATINGS

System	Substrate	Surface Prep	Coating System	Requirements
F1	steel pipes or cast iron	blast clean Sa 3 chemical treatment	fusion bonded epoxy pipe coating powder, applied by electrostatic spray	DFT min 400, max 600µm no EIDs high voltage 3.5 kV full chemical cure
F3	galvanized sheet steel	chemically clean and phosphate	liquid primer polyester powder	DFT min 50, max 100µm over galv. full chemical cure
F4	architectural aluminium	chemically clean SABS 1578	polyurethane powder SANS 1578 or BS 6496:1984	DFT 60 - 80µm SANS 1578 or BS 6496:1984 full chemical cure
F5	steel pipes (large bore)	blast clean Sa 2 ½	low density polyethylene powder, applied by fluidised bed	DFT min 1.5mm no EIDs high voltage 10kv Australian spec. as 2518
F6	steel or sheet steel	chemical clean or abrasive blast	zinc rich epoxy primer/ polyester powder for exterior exposure	DFT min 120µm - 150µm full chemical cure

CATEGORY G - TAPE WRAP SYSTEMS FOR PIPES AND PIPELINES

System	Substrate	Surface Prep	Coating System	Requirements
G1	steel and CI pipes and fittings	mechanical or manual clean min St 2	petrolatum primer petrolatum tape 55% overlap PVC or PE outer tape	DFT 1.5mm or higher to engineer's instructions no bubbles, wrinkles or lifting at overlaps no EIDs high voltage 18 kV
G2	steel and CI pipes and pipelines	mechanical or manual clean min St 2	rubber-bitumen primer rubber-bitumen tape polyethylene outer wrap	DFT min 1.3mm or higher to engineer's instructions no EIDs high voltage 18 kV
G4	flanges and couplings	mechanical or manual clean min St 2	petrolatum primer, then petrolatum mastic or blanket, polyethylene outer wrap	total encapsulation SANS 10129 Section 5.3

CIVIL AND ARCHITECTURAL COATING SYSTEMS

CONTENTS OF CIVIL AND ARCHITECTURAL COATING SYSTEMS

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24 GENERAL

The use of the coating systems given in the previous section, plus some systems applicable only to this section, are given as guidelines

The range of surfaces to be protected and the variation of exposure conditions are such that each plant must be considered as a unique installation

The recommendations given in this section shall be used if confirmed by the Engineer. The systems given in the Project Specification and drawings take precedence over the following recommendations

25 BUILDINGS

The contractor shall quote for the specification stipulated by the Engineer or Architect. Where alternative processes of equal technical merit are stipulated in the Project Specification, the contractor shall quote the lowest price in his tender and clearly state which system he intends to use. He may also offer his own alternative system in addition to his offer for the specified system, provided that he fully motivates the advantages of his system and supplies full technical details for evaluation by the Engineer

25.1 PAINTING WOODWORK

25.1.1 Softwood such as Pine

All wooden surfaces shall be planed and sanded to a smooth surface. Sanding debris shall be removed. Wood shall contain not more than 12% moisture before painting. Large or loose knots shall be removed and plugged with wood. When approved by the Engineer, large firm knots may be cut back below the surface and filled with approved acrylic resin based filler. The filler shall be allowed to dry fully and then sanded down to be flush with the surface. Small firm knots shall be sealed with shellac knotting or similar material that will seal without bleeding into the subsequent coats

System

The clean, dry, smooth surface shall be primed with primer for wood, aluminium base, complying with SANS 678 Type II

After at least 16 hours drying time, apply General Purpose Undercoat complying with SANS 681:1997 Grade 1

After a further minimum 16 hours drying, the surface shall be lightly sanded to remove nibs, dusted off, then one coat high gloss enamel complying with SANS 630 shall be applied

On exterior surfaces a second coat of high gloss enamel complying with SANS 630 shall be applied after 16 hours drying of the first coat

Requirements

The finished system shall be smooth, glossy and uniform in gloss and colour. It shall be free from nibs, occlusions, runs, sags, curtaining, blowholes, blisters or any other visible defect.

The colour shall be a close match to the colour specified by the Engineer

25.1.2 Hardwood, such as teak, oak, iroko etc

Surface Preparation

All hardwood shall be well sanded and dusted off and it shall be dry (not more than 12% moisture when tested with a suitable calibrated electrical conductance mater).

System

Any one of the following systems may be used provided that the contractor states in his tender document which system he intends to use and the reason for his choice

- (i) The clean, smooth, dry surface shall be oiled with Pale Boiled Linseed Oil and rubbed well into the surface. The first coat shall be thinned with 10 to 15% Turpentine Substitute to aid penetration. All subsequent coats shall be applied neat. Apply copiously and after two hours, wipe off the surplus. Repeat the treatment after 48 hours and thereafter at weekly intervals for 5 or 6 weeks. The final application shall be followed with a brisk rub down with a soft cloth to produce a uniform sheen on the surface
- (ii) The clean, dry, sanded surface may be treated with a preservative, developed by the Forestry Product Research Institute (USA) and approved by the Timber Section of SABS

Apply the preservative liberally by brush and allow to soak into the surface. Wipe off any runs or excess material and leave to dry for at least 48 hours. Apply a second coat uniformly and allow drying for a further 48 hours. Particular care shall be taken to preserve the end grain, where exposed, by thorough impregnation. This treatment requires a revival coat every two years
- (iii) The clean, dry, sanded and de-dusted surface of the hardwood may be coated with at least two coats of clear moisture curing polyurethane, designed for use on hardwood, and applied in accordance with the manufacturer's instructions

Requirements

The surface shall have a smooth, uniform, high-gloss, semi-gloss or satin (as required by the Engineer) “luxury” finish, free from runs, sags, bubbles, milkiness or other visible defects and shall enhance the natural grain of the wood

25.2 PAINTING CEMENTITIOUS SURFACES**25.2.1 Ceilings**

All gypsum plaster board ceilings, including cornices and cover strips shall be treated as follows:

- (i) Nail heads shall be punched below the surface and spot primed with zinc phosphate primer for steel
- (ii) Cracks, joints and depressions shall be filled with an approved acrylic based filler, to be slightly proud of the surface. After fully curing, the surface shall be sanded to a smooth finish flush with the surrounding area. Remove all dust and debris
- (iii) Apply two coats interior quality synthetic polymer base emulsion paint complying with SANS 1586 Grade 3

25.2.2 Plastered and Concrete Surfaces

Walls shall be clean, free from oil and grease, shutter release agents, loose sand or friable surface layer

Interior surfaces - where indicated, shall be coated with two coats synthetic polymer base emulsion paint complying with SANS 1586, Grade 1 or Grade 2, as appropriate, for the colour selected. The first coat may be thinned if necessary, with not more than 10% water

Humid interior surfaces shall be treated as for exterior surfaces

Exterior surfaces - where indicated, be coated with two coats synthetic polymer base emulsion paint for exterior use, complying with SANS 1586 Grade 1. The first coat may be thinned, if necessary, to aid penetration with not more than 10% water

In either case, should the uniformity of colour and sheen be unacceptable to the Engineer, a third coat shall be applied at no extra cost

25.2.3 Fibre Cement Surfaces

Treat as for exterior plastered and concrete surfaces

25.3 PAINTING METALWORK**25.3.1 Non-galvanized**

Non-galvanized window frames, door frames, steel doors, etc. shall be supplied coated with an acceptable factory primer

Window

Glazing shall be carried out in accordance with good practice, using glass as specified, well bedded in putty complying with SANS 680, self setting type. The putty shall be well worked before use to obtain adequate plasticity. On completion of glazing, the putty shall be well smoothed off, trimmed to a straight clean edge and sloping to an angle of approximately 60 degrees to the glass to ensure good water run off. Excess putty shall be removed from the window frame before painting. Putty shall not be painted less than 7 days after completion. All mortar splashes, putty, oil, grease, dirt and other contaminants shall be removed from the primed steel window frames

The window frames and putty in non-corrosive environments shall be prepared and coated as specified in Clause 16, using System A.3 (Alkyd System)

Window frames in chlorination rooms shall be prepared and coated as specified in Clause 19, using System D.2 (Vinyl System)

Structural Steel (internal corrosive conditions)

Steel in wet or chemically polluted environments such as chlorination rooms, shall be prepared and painted as specified in Clause 11, using System D1 (Vinyl System)

Structural Steel (immersed in water)

Immersed steel shall be prepared and painted as specified in Clause 17 using System B.1 (Two component solvent borne pure epoxy System)

Structural Steel in mild environments

Steel in mild environments shall be prepared and painted as specified in Clause 16, using System A1, A2 or A3, as appropriate

25.3.2 Galvanized

General - See Sub-Clause 10.7

Surfaces above water - Use System A.4, D.3 or B2A

26 BUND WALLS AND FLOORS

The coating must form a water impermeable tank with sufficient chemical resistance to withstand 40% Ferric Chloride solution and other aggressive chemicals. It must also have sufficient impact resistance that it will resist the impact of dropped hammers, spanners, delivery nozzles and the like. Complete sealing around entry and exit points of pipes, conduits, etc. is essential. This is normally carried out by the use of heavily filled two component epoxy grout. As with all coatings required to resist severe chemical exposure, correct surface preparation is essential. The surface must be dry before application of the coating system

Only specialist contractors may be employed for this work, as experience and technique are critical for successful results. The following is an abbreviated specification giving the essential stages only

Materials may be one of the following:-

An approved solvent free epoxy phenolic coating, resistant to 10% Hydrochloric Acid.

Use System B5, E7

In addition, glass fibre chopped strand mat and surfacing tissue made from 'C' glass, will be required. The primer to be used shall be as recommended by the manufacturer, compatible with the selected system and shall be low viscosity to penetrate the concrete

Surface Preparation

Acid wash all concrete surfaces with 10% hydrochloric acid to remove laitance, oil or grease and to achieve a surface profile provided by the aggregate. Water wash under high pressure to remove all loosened sand and soluble salts resulting from the acid etching process

A good drain of adequate capacity and approved for chemical cargo is essential. Wash until washings are free from soluble chlorides when tested with silver nitrate solution

Allow to dry thoroughly before coating

Procedure

Fill cavities or gaps with epoxy grout

Grind flush any protrusions

Prime all surfaces with low viscosity epoxy phenolic primer, depending on the system to be used

Lay up 300 g/m² of chopped strand C glass mat into either a special acid resistant solvent free epoxy phenolic coating.

Repeat once for epoxy phenolic coating to give a total glass content of 600 g/m².

Lay up glass fibre surfacing tissue with the appropriate resin

Apply one or two coats UV resistant polyurethane top coat, to give the colour required by the Engineer as well as resistance to UV light and the chemicals that may be contained in the bund (the pigment selected shall be resistant to acid)

Requirements

The coating system shall have a uniform appearance and colour approximating to that specified by the Engineer. The coating shall be well bonded to the substrate and shall be free from bubbles, occlusions and other defects detrimental to its performance. The coating system shall show no defects when tested over 100% of the coated area with a high voltage spark tester set at 10kV, or 50% of the breakdown voltage of the system, whichever is lower. Defects may be repaired by a method recommended by the resin manufacturer provided that the repair complies with the requirements of the specification

27 PIPES

Pipes may vary from very large to very small and may be constructed from a wide variety of materials such as mild steel, cast iron, concrete, fibre cement, glass reinforced plastic, etc. They may be exposed to a wide variety of environments from immersion in raw sewage to exposure to sunlight.

The recommendations in this specification cover only mild steel or cast iron pipes. For other types of pipe requiring lining and coating, separate specifications must be obtained

Pipes buried in aggressive soil require cathodic protection which is installed after the pipeline is laid and backfilled. If cathodic protection is considered, then steps must be taken to ensure continuity bonding across hydraulic couplings and valves chambers, or insulation where pipes join process vessels or leave the ground

27.1 FACTORY LINING AND COATING OF PIPES

The lining and coating of pipes is a specialized field of coating application, with specific requirements before, during and after coating. For this reason, only contractors with the necessary equipment, experience and Quality Control facilities will be considered for supply. Approval to ISO 9000 - 2000 is preferred

27.2 TYPES OF PIPE THAT MAY BE SPECIFIED BY THE ENGINEER.

Material may be mild steel or cast iron, in which case spheroidal graphite cast iron (S.G. iron) is preferred. Mild steel pipes may be seamless, longitudinally welded or spiral welded, as specified by the Engineer

Colour Coding, where required, shall be as specified in SANS 10140, Part 3

Pipes may be joined by flanges, flexible couplings or by circumferential welding or by proprietary jointing methods such as *Sintajoint*® or special bell and spigot type joint (*Hall Longmore Ltd*). The problem with all jointing methods is the treatment of the pipe ends and repair of the lining after joining on site

Circumferential welding is only recommended for pipes of nominal bore 450mm and over, unless an *in situ* pipe lining is employed, which is not covered in this specification

Bonding lugs shall be welded on to pipes where necessary for continuity bonding for cathodic protection

27.3 MECHANICAL PRE-TREATMENT BY THE PIPE MANUFACTURER

Pipes shall not be accepted for lining or coating, or both, unless they comply with the following requirements, which shall be notified to the pipe manufacturer

All weld spatter shall be removed by chipping or grinding to a smooth surface flush with the surrounding steel

All welds shall have a smooth contour, free from sharp edges, protrusions and undercuts. Longitudinally welded pipes shall have the internal weld scarfed flush with the wall of the pipe. No sharp edged projections are permitted

All sharp edges that are required to be coated shall be ground to a radius of curvature not less than 3mm

Hydraulic testing of the pipe shall be carried out after completion of the above processes

27.4 SURFACE PREPARATION BY THE LINING/COATING CONTRACTOR

The lining/coating contractor shall inspect pipes before surface preparation in accordance with Quality Control procedures to ensure that the requirements of 12.3 have been complied with

Degreasing Pipes shall be free from oil and grease. When necessary, local deposits of oil and grease shall be removed by the use of suitable solvents. In this case, care shall be taken to ensure that the contaminant is removed and not spread over a larger area. When pipes are extensively contaminated by oil or grease, they shall be completely degreased by one of the methods given in SANS 10064 Section 3

Blast Cleaning Pipes for lining or coating shall be blast cleaned by air blast or centrifugal equipment. Compressed air and abrasive shall be free from oil, grease and similar contaminants. The abrasive particle size and distribution shall be chosen to remove millscale and achieve the surface condition specified below:

Surface profile: 50 to 75 microns average, or 'medium grade, when determined by ISO 8503 Part 2

For coatings exceeding 500 microns in thickness, the profile may be 50 - 150 microns or 'course', when measured as specified above

Cleanliness: Sa3 of ISO 8501-1

If laminations in the steel appear after blast cleaning, they shall be ground out and the ground area shall be blast cleaned. Where grinding is not practical or when the lamination requires grinding to a depth greater than 7% of the wall thickness, the pipe shall be rejected.

NOTE: Blast cleaning of CAST IRON PIPES requires that fine or medium grade mineral grit abrasives shall be used. Abrasive shall be new, unused and shall not be re-used. All sand particles, residual burnt on sand and casting skin shall be removed prior to galvanizing or painting

Removal of Dust and Debris Dust and debris from the blast cleaning process shall be removed by blowing with clean, dry compressed air, or preferably by vacuum cleaning, to achieve a residual dust and debris level not greater than Class 2 when tested by ISO 8502-3, or as agreed by the Engineer

Water Soluble Salts Surfaces to be lined or coated that will subsequently be immersed or buried shall show not more than 100 mg/m² soluble iron salts when tested with the Weber-Rielly Reagent

Masking of Ends to be Welded Pipes to be welded on site shall have the ends squared and machined to a 45° angle. After blast cleaning, ends to be welded shall be masked with good quality masking tape for a distance of 50mm from the end. During application of the masking tape, the adjacent surface of the blast cleaned pipe shall not be contaminated by perspiration, oil or grease. To prevent such contamination, operatives shall wear clean gloves when masking off. After site welding, all residual adhesive from the masking tape shall be completely removed by suitable solvents before the application of coating or lining repair material. The blast cleaned surface thus exposed shall be abraded with 80# abrasive paper prior to coating

Treatment of ends to be joined by flexible couplings The total thickness of lining of the coupling sleeve and coating of the pipe shall not be greater than 40% of the clearance allowed by the coupling manufacturer. In the event of this combined thickness being greater than the clearance, steps must be taken to reduce one or both of the thicknesses by the use of a suitable coating system which will provide adequate corrosion protection within the required thickness limits. Provided that these thickness limits have been catered for, the lining of the pipe should be continued to the end of the pipe, over the end and back along the outside of the pipe for sufficient length to cover the area to be covered by the coupling after joining on site

27.5 APPLICATION OF LINING OR COATING

Application of lining or coating shall be carried out as soon as possible and before any condensation, oxidation or contamination of the cleaned surface can take place

Lining or coating of pipes shall not be carried out unless the surface temperature is at least 15°C and 3°C above dew point

Mixing and proportioning of two component materials shall be strictly in accordance with the manufacturer's instructions. Split packs are not permitted

Final coating thickness shall comply with the requirements of the relevant specification

When solvent borne multicoat systems are used, the maximum thickness per coat and the time interval between coats shall be strictly in accordance with the manufacturer's instructions. Each successive coat shall differ in colour from the preceding and succeeding coat. Where solvent borne systems are used, a forced draught of warm air through the pipes may be necessary to prevent solvent retention

When solvent free two component materials are used, the application equipment shall be in accordance with the manufacturer's instructions. Tests shall be carried out frequently to ensure that the correct ratio of base to curing agent is maintained. Incorrect mix ratio of two component materials will lead to rejection of the coated articles

Powder shall be applied by the method stipulated in the relevant specification

Application equipment shall at all times be maintained in a clean condition such that there are no excessive occlusions of dry powder or dry over spray

27.6 RECOMMENDED SPECIFICATIONS

One of the following systems shall be used in accordance with the Project Specification:

27.6.1 Lining of pipes

In the factory

System B1 or E1 or Cement Mortar to SANS 1200 2000 for potable water, depending on pipe size and quantity

System C1 or E3 for sewage and acid waters

On site

Cement Mortar lining *in situ* (not covered in this specification) or System B1 for non-acidic waters only

Systems E3, or C1 for sewage and acid waters. NOTE: System C1 may not be used for potable water, due to its tainting properties

27.6.2 Coating of pipes

In the factory

Systems E1, E3, E4, E7 or F1 or F5 are all suitable for burial in soil. Due to their high cost, systems E3, E4 or E7 would only be used for extremely aggressive soil or pipe jacking

System B1A for pipes, valves, etc. aboveground in corrosive environments exposed to sunlight

On site

System G2 for pipe to be buried, with G1 or G4 for specials and couplings

28 FLANGES AND COUPLINGS

All flanges and couplings shall be protected from corrosion after tightening of all bolts and pressure testing as required by the Engineer. Pipes may be joined to each other and to ancillaries such as valves, tees, etc.

Methods of joining pipes

Circumferential welding: This is only practical on pipes of diameter in excess of 450mm (unless *in situ* cement mortar lining is to be applied) to allow man access to repair the pipe lining at the weld. The coating and lining of welding joints are normally repaired by the procedures given under the specific system used for coating and lining the pipes

Flanges: These are normally used only on small diameter pipes because of the high cost of flanges

Flexible Couplings, also known as Hydraulic Couplings: These comprise a coupling sleeve which fits over the pipe ends, together with clamps at each end and rubber sealing rings to make a watertight joint that will tolerate a certain amount of movement. Since the sleeve fits over the pipe, it is normally lined with the same material and to the same standard as the pipe. However, care must be taken when thick (1mm and over) pipe coatings or linings are used to ensure that the lining and coating combined does not exceed the clearance between sleeve inner diameter and the pipe exterior diameter

Proprietary couplings are those such as *Sintajoint*® and modified bell and spigot joint (Hall Longmore Ltd.)

29 CATHODIC PROTECTION

Cathodic protection is an electrical method of corrosion protection applied to prevent corrosion of underground or underwater structures to supplement the corrosion protection provided by the coating system (insulation against corrosion). The protection may be in the form of impressed current from a mains supply via a transformer rectifier or in the form of sacrificial anodes. Cathodic protection must be designed specifically for each location, depending on soil corrosivity, stray currents, etc. It is important to engage a cathodic protection specialist timeously since his recommendations can affect the construction of the pipes and ancillary components. Where there may be any break in continuity, bonding cables must be attached. Insulation joints must be installed where the cathodically protected structure requires to be insulated from the main structure, e.g. a pipeline entering a process plant.

30 SECURITY FENCE

30.1 FENCING POSTS

Fabricate all posts from mild steel with due attention to Clause 5. After fabrication, fencing posts shall be hot dip galvanized to comply with SANS 121 :2000/ISO 1461:1999. The bottom of fencing posts to be buried in soil shall be cleaned in accordance with Clause 10.4, then coated with bitumen to a dry film thickness not less than 30 or greater than 70 microns. Allow a minimum of 16 hours drying, then apply one coat Bituminous Aluminium Paint, complying with SABS 802, allowing a minimum of 3 days before burial

The coating shall cover the whole of the base plate and upwards to a height of not less than 500mm above ground. The total dry film thickness of primer and bituminous aluminium shall be not less than 50 microns

30.2 STRAINING WIRES, FENCING WIRE, TIE WIRES AND BARBED WIRE

Shall be hot dip galvanized to comply with SANS 675 Class A. galvanized wire complying with SANS 675:1997 is not acceptable

30.3 CONCERTINA RAZOR/BARBED WIRE COILS

Shall be manufactured from stainless steel, type 304 or from 3CR12 or as recommended for specific conditions

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APPENDIX A - LIST OF STANDARDS AND CODES APPLICABLE

A1 NATIONAL STANDARDS AND CODES

Standards South Africa	Previous SABS Number	DESCRIPTION
SANS 10064 :2005	064 1979	The Preparation of Steel Surfaces for coating
SANS 10120 :1986	0120 1986	Code of Practice for use with standardized specification for Civil Engineering Construction - General
SANS 10129 :2006	0129 1977	Plastic tape wrapping of steel pipelines * (Project on Progress)
SANS 10140 :2003	0140 1992	Identification colour marking Part 3 - Contents of pipelines
SANS 10158 :1982	0158 1987	Code of Practice for Glossary of terms for Quality Assurance and Quality Control
SANS 1117	1117 1977	Plastic Wrappings for the protection of steel pipelines
SANS 1149	1149 1977	Flat and taper steel washers
SANS 1200 A 1986	1200A 1986	Standardized specification for Civil Engineering Construction Section A: General
SANS 1200 A 1986	1200AA 1986	Standardized specification for Civil Engineering Construction Section AA: General (small works)
SANS 1200 AH 1986	1200AH 1986	Standardized specification for Civil Engineering Construction Section AH: General (structural)
SANS 1200 H 1990	1200H 1990	Standardized specification for Civil Engineering Construction Section H: Structural steelwork
SANS 1200 HA 1990	1200HA 1985	Standardized specification for Structural Steelwork - General Section HA: Structural steelwork (sundry items)
SANS 1200 HB 1985	1200HB 1985	Standardized specification for Structural Steelwork - General Section HB: Cladding and Sheetting
SANS 1200 HC 1988	1200HC 1988	Standardized specification for Civil Engineering Construction - Corrosion Protection of Structural Steelwork

SANS 121 :2000 / ISO 1461:1999	SABS/ISO 1461:2000	Hot dip galvanized coatings on fabricated iron & steel articles – Specifications and Test Methods
SANS 1217 :1984	1217 1984	The Production of Painted and Powder-coated Steel Pipes
SANS 1274 :2005	SABS 1274 :2005	Coatings applied by the powder coating process
SANS 1391 SET : 1983	SABS 1391 SET:1983	Thermally sprayed metal coatings
SANS 14713 :1999 / ISO 14713:1999	SABS/ISO 14713:1999	Protection against corrosion of iron and steel structures. Zinc and Aluminium coatings - Guidelines
SANS 1578 :2003	1578:1993	Organic powder coating for external architectural aluminium
SANS 1586 :1995	1586 1995	Emulsion Paints
SANS 1796 :2001	1796 Edition 1 2001	Coatings of durable organic powder for external Aluminium
SANS 2063	1391 1998	Metallic and other inorganic coatings – Thermal spraying – Zinc, aluminium and other alloys
SANS 32 :1997 / EN10240:1997	SABS/EN 10240:1997	Internal and/or external protective coatings for steel tubes- specification for hot dip galvanizing coating applied in automatic plants
SANS 3575 :1996 / ISO 3575:1996	SABS/ISO 3575:1996	Continuous hot-dip (galvanized) zinc coated carbon steel sheet of commercial, lock forming and drawing qualities
SANS 4998 :1996 / ISO 4998:1996	SABS/ISO 4998:1996	Continuous hot dip (galvanized) zinc coated steel sheet of structural quality
SANS 630:2001	630 1972	Decorative High Gloss Enamel Paint for Interior and Exterior Use
SANS 675:1997	675 1997	Zinc coated Fencing Wire (Plain and barbed)
SANS 678:1973	678 1987	Primers for Wood for Interior and Exterior Use
SANS 679:1959	679 1972	Zinc Chromate Primer for Steel
SANS 680:1959	680 1979	Glazing putty for wooden and metal window frames
SANS 681 :1997	681 1997	Undercoats for Paints
SANS 684:1959	684 1972	Structural Steel Paint
SANS 716 :1962	716 1972	Mineral Turpentine (white spirit)
SANS 723	723 1973	Wash Primer (Metal etch primer)
SANS 802 :1966	802 1972	Bituminous Aluminium Paint

SANS 935 :1969	935 1993	Hot Dip (Galvanized) Zinc coatings on steel wire
SANS 975 :1970	975:1970	Pre-stressed concrete pipes
SANS 999 :1986	999 1998	Anodized Coatings on Aluminium (For architectural applications)

- New Specifications may be submitted in the future

A2 INTERNATIONAL STANDARDS

SPECIFICATION	Previous number	SPECIFICATION DESCRIPTION
	ASME	
ASME 1X 2004	1X 1983	Coded Welders
	ASTM	
ASTM G 8	G-8	Cathodic Disbonding of Pipeline Coatings
ASTM G 14	G-14	Impact Resistance of Pipeline Coatings (Falling weight test)
	AUSTRALIAN	
AS 2518	AS 2518	Fusion-bonded low density polyethylene coating for pipes and fittings
	BRITISH GAS	
BGC/S/CW 6	BGC/S/CW 6	British Gas Engineering Standard - Specification for the External Protection of Steel line Pipe and Fittings
	British Standard	
BS 6496:1984	6496	Powder organic coatings for application and stoving to aluminium alloy extrusions, sheet and preformed sections for external architectural purposes etc.
BS EN 10132 -	1449	Steel plate sheet and strip for automobile and general engineering purposes
BS EN ISO 15614-1:2004	4870-Part 1	Specification and qualification of welding procedures for metallic materials. Welding procedure test. Arc and gas welding of steels and arc welding of nickel and nickel alloys
	Canadian Standards Association	
CAN/CSA-Z245.20-M86	CAN/CSA-Z245.20-M86	External fusion bond epoxy coated steel pipe

ISO STANDARDS:

ISO Standards:	ISO Number	DESCRIPTION
ISO 2409	2409	Adhesion test method
ISO 3575	3575 1996	Continuous hot-dip (galvanized) zinc coated carbon steel sheet of commercial and drawing qualities
ISO 6272-1	6272	Impact test method
ISO 8501-1	8501-1	Preparation of Steel Substrates before application of paint and related products Visual assessment of surface cleanliness; part 1: rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings (pictorial surface preparation standards for painting steel surfaces)
ISO 8502.3	8502.3	Preparation of Steel Substrates before application of paint and related products. Tests for the assessment of surface cleanliness. Part 3 - Assessment of dust on steel surfaces prepared for painting (pressure sensitive tape method)
ISO 8503 Part 2	8503 Part 2	Preparation of Steel Substrates before application of paint and related products. Surface roughness characteristics of blast cleaned steel substrates. Part 2 - Method of grading of surface profile of abrasive blast cleaned steel - comparator procedure
ISO 9000	9000	Quality management systems-Fundamentals and vocabulary

APPENDIX B FORM STATING PROPOSED SUB- CONTRACTORS

This form to is be completed and signed by the tenderer, together with completed Form Appendix C

No change after acceptance is permitted without written approval by the Engineer

Contract Title		Number	

Main Contractor		Contact	
Address		Tel No Fax No Cell phone	

Fabrication Sub – Contractor		Contact	
Address		Tel No Fax No Cell phone	

Painting Sub – Contractor (Yard)		Contact	
Address		Tel No Fax No Cell phone	

Painting Sub – Contractor (Site)		Contact	
Address		Tel No Fax No Cell phone	

I certify that we will adhere to the above unless otherwise agreed in writing by the Engineer

Date:

NAME..... For Tenderer

Company Stamp

APPENDIX C FORM STATING MATERIALS TO BE USED

This form to be completed and signed by the material supplier and submitted by the tenderer with the completed Form Appendix B

Contract Title		Number	

Item	System No	Material Supplier	Product Name	Product Code No

I certify that I have read the requirements stated in 10.1 of the *GOLDER 2006 CORROSION SPECIFICATION* and the above materials comply with the specification for the above contract and that these materials are suitable for the purpose intended.

Date:.....

Name.....Signature.....

ON BEHALF OF..... (Material Supplier)

Witness Signature.....

COMPANY STAMP

Filename: Golder 2006 Corrosion Spec Rev 4-July06-Final.doc
Directory: G:\Company\Water Engineering\Corrosion
Template: Normal.dot
Title: grs amendments to Draft new Wates corr spec
Subject:
Author: Eric Duligal/Ludik
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PARTICULAR SPECIFICATION

M05: MECHANICAL ANAEROBIC AND ANOXIC MIXING EQUIPMENT

4	2013-10-23	Minor updates and re-issued	J Ritchie	
3	2012-07-30	Review and update	T Wellard	
2	2010-02-15	General review	J Ritchie	
1	2009-05-12	Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance		
Rev	Date	Description	Signature: JW Wastewater Partnership	Signature: Approval from Johannesburg Water

PARTICULAR SPECIFICATION: M05: MECHANICAL ANAEROBIC AND ANOXIC MIXING EQUIPMENT

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M05.1 SCOPE

This specification covers the detailed design parameters, manufacture, supply, installation, test and commissioning of mechanical mixing equipment for anaerobic and anoxic compartments within a biological reactor at a wastewater treatment works.

M05.2 INTERPRETATIONS

M05.2.1 Abbreviations

In this Specification the following abbreviations will apply:-

ANSI	:	American National Standards Institute
ASTM	:	American Society for Testing and Materials
BS	:	British Standards Institution
SANS	:	South African National Standards
SIS	:	Swedish Institute of Standards
DIN	:	Deutsch Industry Normen
ISO	:	International Organisation for Standardization
ASME	:	American Society of Mechanical Engineers
SAECC	:	South African Electrolytic Corrosion Committee
AGMA	:	American Gear Manufactures Association

M05.2.2 Standards

All design standards for the mixing equipment shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 10400: 1990	:	National Building Regulations
BS 5304: 1988	:	Code of practice for safeguarding of machinery
SANS 9606 - 1: 1994	:	Testing of welders, where applicable to the type of welding required
BS 292 Part 1: 1987	:	Dimensions of ball bearings, cylindrical and spherical roller bearings
SANS 10044-3	:	Welding Part 3: The fusion of steel (including stainless steel): Tests for the approval of welding procedures
SANS 10044-4	:	Welding Part 4: The fusion welding of steel (including austenitic stainless steel): Tests for the approval of welders working where weld procedure approval is not required.
SANS 10064	:	The preparation of steel surfaces for coating
SANS 10111-2-1	:	Engineering Drawing Part 1: General principles Engineering Drawing Part 2: Geometric Tolerancing Section 1
SANS 10341	:	Installation and maintenance of bearings – General guidelines
SANS 1700-5-9	:	Fasteners Part 5: General requirements & material properties Section 8: Corrosion resistant stainless steel fasteners-Bolts, Screws & Studs
SANS 1700-5-10	:	Fasteners Part 5: General requirements & material properties Section 8: Corrosion resistant stainless steel fasteners-Nuts
SANS 1034: 1975	:	Grey iron castings

M05.2.3 General Requirements

This specification must be read in conjunction with the following specifications:-

M08: Volume M08: Particular Specification for Gearboxes

E01: Volume E01: Particular Specification for Electric Motors

G01: Particular Specification for Colour Codes

G02: Particular Specification for Corrosion Protection

M05.3 **DESIGN OF MIXING EQUIPMENT**

M05.3.1 General Design Parameters

Equipment shall be designed:

- To facilitate manufacture, inspection, installation, maintenance, cleaning and repairs.
- To ensure safe and satisfactory operation for an acceptable life expectation of 12 years under the ambient conditions prevailing at the Site.
- To prevent undue stresses being produced by expansion due to temperature changes.
- To keep maintenance costs to a minimum.
- To facilitate inter-changeability of units and/or sub-parts throughout the Contract works with regard to new equipment and equipment and/or sub-parts currently being used on the existing JW Wastewater Treatment Works.
- To operate without undue vibration and excessive noise. Maximum of 84dBA measured at 1 metre from operating equipment.
- To comply with the legal requirements in respect of safety as well as the prevention of water and air pollution.
- To satisfy any specific requirement contained in the statutory codes and legislation.
- To be suitable for operation 365 days per year, 24 hours per day under specified design conditions.

M05.3.2 Specific Mixer Design Parameters

All mixing equipment shall be surface mounted. Mixing equipment shall be designed to operate satisfactory under the atmospheric, ambient and other conditions specified in the Project Specifications. The approximate compartment volumes shall be detailed in the Project Specification.

Mixed liquor may have a maximum suspended solids concentration of approximately 6 kg/m³ and shall be continuously mixed. The sludge Design Sludge Volume Index (DSVI) will be between 80 and 240 ml/gm under normal operating conditions.

Power input and the flow pattern shall be such as to minimise vortex formation and surface turbulence and any undue oxygenation.

The rotational design speed of the mixer shall not exceed 25 r/min.

Mixed liquor shall contain limited amounts of rags and fibrous material and the turbine blades shall be designed to prevent the build-up of this material on them.

In the event of a power outage, the mixers shall be capable of re-suspending all settled solids throughout the basin and the scouring velocity shall be a maximum as close to the floor as possible.

Different materials of construction shall be isolated from each other to prevent corrosion due to galvanic reaction.

Periodic stopping and restarting of the mixers units shall be accounted for in the mixer design and this should not be detrimental to the operation of the mixers units supplied.

The direction of rotation of the mixer turbine impellers shall be as specified in the project specific specification.

M05.4 MIXER TURBINE DESIGN

M05.4.1 Impellor Design Parameters

Mixer turbines shall be of a dual impellor arrangement ensuring maximum mixing efficiency, consisting of a radial flow type impellor (flat back curved blade or retreating type) design to assist in centering the unit and promote self cleaning, positioned suitably from the basin bottom creating the necessary radial mixing flow pattern. The axial flow type impellor shall be designed to prevent the undue accumulation of rags and debris material around the shaft at the liquid surface level. The axial flow impellor shall be installed at a distance of at least twice the impellor diameter below the liquid surface but shall be not less than 800mm.

The mixing energy required for the radial flow type impellor shall be 4-5 W/m³ whilst the axial flow impellor shall impart a maximum of 0.5 W/m³ mixing energy. Mixing energy shall be defined as the actual power imparted into the mixed liquor via the turbine by the motor and gearbox assembly.

The tip speed of the radial flow impellor shall not exceed 2,5m/s

The shape of the mixer blades shall be such as to prevent surface movement, aeration of the mixed liquor and shear forces exerted on the surrounding liquid. An anti vortex baffle or disc shall be incorporated in the turbine design to eliminate this condition. Tenderer's considering addition anti vortex baffles shall be required to indicate the requirement in their offer to achieve the desired mixing efficiency without any aeration. Full details shall be included in their tender. Any additional costs therefore shall be deemed to be included in their tender pricing schedules.

Note: where the mixer is specified in the project specific specification to be installed in a balancing tank then the top axial flow type impellor is not required and only the bottom radial flow shall be supplied.

M05.4.2 Mixer Impellor Material

The mixer blades shall be manufactured from 304 L stainless steel plate with a minimum thickness of 6 mm.

M05.4.3 Mixer Shaft

The shaft diameter shall be sufficient to prevent whipping or deflecting of the mixer shaft if rags and fibrous material collect on the shaft or blades. The shafts and bearings design shall allow for the out of balance forces that result from mixer operation at the Works. The shaft shall run at below critical speed and shall be able to operate at all liquid levels that may arise in the reactor.

Mixer shafts shall preferably be tubular to withstand all forces set up by the turbines and shall be manufactured in LDX 2101 Duplex Stainless Steel and shall be structurally sound to prevent instability due to rag build-up.

The mixer shaft shall be flanged at both ends and designed to prevent any eccentricity when installed in the field. Fitted machine bolts are preferred to join the shafts to the flanges and marking of the respective positions for installation shall be noted during manufacture. Special attention shall be paid to the alignment of gear output shaft, drive shaft and mixer impeller. Flanges shall be machined only after all welding has been completed.

The mixer assembly shall be statically balanced during manufacture and checked after installation for perceptible vibration or undue swaying under operating conditions.

M05.4.4 Fasteners

All under water fasteners shall be 316 SS and mating flanges shall be sealed against the ingress of any crevice corrosion by means of a sealant suitable for underwater conditions.

M05.5 GEARBOX ASSEMBLIES

Refer to Particular Specification M08: Volume M08: Gearboxes for a detailed specification on gearboxes.

M05.6 MIXER BASE PLATE

A robust HD galvanized base plate shall be provided to fix the drive unit securely to the existing mounting platform using hot dip galvanized or 316 SS (chemical type) foundation bolts. The Contractor shall include for all necessary civil preparation work required on the existing platforms, drilling, core drilling for foundation bolt holes and spindles and grouting of bolts and base plates into position.

The Contractor shall also repair all non re-useable pockets and holes at the mixer positions to the satisfaction of the Engineer.

The base plate shall elevate the mixer assembly to facilitate the draining of oil from the gearbox.

M05.7 MIXER MOTORS

Motors shall be vertical flange mounted. The electrical motors shall be coupled to the gearboxes by means of a pin type flexible coupling. The input power of the mixer, when measured at the mixer shaft shall not be less than 5 W/m³. Weather hoods shall be fitted to all motors to prevent ingress of rain into the motor.

For a detailed specification for the electrical motors required refer to Particular Specification E01: Volume E01: Electric Motor.

M05.8 CORROSION PROTECTION

Refer to Particular Specification G02: Corrosion Protection.

M05.9 COLOUR CODES

The standard final colour codes for equipment supplied under this Contract shall conform to Particular Specification G01: Colour Codes.

M05.10 MIXER PERFORMANCE

Information shall be supplied in the Tender of where and when such equipment has been previously installed. The Tenderer shall also indicate in his tender what mass, torque, radial load, bending moment, AGMA rating and mechanical power and thermal ratings are involved.

The performance of the mixers will be evaluated by checking that no sludge build-up occurs in any part of the reactor and that there is no air entrainment or vortexing taking place within each zone of influence of each mixer supplied under this Contract.

M05.11 QUALITY MANAGEMENT (QM) AND QUALITY ASSURANCE (QA)

QM shall be categorised as 'critical and major' for this section of the Project.

M05.11.1 Manufacture

Tenderers shall submit with their tender a detailed Project Quality Plan, stating how they control the flow of paperwork from commencement of the Project through final handover to the Client, a sample of their Quality Control Plan, (QCP) and Project Quality Plan, (PQP) both during the course of the Project, manufacture and finally, installation.

All items of equipment shall be subject to inspections by the Engineer during design and manufacture per these QCP's.

In general, it is anticipated that this Project shall be in accordance with the relevant ISO 9000 requirements.

M05.11.2 Installation

The successful Tenderer shall submit a QCP covering all aspects of the installation of each item of equipment to be installed under this Project. The Engineer shall be requested to attend certain stages of completion of installation to ascertain compliance with the Specifications and to witness the Contractor's site inspections at the Engineer's discretion.

M05.11.3 Performance Testing

Works testing

Each item of equipment shall be subject to inspection and testing prior to despatch from the works. All performance test results shall be made available to the Engineer for verification or when the QCP's require intervention or hold points for inspection.

In the case of gearboxes, they shall be subject to testing under operating conditions for at least 12 hours on the test bed. All results shall be available for inspection.

Before commissioning

- Check for correct oil level in gearboxes and that motors are greased properly.
- Ensure all HD bolts are torqued down correctly.
- The alignment and levelling of each assembly shall be checked and the results shall be available for inspection by the Engineer.
- Check correct submergence of each turbine and adjust on the jacking bolts.
- The electrical functions and control shall be checked by a responsible inspector prior to attempting to start any motor on this Project.

After Initial Commissioning

- Ensure all oil pumps and flow or pressure switches are functional.
- Check for correct operation of mixer rotation, speed, vibration and noise.
- Note vibration readings.
- Note amperage drawn by each assembly.
- Visual check of excess vortexing at each mixer
- Check gearbox oil temperature after 6 hours of operation and take corrective action as required.

M05.11.4 Before Expiry of the Defects Liability Period

The Engineer requires the Contractor to visit the site every quarter to inspect for the correct operation of the installed equipment. A report after each visit shall be submitted in writing.

M05.12 MEASUREMENT AND PAYMENT

Payment under scheduled items shall be made per complete installation as specified, electrical connections, etc and grouting, etc. Measurement and payment will distinguish between supply / delivery and installation / commissioning of the equipment.

The Contractor shall include in the Tendered rate for straining of the gearbox oil after 600 hours of initial operation. The Contractor shall furnish the Engineer with a report recording any irregularities when cleaning the sieves after straining.

The tendered rates or sums shall cover the cost of design, drawings, manufacture, supply, testing at the manufacturers works, delivery to site, off loading, installation, site testing, setting into operation, the supply of O & M manuals, commissioning and maintenance during the warranty period of all equipment specified and also for anything not specifically mentioned but obviously required, (e.g. all ancillaries, including all bolts, fastenings and brackets, safety guards and any work or material required for the proper installation of such equipment) to enable the equipment to be installed and/or function safely and correctly as specified. No claims whatsoever for extras will be allowed on the grounds that a necessary piece of equipment or a part thereof is not specifically mentioned.



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PARTICULAR SPECIFICATION

M08: MECHANICAL GEARBOXES

4	2013-10-23	Minor updates and re-issued	J Ritchie	
3	2012-07-30	General review	T Wellard	
2	2010-02-15	General review	J Ritchie	
1	2009-05-12	Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance		
Rev	Date	Description	Signature: JW Wastewater Partnership	Signature: Approval from Johannesburg Water

PARTICULAR SPECIFICATION: M08: MECHANICAL GEARBOXES

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M08.1 SCOPE

This specification covers the detailed design parameters, manufacture, supply, installation, test and commissioning of complete Gearboxes. The Specification shall be read in conjunction with the Project Specification.

M08.2 INTERPRETATIONS

M08.2.1 Abbreviations

In this Specification the following abbreviations will apply:-

ANSI	: American National Standards Institute
ASTM	: American Society for Testing and Materials
BS	: British Standards Institution
SANS	: South African National Standards
SIS	: Swedish Institute of Standards
DIN	: Deutsch Industry Normen
ISO	: International Organisation for Standardization
ASME	: American Society of Mechanical Engineers
SAECC	: South African Electrolytic Corrosion Committee
AGMA	: American Gear Manufactures Association

M08.2.2 Standards

All design standards for the mechanical gearboxes shall be subject to the latest amendments and editions of the following standard specifications:-

BS 5304	: Code of practice for safeguarding of machinery
SANS 9096-1: 1994	: Testing of welders, where applicable to the type of welding required
BS 292 Part 1: 1987	: Dimensions of ball bearings, cylindrical and spherical roller bearings
SANS 10162-4	: Structural use of Steel Part 4: The design of cold-formed stainless steel structural
SANS 1044-3	: Welding Part 3: The fusion of steel (including stainless steel): Tests for the approval of welding procedures
SANS 10044-4	: Welding Part 4: The fusion welding of steel (including austenitic stainless steel): Tests for the approval of welders working where weld procedure approval is not required.
SANS 10064	: The preparation of steel surfaces for coating
SANS 10111-2-1	: Engineering Drawing Part 1: General principles Engineering Drawing Part 2: Geometric Tolerancing Section 1
SANS 10341	: Installation and maintenance of bearings – General guidelines
SANS 1700-5-9	: Fasteners Part 5: General requirements & material properties Section 8: Corrosion resistant stainless steel fasteners-Bolts, Screws & Studs
SANS 1700-5-10	: Fasteners Part 5: General requirements & material properties Section 8: Corrosion resistant stainless steel fasteners-Nuts
ISO 281	: Rolling bearings -- Dynamic load ratings and rating life

BS 4999 : General requirements for rotating electrical machines. Specification for standard dimensions

SIS 05 59 00 : Pictorial Surface Preparation Standards for Painting Steel Surface

M08.2.3 General Requirements

This specification must be read in conjunction with the following specifications:-

G01: Particular Specification for Colour Codes

G02: Particular Specification for Corrosion Protection

M08.3 **GEARBOXES**

M08.3.1 Design Parameters

The Tenderer shall submit with his Tender a catalogue of the make of gearbox offered and indicate how the selection of gearboxes was made.

Unless otherwise stated, the gearboxes shall be directly mounted to the motor. The gears shall be helical gears which are used in applications with high speeds, large power transmission and low noise levels.

Gear drives shall be sized to ensure that the running load peak does not exceed the endurance limits of the components.

Gearboxes shall have an efficiency of not less than 96% on two stage reduction and 95% on three stage reduction.

Simple cooling may be by convection from the gearbox casings but without assistance from cooling fins or fans. Adequate other cooling means shall be provided as applicable. The exterior of the gearbox shall be free from dust or moisture traps. Access for inspection purposes shall be allowed for in the design of the gearbox casing. Maintenance free oil lock seals on the high speed shafts shall be a standard design feature.

Where the lubrication system requires the use of an oil pump then the circulation system will be fitted with an oil flow switch in order for any no flow or low flow conditions to be monitored on the works SCADA system. This will require that a potential free contact capable of switching 500 mAmp at 230 Volts A.C. be provided.

The bearing span shall be suitably selected for vertical gearbox application and shall promote shaft support for the intended application. Rigid lateral load distribution shall be by means of a standardized pinioned arrangement reducing noise and vibration.

A rigid half coupling shall be shrunk onto the output shaft of the gearbox and shall be secured by an additional keep plate and bolted connection in a recognised manner.

Substantial eye bolts shall be provided for all reasonable lifting purposes.

The gearboxes shall carry the manufacturer's identification details together with the rated shaft speeds, output power and maximum ambient operating temperature.

The gearboxes shall conform to the relevant British Standards and AGMA ratings with respect to the following requirements:

- (a) The design ambient temperature shall be 45°C.
- (b) The noise at 100% of the full output power and 45°C ambient shall not exceed 90 dBA as measured 1 m in distance from the equipment.

(c) The gearing shall give double the life of the bearings when subjected to similar loadings.

The design of the gearbox shall be such that the following calculation shall be adhered to: -

$$\frac{\text{Actual Radial Load}}{\text{Permissible Actual Radial}} + \frac{\text{Actual Axial Load}}{\text{Permissible Axial Load}} \text{ shall be } \leq 1,0$$

Calculations shall be submitted. Failure to do so may render the Tender invalid.

Tenderers shall state in their tenders whether external oil filters, flow and pressure switches are included in their offer.

A stainless steel ball valve and extension drain pipe and plug shall be provided to facilitate oil changes by the maintenance staff. The termination of this drain shall be accessible from the operating platform.

M08.3.2 Gears

The gears shall be high efficiency case hardened helical gears and rated in accordance with the AGMA Code of Practice 420.04 for continuous operation. The gears shall be manufactured from high cast iron to BS 1542 Class 220 or an equivalent standard.

Semi-hardened and subsequently machined gears will not be accepted. Pinions shall be manufactured in accordance with AGMA 390.02 Class 12.

M08.3.3 Service Factor

The service factors indicated in the table below shall be based upon the installed power:-

Process Units	Service Factor
Rotating Bridges: Sedimentation & Clarifier Tanks	1.5
Rotating Scraper System: WAS Thickeners & Fermentation Tanks	1.75
Aerators	2.25
Mixers	2
Screw & Plunger Pumps	2.25
Centrifugal Pumps	2
Dosing Pumps	2
Mechanical Screens	2

M08.3.4 Bearings

Roller bearings shall be used throughout. Taper roller bearings shall be used to sustain radial and thrust loads. Bearings shall be designed for a design life in excess of the indicated hours in the table below, in accordance with ISO.281. Bearings for the output shaft shall be designed to withstand bending, up thrust, down pull and radial loads imposed by the equipment being driven. Tenderer's shall indicate what these forces are and how these shall be accommodated.

The Contractor shall ensure the lubricant used for the initial filling and specified in the maintenance manual, is adequate for prolonged operation in ambient temperatures of up to 45°C without overheating.

Process Units	Design Life	Operation
Rotating Bridges: Sedimentation & Clarifier Tanks	L10 for 75 000	Continuous
Rotating Scraper System: WAS Thickeners & Fermentation Tanks	L10 for 75 000	Continuous
Aerators	L10for 100 000	Continuous
Mixers	L10 for 100 000	Continuous
Screw & Plunger Pumps	L10 for 100 000	Continuous
Centrifugal Pumps	L10 for 100 000	Continuous
Dosing Pumps	L10 for 100 000	Continuous
Mechanical Screens	L10 for 75 000	Continuous

M08.3.5 Lubrication

The gearboxes shall be constructed with a dry well for the low speed shaft bearing to avoid complete drainage of oil in the event of an oil seal failure. Provision to monitor the oil level must be provided. The bearing shall be grease lubricated with the greasing point easily accessible.

A stainless steel ball valve and extension drain pipe and plug shall be provided to facilitate oil changes by the maintenance staff. The termination of this drain shall be accessible from the operating platform.

M08.3.6 Gearbox / Motor Coupling

The coupling shall be fully rated to transmit the motor full load power and tested to prove static and dynamic balance. The coupling shall accommodate small axial, lateral and angular misalignments without imposing undue stresses on the shaft and bearings. The coupling shall be enclosed in a stationery solid-plate guard to the Engineers satisfaction.

M08.3.7 V-belt

V-belts shall be designed to withstand the high tension and high power drives, shall be long wearing, tough and trouble free. The V-belt cover shall be oil, heat and ozone resistant in order to protect the inner components. The compression section shall provide excellent gripping action and a high coefficient of friction, but shall also allow an initial start-up clutching action in order to eliminate power spikes and excessive bearing loading. The moulded cogs shall provide optimum flexibility with minimal build up of heat.

M08.3.8 Flexible Couplings

Flexible couplings consist of two types: gear type and multiple disc/diaphragm type. The gear type uses gear teeth to make them flexible and is either grease lubricated or oil lubricated depending upon their size. Diaphragm couplings do not require any form of lubrication and the flexibility is created by a series of multiple discs or a diaphragm made of spring steel and flexes as the shaft rotate.

Misalignment of the coupling is to be prevented by proper alignment of the coupling by means of a taper gauge or set of feeler gauges and a straight edge or dial indicator. Two types of misalignments are encountered by flexible couplings: Angular misalignment and parallel misalignment. Any adjustment to correct the misalignment in one direction may affect the other direction and both the angular and parallel alignment shall be checked after each adjustment.

A periodic check of the coupling alignment shall be performed.

M08.3.9 Housing

The gearbox shall be manufactured high strength cast iron which enables the gearbox to be used in harsh environments.

A breather designed to prevent moisture from entering the housing of the gearbox, shall be fitted to each unit supplied under this contract. Breather unit allowing continues oil spillage due to the overfilling of the gearbox shall not be accepted.

Oil level sight glasses (fully protected and UV resistant) shall be provided with levels marked for running and filling minimum and maximum positions respectively. These shall be arranged for easy viewing and shall take into account the angle of mounting.

M08.3.10 Shaft

The Input and output shafts shall be of sufficient dimension in order to avoid excessive torsional or bending stresses and deflection. The impeller shall be secured to the shaft in such a way that it can be readily removed without any damage to the impeller and the shaft.

The shafts shall be protected by replaceable sleeves manufactured from non-corrosive material. The shaft shall be manufactured from stainless steel.

M08.4 **SPARES AND TOOLS**

The Tenderer must submit on the appropriate schedule a priced list of spare parts which it is recommended should be kept by the water treatment plant for maintenance of the plant. Spares which the Management decides to order must be manufactured simultaneously with the rest of the equipment and be subject to the same tests for dimensions, tolerances, strength, etc. All spares must be packed separately and the cases appropriately marked. All spares must be new and unused.

A full range of spares must be kept available for not less than 15 years.

Tenderers must submit a provisional price (where applicable) for a complete set of spanners, keys and tools required for the operation, adjustment and overhaul of the plant supplied. All spanners, keys and tools shall be new and unused.

M08.5 **PROOF OF MAINTENANCE**

The period of maintenance will extend over a period of 12 months calculated from the Completion as defined in the Appendix. However, should a portion or all of the plant and equipment fail / or require rectification during this period, the Engineer reserves the right to extend the Period of Maintenance in respect of such portion or all of the plant and equipment for a further period of not more than 12 months calculated from the date of Commissioning of such plant and equipment after rectification

M08.6 **METAL PREPARATION AND CORROSION PROTECTION**

Refer to Particular Specification G02: Corrosion Protection

M08.7 **COLOUR CODES**

The standard final colour codes for equipment supplied under this Contract shall be in accordance with Particular Specification G01: Colour Codes.

M08.8 QUALITY MANAGEMENT (QM) AND QUALITY ASSURANCE

QM shall be categorised as 'critical and major' for this section of the Project.

M08.8.1 Manufacture

Tenderers shall submit with their tender a detailed Project Quality Plan, stating how they control the flow of paperwork from commencement of the Project through final handover to the Client, a sample of their Quality Control Plan, (QCP) and Project Quality Plan, (PQP) both during the course of the Project, manufacture and finally, installation.

The successful Tenderer shall submit a QCP covering all aspects of the manufacturing process, indicating held points to allow the Engineer opportunities to evaluate the equipment for compliance to this specification.

All items of equipment shall be subject to inspections by the Engineer during design and manufacture per these QCP's.

In general, it is anticipated that this Project shall be in accordance with the relevant ISO 9000 requirements.

M08.8.2 Installation

The successful Tenderer shall submit a QCP covering all aspects of the installation of each item of equipment to be installed under this Project. The Engineer shall be afforded every opportunity to certain stages of completion of the installation to ascertain compliance with the Specifications and to witness the Contractor's site activities at the Engineer's discretion.

M08.9 SYSTEM PERFORMANCE

Works testing

Each item of equipment shall be subject to inspection and testing prior to despatch from the works. All performance test results shall be made available to the Engineer for verification or when the QCP's require intervention or hold points for inspection.

Gearboxes shall be subject to testing under operating conditions for at least 12 hours on the test bed. All results shall be available for inspection.

Before commissioning

- Check for correct oil level in gearboxes
- Ensure all HD bolts are torqued down correctly.
- The alignment and levelling of each assembly shall be checked and the results shall be available for inspection by the Engineer.
- The electrical functions and control shall be checked by a responsible inspector prior to attempting to start any motor on this Project.

After Initial Commissioning

- Ensure all oil pumps and flow or pressure switches are functional
- Vibration testing

M08.9.1 Before Expiry of the Defects Liability Period

The Engineer requires the Contractor to visit the site every quarter to inspect for the correct operation of the installed equipment. A report after each visit shall be submitted in writing. The Contractor shall be requested to drain and replace the oil in each gearbox before the expiry of

the defects liability period. The drained oil shall be sieved and inspected for any contamination in the oil. In the event of any unusual contamination, (metal deposits etc) the Contractor, will take the necessary steps, to investigate the cause, and where required to replace and or repair the gearbox (s) at no cost to the employer.

M08.10 MEASUREMENT AND PAYMENT

Measurement and payment will distinguish between supply/delivery and installation/commission as well as per installation point. The respective tender rates shall cover all costs from supply to commission of each gearbox but excluding the electrical power supply and electrical cable connection.

The tendered rates or sums shall cover the cost of design, drawings, manufacture, supply, testing at the manufacturers works, delivery to site, off loading, installation, site testing, setting into operation, the supply of O & M manuals, commissioning and maintenance during the warranty period of all equipment specified and also for anything not specifically mentioned but obviously required, (e.g. all ancillaries, including all bolts, fastenings and brackets, safety guards and any work or material required for the proper installation of such equipment) to enable the equipment to be installed and/or function safely and correctly as specified. No claims whatsoever for extras will be allowed on the grounds that a necessary piece of equipment or a part thereof is not specifically mentioned.



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PARTICULAR SPECIFICATION

M15: FILTER BELT PRESS EQUIPMENT

4	2013-10-23	Minor updates and re-issued	J Ritchie	
3	2012-07-30	General update and re-issue		
2	2010-02-16	General review	J Ritchie	
1	2009-05-12	Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance		
Rev	Date	Description	Signature: JW Wastewater Partnership	Signature: Approval from Johannesburg Water

PARTICULAR SPECIFICATION: VOLUME M15: FILTER BELT PRESS EQUIPMENT

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M15.1 SCOPE

This specification covers the detailed design parameters, manufacture, supply, installation, test and commissioning of mechanical belt filter press and ancillary equipment for the dewatering of anaerobic digested sludge and waste activated sludge generated at wastewater treatment works.

M15.2 INTERPRETATIONS

M15.2.1 Abbreviations

In this Specification the following abbreviations will apply:-

ANSI	:	American National Standards Institute
ASTM	:	American Society for Testing and Materials
BS	:	British Standards Institution
SANS	:	South African National Standards
SIS	:	Swedish Institute of Standards
DIN	:	Deutsch Industry Normen
ISO	:	International Organisation for Standardization
ASME	:	American Society of Mechanical Engineers
SAECC	:	South African Electrolytic Corrosion Committee
AGMA	:	American Gear Manufactures Association

M15.2.2 Standards

All design standards for the belt press equipment shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 10400: 1990	:	National Building Regulations
BS 5304: 1988	:	Code of practice for safeguarding of machinery
SANS 9606 - 1: 1994	:	Testing of welders, where applicable to the type of welding required
BS 292 Part 1: 1987	:	Dimensions of ball bearings, cylindrical and spherical roller bearings

M15.2.3 General Requirements

This specification must be read in conjunction with the following specifications:-

M08: Particular Specification for Gearboxes

M16: Particular Specification for Conveyor Equipment

M19: Particular Specification for Dosing Pumps

M21: Particular Specification for Pressure Pipework

M30: Particular Specification for Polyelectrolyte handling, storage, make up and dosing

E01: Particular Specification for Electric Motors

G01: Particular Specification for Colour Codes

G02: Particular Specification for Corrosion Protection

Automation and Control Design Standards Volume 8: Flow Measurement

M15.3 DESIGN OF BELT FILTER PRESS EQUIPMENT

M15.3.1 General Design Parameters

Equipment shall be designed:

- To facilitate manufacture, inspection, installation, maintenance, cleaning and repairs.
- To ensure safe and satisfactory operation for an acceptable life expectation of 12 years under the ambient conditions prevailing at the Site.
- To prevent undue stresses being produced by expansion due to temperature changes.
- To keep maintenance costs to a minimum.
- To facilitate inter-changeability of units and/or sub-parts throughout the Contract works with regard to new equipment and equipment and/or sub-parts currently being used on the existing JW Wastewater Treatment Works.
- To operate without undue vibration and excessive noise. Maximum of 84dBA measured at 1 metre from operating equipment.
- To comply with the legal requirements in respect of safety as well as the prevention of water and air pollution.
- To satisfy any specific requirement contained in the statutory codes and legislation.
- To be suitable for operation 365 days per year, 24 hours per day under specified design conditions.

M15.4 CONVEYOR SYSTEMS

The design of the conveyor system shall comply with particular specification M16: Conveyor Equipment. Specific design parameters pertaining to the project shall be detailed in the Project Specification.

M15.5 POLYELECTROLYTE MAKE-UP AND DOSING SYSTEM

The polyelectrolyte make-up and dosing installation shall compile with particular specification M30: Polyelectrolyte Handling, storage, make up and dosing. The dosing rate shall be as specified in the Project Specification.

M15.6 FILTER BELT PRESS

M15.6.1 Specific Performance Design Parameters

The sludge feed stream will have a solid content between 2 per cent and 6 per cent by mass. Sludge will be fed to the press at a rate of between 650 and 900 kg dry solids per hour.

A minimum Dry solids content of 18 per cent for the digested sludge is required to be achieved by the presses. Flocculent dosing must not exceed 4.5 kg per ton of dry solids. The belt filter press unit shall have an effective belt width of 2.0 m.

It is recommended that the Tenderer arranges to obtain samples of the material for testing to ensure that the belt press offered will achieve the required performance specified.

Filtrate and washwater effluent quality shall be that the suspended solids content does not exceed 300 mg/l and 1000 mg/l respectively.

The belt press design shall incorporate a large gravity dewatering section to pre-thicken the sludge prior to entering the press stages of the dewatering section. Sludge ploughs shall be strategically positioned on this section to assist with the removal of excess liquid from the flocculated sludge. Sludge ploughs shall be adjustable.

The pressure dewatering section shall comprise a set of not less than 10 no. dewatering pressure rollers of adequate size to achieve the required degree of dewatering with the pressure being evenly distributed on the sludge to prevent it from being squeezed through or out of the sides of the filter cloth. Rollers shall be of rigid design to prevent uneven pressure and cake distribution due to deflection of the rollers. The minimum diameter of the pressure

rollers shall be 215mm.

The pressure rollers shall be designed using a minimum design load of 10 Newton per linear millimetre with a maximum deflection of 1mm per metre of roller length.

The pressure rollers shall be manufactured using a stainless steel shell to ensure optimum life.

Rubber coated mild steel pressure rollers shall not be acceptable.

M15.7 FILTER BELT PRESS CONSTRUCTION

The press shall be a robust unit incorporating a stainless steel frame and rollers, stainless steel filtrate collection trays and sump, as well as a sludge inlet distribution and flocculation system with a stainless steel sludge distribution chute.

In adjudication of the contract, consideration will be given to the overall mass of the belt press unit. In order to comply with the technical requirements of this specification it is envisaged that a belt press with a total mass of approximately 7000kg will be required.

Materials of construction and all parts in contact with the sludge, washwater and liberated-gases, shall be manufactured from grade 304 and 316 stainless steel. Parts not subject to load may be from other suitable corrosion resistant material such as PVC. In order to contain and manage splashing and to minimize aerosol escape from the press, the design shall be of the enclose type, with all components such as bearings, limit switches and drives units outside of the enclosed area.

All steelwork outside the enclosure shall be 304 Stainless Steel.

All bearings shall be greased with minimum life of 100 000 hours (L10) and should be housed external to the press side frames.

If it is expected that the bearing life shall exceed the 100 000 hours, then bearings mounted internally to the press side frames can be accepted provided that the greasing points for the bearings are mounted externally to the press side frames and are easily accessible

All bearings shall be grease lubricated and effectively sealed against penetration by dust and water.

Washwater pipe work installed and supported off the belt press shall be manufactured from 304 L stainless steel. PVC piping shall not be acceptable. Tenders not complying with this requirement may lead to the disqualification of the Tender submitted.

M15.7.1 Enclosure Material

The press unit offered shall be totally enclosed on all sides (including the gravity filtration section), and suitable for operation under a negative pressure.

The air extraction opening(s) shall be positioned such that the amount of spray water drawn directly into the ducting is minimized.

Inspection hatches shall be provided on both sides of the press and at the top of the enclosure to allow examination inside the enclosure of the belts, rollers and general operation of the press.

The maximum total area of all permanently open apertures in the enclosure shall be stated in the data sheet for the belt press. Total open areas of 0.2 m² shall be considered as acceptable.

All moving mechanical and electrical components requiring on-line adjustments and servicing,

shall be located outside the press enclosure.

M15.7.2 Sludge Flocculation

The inlet end of the press shall be fitted with an upward flow flocculation tank.

A suitable designed mixer with continuously variable speed adjustment shall be provided in the flocculation tank for gentle mixing of the sludge and flocculent ensuring that any heavy sludge particles are kept in suspension. The mixer impeller shall be manufacture from 304 L stainless steel.

The flocculation tank shall discharge via a stainless steel spreader chute that shall ensure an even flow of sludge onto the gravity dewatering zone of the belt press. The spreader chute should be at an angle for easy flowing to prevent build up of sludge cakes.

If an in-line mixer is offered, an inspection box is required before discharging onto the gravity drainage section of the press as a visual check on the flocculation process.

In all case adequate contact time between the feed sludge, the inspection box and the flocculation tank shall be provided.

M15.7.3 Sludge Cake Handling

The press shall be provided with a stainless steel cake discharge chute suitable for delivering the sludge cake on to the sludge cake conveyor belt as indicated on the general arrangement drawing.

A sludge cake doctor blade arrangement must be provided that allows a constant adjustable and even liner pressure for the blade.

The washwater supplied by the Client shall be final effluent that can contain up to 30 mg/l solids. The volume in m³/h and head in kPa for each type of belt press shall be stated by the Tenderer.

Adequately sized collection trays and sumps within the press housing shall be provided to collect washwater and liquids from the sludge and to prevent re-wetting of the sludge cake. All liquids shall be piped to a common outlet at the base of the press and suitably flanged for external drainage piping. The spray system shall be self clean and the brush system shall be removable for inspection purposes.

M15.7.4 Filter Belt

The filter belts shall be provided as part of the press assembly and shall be of the seamless, type manufactured from durable monofilament polyester fibre. If not seamless then rugged S.S. clipper seam with adequate strength pintec wire shall be provided.

The belts shall be driven via drive rollers using externally mounted variable speed drive (VSD) units controlled by a frequency inverter. The VSD shall be a vector control type and shall be installed in a controlled environment away from the belt press in a PLC room designed for that purpose.

The belt tension shall be adjustable and tension shall be provided by two adjustable, parallel motion, synchronized belt tensioning devices of an approved design, mounted outside of the side frames, to automatically maintain the predetermined belt tension.

Belt alignment shall be automatically controlled by electrically operated belt edge tracking sensors.

A proximity switch shall be provided to automatically switch off the filter belt press in the event of the belts not being maintained on track. The switch shall initiate an alarm system on the control panel.

The belt misalignment switch shall be designed such that it will operate under any condition.

Adjustment of belt speed shall be possible with the machine in operation.

M15.7.5 Emergency Switch

An emergency trip wire switch shall be provided for each motor on the belt press unit to isolate the motors.

M15.7.6 Fasteners

All under water fasteners shall be 316 stainless steel.

M15.8 **GEARBOX ASSEMBLIES**

Refer to Particular Specification M08: Gearboxes for detail.

M15.9 **BELT PRESS ACCESS LADDER**

M15.9.1 Specific Design Parameters

The objective of the belt press access stairs and Platforms shall be to gain access to the top of the belt press for cleaning and maintenance purposes.

The required access stairs and platform layout is specified in the project specific specification and will comply with the following details.

M15.9.2 Platform

The platform shall be a minimum of 1200 mm in width and designed such that full access around the top of the belt press is possible. The platform shall be fitted with handrails and kick plates made from angles or flats that rise at least 100 mm above the platform. The handrails shall extend up from the access stairs and shall continue along the length of the platform and enclose the platform at the far edge.

M15.9.3 Handrails

Single handrails shall be provided on each side of the ladder, with a distance between them of no less than 750 mm centre to centre. Tubular hand and kneerails shall be made from steel tube with a thickness of no less than 2.5 mm. Joints shall be butted using tubular steel ferrules that shall be screwed and shall be located at points of minimum stress. Handrailing shall be prevented from rotating or moving longitudinally.

The steel tube shall be 34 mm outside diameter. Handrails shall be fabricated from hollow sections no less than 3 mm thick. The handrailing shall extend from the bottom stair up along the ladder, along the length of the platform and enclose the platform.

M15.9.4 Platform Support Frame

The access stairs and platforms shall be supported by a steel frame. The steel frame shall consist of a base and bracing designed to support the ladder and platform to prevent buckling. It is preferred that the support frame is independent from the belt press main frame.

M15.10 PIPE WORK

The design of the wash water, sludge feed and drain pipe work shall comply with Particular Specification M21: Pipework. All pressure pipes on the press and sludge pipework shall be manufactured from 304 stainless steel.

M15.11 ELECTRICAL CONTROL PANEL

The filter belt press shall be supplied complete with an integral control panel and shall provide electrical interlocks and indication of the following:-

- Belt track condition
- Belt misalignment protection switches to prevent belts from being damaged.
- Broken belt detection
- Low flow or pressure of washwater
- Low or no flocculent supply
- Low or no sludge flow
- Manual stop/start
- Forward and reverse control facility on the belt drive to assist mechanical maintenance to replace belts.(This facility shall be available on the control panel)
- All of the necessary fault conditions within the belt filter press that will cause damage, system failure or injury.
- The control panel shall have easy access in the front and back and have adequate lighting for maintenance purposes.
- All equipment supplied on the panel shall have a very high protection rating of IP66 for protection against ingress of water.
- The indication lamps must be the multi cluster LED type for longer life.
- All protection systems and devices shall be clearly displayed on the SCADA in order to alert the relevant maintenance or process staff to the problems with the belt.
- A comprehensive list of alarms shall be displayed on the SCADA to alert process or maintenance personnel when a belt goes into a shut down condition.
- An hour meter on the belt drive.

The control panel shall further be linked to a PLC as follows: (THE PLC SHALL NOT BE IN THE CONTROL PANEL but in a controlled environment away from the belt presses in a PLC room designed for that purpose).

- The PLC must be supplied, installed and programmed in accordance with the JHB Water Standards for PLC hardware, PLC software and PLC panels.
- The PLC must be interfaced with either the master PLC in the MCC, which in turn must be interfaced with the existing plant SCADA, or the PLC must be interfaced directly with the existing plant SCADA if there is no master PLC.
- PLC/SCADA interfacing must be done via the existing network or by extending the existing network if required.
- The PLC shall be able to interface directly with the rest of the PLC Network using Ethernet protocol and **not** use converters installed on the network.
- The control of the belt press's shall be done on the SCADA and not on the control panel, all adjustments of set points etc must be done on the SCADA.
- The control panel shall only be used for maintenance purposes and **not** to control the belt, all controls shall be done via the SCADA.
- The belt press shall have an electro-magnetic flow meter (mag flow) for measurement of instantaneous and totalised sludge, Poly and dilution water flows to the belt press. These flow meters shall comply with the Automation and Control Design Standards Volume 8: Flow measurement. The flow data (instantaneous flow and totalising pluses) from the flow meters shall be made available to the SCADA or the master PLC for ratio calculation and reporting purposes.

M15.12 ELECTRICAL MOTORS

The electrical motors shall be coupled to the gearboxes by means of a pin type flexible coupling.

The motors shall have an IP rating of at least IP 55 or IP 56 and not the standard rating of IP 54.

The motors shall be so installed that the terminal boxes are facing downwards to prevent ingress of water.

For a detailed specification for the electrical motors required refer to Particular Specification E01: Electric Motors

M15.12.1 Instrumentation

All control valves shall be electrical actuated.

All instrumentation such as control valves, magnetic flow meters etc., shall have easy access for repairs and calibration.

M15.13 ACCESS, MAINTENANCE AND OPERATION

All the necessary safety guards shall be fitted as part of the press assembly.

Access stairs, ladders and platforms adequate for safe operation, inspection and maintenance activities shall be provided. This shall include hand railing and kick plates.

The access platforms shall be supported to allow clear access underneath except where columns are positioned, and the height shall allow safe access to the press gravity dewatering area.

An overhead crawl beam will be available for maintenance purposes (provided by others). Access for maintenance from the top and from the sides shall be possible by easily removal of enclosure panels.

M15.14 COLOUR CODES

The standard final colour codes for equipment supplied under this Contract shall conform to Particular Specification G01: Colour Codes. The cost of painting shall be deemed to be included in the supply and delivery of the particular item supplied and installed under the Contract.

M15.15 PERFORMANCE GUARANTEE

Tenders shall offer a guarantee on the performance of the press at designed solids loading rate. The dry solids content of the cake (% D.S. by mass) and the associated consumption (kg/t dry solids) of the polymer shall be offered.

This guarantee data will be used to compare Tenderers over the life expectancy of the plant (15 years).

The performance of the completed plant shall be tested. Failure of the equipment to perform shall be penalised by withholding of a sum equal to:-

- In the case of failure to meet guarantee solids content, the amount specified in the project

specific specification will be deducted from monies payable to the contractor.

In the case of failure to meet guarantee polyelectrolyte consumption during the test period, by the cost of polyelectrolyte calculated to-be used on:

- The excess consumption rate determined during the test period;
- An average dry solids loading as specified in the Project Specification as dry tons per day;
- The current cost to the client of polyelectrolyte delivered on site;
- An operating period of 15 years, and;
- A discount rate of 6 per cent p.a.

M15.16 QUALITY MANAGEMENT (QM) AND QUALITY ASSURANCE (QA)

QM shall be categorised as 'critical and major' for this section of the Project.

M15.16.1 Manufacture

Tenderers shall submit with their tender a detailed Project Quality Plan, stating how they control the flow of paperwork from commencement of the Project through final handover to the Client, a sample of their Quality Control Plan, (QCP) and Project Quality Plan, (PQP) both during the course of the Project, manufacture and finally, installation.

All items of equipment shall be subject to inspections by the Engineer during design and manufacture per these QCP's.

In general, it is anticipated that this Project shall be in accordance with the relevant ISO 9000 requirements.

M15.16.2 Installation

The successful Tenderer shall submit a QCP covering all aspects of the installation of each item of equipment to be installed under this Project. The Engineer shall be requested to attend certain stages of completion of installation to ascertain compliance with the Specifications and to witness the Contractor's site inspections at the Engineer's discretion.

M15.16.3 Performance Testing

Works testing

Each item of equipment shall be subject to inspection and testing prior to despatch from the works. All performance test results shall be made available to the Engineer for verification or when the QCP's require intervention or hold points for inspection.

M15.16.4 Before Expiry of the Defects Liability Period

The Engineer requires the Contractor to visit the site every quarter to inspect for the correct operation of the installed equipment. A report after each visit shall be submitted in writing by the Contractor.

M15.17 MEASUREMENT AND PAYMENT

Payment under scheduled items shall be made per complete installation as specified, electrical connections, etc and grouting, etc. Measurement and payment will distinguish between supply / delivery and installation / commissioning of the equipment.

The tendered rates or sums shall cover the cost of design, drawings, manufacture, supply, testing at the manufacturers works, delivery to site, off loading, installation, site testing, setting

into operation, the supply of O & M manuals, commissioning and maintenance during the warranty period of all equipment specified and also for anything not specifically mentioned but obviously required, (e.g. all ancillaries, including all bolts, fastenings and brackets, safety guards and any work or material required for the proper installation of such equipment) to enable the equipment to be installed and/or function safely and correctly as specified. No claims whatsoever for extras will be allowed on the grounds that a necessary piece of equipment or a part thereof is not specifically mentioned.



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M16: MECHANICAL CONVEYOR EQUIPMENT

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PARTICULAR SPECIFICATION M16: MECHANICAL CONVEYOR EQUIPMENT

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M16.1 SCOPE

This specification covers the detailed design criteria, manufacture, supply, installation, test and commissioning of mechanical belt conveyor systems for the conveyance processed sludge at a waste water treatment works.

M16.2 INTERPRETATIONS

M16.2.1 Abbreviations

In this Specification the following abbreviations will apply:-

ANSI	: American National Standards Institute
ASTM	: American Society for Testing and Materials
BS	: British Standards Institution
SANS	: South African Bureau of Standards
SIS	: Swedish Institute of Standards
DIN	: Deutsch Industry Normen
ISO	: International Organisation for Standardization
ASME	: American Society of Mechanical Engineers
SAECC	: South African Electrolytic Corrosion Committee

M16.2.2 Standards

All design standards for the conveyor systems shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 1168, 1313 and 1173	: Conveyor equipment
ISO 5048	: Design of Conveyors
ISO 5048	: Continuous mechanical handling equipment, Belt conveyors with carrying idlers, Calculations of operating power and tensile forces
SABS 400: 1990	: National Building Regulations
BS 5304: 1988	: Code of practice for safeguarding of machinery
SABS 044 Part III to IV: 1993	: Testing of welders, where applicable to the type of welding required
BS 292 Part 1: 1987	: Dimensions of ball bearings, cylindrical and spherical roller bearings
SIS 05 59 00	: Pictorial Surface Preparation Standards for Painting Steel Surface

M16.2.3 General Requirements

This specification must be read in conjunction with the following specifications:-

G01: Particular Specification for Colour Codes

G02: Particular Specification for Corrosion Protection

M16.3 DESIGN OF CONVEYOR EQUIPMENT

M16.3.1 General Design Parameters

Equipment shall be designed:

- To facilitate manufacture, inspection, installation, maintenance, cleaning and repairs.
- To ensure safe and satisfactory operation for an acceptable life expectation of 12 years under the conditions prevailing at the site.
- To prevent undue stresses being produced by expansion due to temperature changes.
- To keep maintenance costs to a minimum.
- To facilitate inter-changeability of units and/or sub-parts throughout the contract works with regards to new equipment and equipment and/or sub-parts currently being used on the existing Johannesburg Water Sites.
- To operate without undue vibration and excessive noise. Maximum of 84dBA measured at 1 metre from operating equipment.
- To comply with the legal requirements in respect of safety as well as the prevention of water and air pollution.
- To satisfy any specific requirement contained in the statutory codes and legislation.
- To be suitable for operation 365 days per year, 24 hours per day under specified design conditions.
- As a minimum, components shall be selected with a service factor of 1.5 applied to the maximum operating power to be transmitted or otherwise as per the manufacturer's recommendations.

M16.3.2 Belt Conveyors Design of Parameters

All plant and equipment shall be designed to operate satisfactory under atmospheric, ambient and other conditions specified in the Project Specifications.

All conveyors shall be designed for a surcharge angle of 0° and a troughing angle of 35°.

Design tonnage and maximum tonnage for belt conveyors shall be for a digested sludge cake of 18 – 22 % dewatered from a belt press process. No additional percentage shall be applied to the maximum feed tonnage to obtain a maximum design tonnage.

The maximum belt speed for a conveyor system shall be 0.75 m/s. Conveyors shall be capable of starting up under full load.

Inclination of conveyors shall be such that no runback of material occurs when the belt is loaded. The maximum inclination of any conveyor will be 14°.

Where transfer points are located outside a building then the transfer point is to be covered with a steel structure with roof sheeting and side sheeting to the top 50% of the side height to facilitate maintenance.

Gearboxes shall be standardised as far as is possible. Integral holdbacks shall be provided for conveyors where required. Speed reducers shall be of the helical geared, shaft-mounted types. Gear unit ratios shall be based on 4 pole, 50Hz motors with the minimum gear unit service factors being 2.0 based on installed motor power. Thermal and mechanical service factors shall be selected such that the gearbox shall be able to operate effectively without the risk of excessive heat build-up under all operating and ambient conditions specified.

A spare gearbox for each size of gearbox used in the conveyor system installation shall be supplied for storage in the client's stores.

All conveyor equipment will comply with SANS 1173. In the design of the equipment, special consideration shall be given to the standardisation of such parts as pulleys, gearboxes, hold-backs, couplings, shafts, bearings, electric motors, etc. reducing spare equipment to a minimum.

Belt widths, belt speeds and transfer points shall be designed with particular attention to the prevention of spillage. The maximum belt loading capacity shall be 85% of theoretical loading capacity.

M16.3.3 Starting Equipment

Accelerating and braking forces shall be taken into account in the calculations of belt tensions and counterweights. Starting equipment shall be designed that the belt is not over-stressed when started under a full load.

M16.3.4 Pulleys

The diameter of driving, tail and tripper pulleys as well as pulley shafts shall be as specified in SANS 1169 and shall be calculated for belt tensions between 100 - 150% of the maximum operating working tensions.

Pulley bearings shall be of the spherical roller bearing type with a L10_h life rating of 100,000 hours. Pulleys shall be of the fabricated type, bearings and pulleys shall be standardised.

The driving and tail pulley shall be rubber lined after manufacture

M16.3.5 Idlers

Outer surfaces shall be smooth and corners chamfered. Each assembly of roll, shaft, bearings, seals, etc. shall be concentric. Rolls shall be no less than 125 mm outside diameter.

Bearings shall be high-grade anti-friction type and shall have a minimum L10_h life rating of 100,000 hours. Idler bearings shall be of the life lubricated type. The bearings shall be protected by an effective sealing arrangement.

Troughing idler assemblies shall be of the three-roll type, in accordance with SANS 1313.

Parts exposed to dirt accumulation shall be designed and constructed for self-cleaning. Idler spacing shall comply with the spacing specified in SANS 1173. Return idlers shall be subject to the same basic design principles as the troughing idlers shall also apply to impact idlers.

At the loading points, closely spaced troughing idlers shall be used. The same provisions regarding bearings, etc. applicable to troughing idlers shall apply to impact idlers.

M16.3.6 Loading and Transfer Points

Loading and transfer points shall be designed with the primary objective of reducing belt wear to a minimum and to eliminate spillage. Feed presentation from belts to equipment in parallel via trouser leg chutes will be central to the chute to avoid preferential feed to the equipment.

Feed presentation to the belt shall be central to avoid training problems. Chutes shall be designed to utilise the most suitable and economical wear resistant materials available and shall be made large enough to facilitate access for maintenance purposes.

Chute valley angles shall be a minimum of 60° from vertical.

New chutes and hoppers shall be provided with replaceable liners. All surfaces to be lined shall be covered over the full surface area that may be subject to wear.

Sideliners shall be made of not less than 4.5 mm thick VRN 500 plate. Impact liners shall be made of no less than 4.5 mm thick VRN 500 plate.

The liners shall be sized to facilitate ease of replacement and inter-changeability.

Chutes shall be provided with inspection hatches to allow for ease of inspection and block chute detection if required.

M16.3.7 Take-ups

Gravity type take-ups shall be provided on all conveyors exceeding 40m between centres of the drive and tail pulley. Take-ups for conveyors shorter than 40m shall be screw type.

M16.3.8 Walkways and Gantries

Walkways shall be open grid flooring suitably corrosion protected and shall be 750mm wide. All inclined walkways on conveyor gantries shall be of sloped construction and not stepped. All conveyors are to be supplied with only one walkway.

Where weight meters are to be installed on conveyors, a straight section of at least 6m will be allowed for the installation.

Where conveyors interface with buildings at ground level, external access to the gantry shall be allowed for without having to enter the gantry through the building.

M16.3.9 Belting

Belting shall conform to SANS 1173. All splices shall be hot vulcanised.

M16.3.10 Belt Cleaning

Scorpio type (or similar approved by the Engineer) primary and secondary scrapers shall be used for belt cleaning of all conveyors.

M16.3.11 Return Belt Ploughs

All conveyors shall be fitted with Scorpio type (or similar approved by the Engineer) belt ploughs on return belts situated at the tail end.

M16.3.12 Skirts

Skirts shall be provided at all feed points.

M16.3.13 Deck Plates

Deck plates shall be provided at head, take-up and tail terminal points, including areas where conveyors cross access roads or buildings. All deck plates shall be of mild steel construction and painted to the paint specification requirements.

M16.3.14 Protection

Suitable protection shall be provided for slippage and in the event of an obstruction causing the conveyor operation to be interrupted. The protection provided shall interrupt the operation of the conveyor.

The protection device shall be of an Intelligent Motor Protection Relay type with built in phase angle protection. As a backup device a torque overload coupling with a limit switch shall be provided. The limit switch must have at least one SPDT contact or one normally open and one normally closed contact capable of switching at least 500mA at 230 Volts AC. The contractor shall provide details of the proposed system at the time of tendering.

All conveyor equipment shall have a trip switch operated by a switch wire on both sides of the conveyor for emergency tripping. The trip wire must be operational along the full length of the conveyor.

Suitable protection shall be provided for belt tracking/alignment. The contractor shall provide details of the proposed system at the time of tendering.

It is a requirement of this specification that the above malfunction in operation be reflected on the works SCADA system.

M16.4 DESIGN SERVICE FACTORS

M16.4.1 Service Factors Specified

Where special requirements exist, these shall be stated in the individual equipment specifications/data sheets and design service factors shall exceed these values.

M16.4.2 Service Factors Unspecified

For continuous duty and heavy shock loads, service factors shall be individually considered and shall be approved. For medium duty and light shock loads, the following service factors shall apply. Consideration must also be given to the individual starting conditions in the selection of these components.

In selecting the capacity of electric motors, gears, gearboxes, power transmissions, couplings, pulleys, shafts, belts, etc., the design theoretical kilowatt ratings shall be increased by 20%.

In selecting the capacity of electric motors, couplings, shafts, vee-belts, and vee-belt drives, etc. for pumps, the designed theoretical kilowatt rating shall be increased by 25% to 50%, and for agitators (not stirrers) by 50%, to allow for possible overloading produced by pumps delivering larger quantities or at specific gravities higher than specified by the process requirement.

The factors of 25% to 50% and 50% shall be additional to the design factors used to obtain the theoretical kilowatt rating.

M16.4.3 Overload Capacities

Machinery and equipment, excluding motors, shall be designed to withstand a starting overload based on a minimum of 100% momentary overload, 50% overload allowance for 15 minutes and 25% overload allowance for periods not exceeding 2 hours. Refer to individual equipment specifications for variations.

M16.4.4 Transmission

Chain drives shall be in accordance with BS 228: 1984 – Transmission Roller Chains, Chain Wheels and Cutters.

Sufficient take-up allowance shall be provided on the motor mounting to take up two full chain pitches. Where take-up allowance is not possible due to fixed shaft centres, an adjustable chain wheel idler shall be incorporated.

All chain drives shall be adequately guarded and lubricated.

Unless otherwise specified, V-belt drives shall be standard sections and of the Space-Saver type. Belts shall be furnished in matched sets. Sheaves shall be accurately balanced and fitted with keyed 'Taper-Lock' bushings.

Drive motors shall be mounted on slide or pivoted bases allowing sufficient adjustment for correct belt tensioning according to the manufacturer's requirements. Bases shall incorporate jack screws with lock nuts. All V-belt drives shall be adequately guarded.

Gearboxes

Gearing shall be in accordance with the appropriate AGMA standards as revised. All gearing shall be machine cut to high commercial grade and shall be suitably heat treated before final machining.

Gearing not enclosed in an oil bath shall be adequately guarded and provision shall be made for safe lubrication.

Speed reduction units shall be of approved design and manufacture. Allowance for efficiency, cooling and lubrication shall conform to the manufacturer's recommendations.

Gearboxes shall be of rigid construction manufactured either from cast steel or fabricated from mild steel plate.

Gearboxes shall be dustproof and equipped with inspection covers, drain and filler plugs, breathers with suitable filters, oil level indicators or dip sticks and lifting lugs as required.

Fabricated gearboxes shall be guaranteed against distortion when in service.

Foot mounted gearboxes shall be assembled together with the prime mover on a common baseplate and accurately doweled in position. Shaft mounted gearboxes shall be mounted according to the manufacturer's recommendations.

NOTE: A spare gearbox for each size of gearbox used in the conveyor system installation shall be supplied for storage in the client's stores.

All rotating equipment shall be clearly marked with an arrow showing the direction of rotation.

Bearings

Where required by design considerations, well lubricated non-ferrous bushings and bearings may be used.

Where phosphor bronze bearings are used the quality shall be to SAE 64 or equivalent. The supplier shall be required to provide details of specification number and analysis of metals used. This requirement shall also apply to the use of white metal.

Self-lubricating graphite or compound bearings shall not be used unless specifically requested.

For heavy duty and continuous service, Plummer blocks shall be anti-friction spherical roller type with split housing rated to suite the application. All Plummer blocks shall be fully self-aligning with one fixed and one floating type for each shaft assembly. With parallel shafts, inner ring adapter sleeves may be used.

For lighter duty, 80mm diameter and less, ball bearing Plummer blocks may be used.

Unless otherwise specified, the basic rated life for all anti-friction bearings shall be 75,000 hours

(L10_h as defined by SKF).

Plummer blocks shall be mounted on accurately machined sole plates equipped with lugs and jack screws with lock nuts for proper horizontal alignment.

All Plummer blocks shall be installed such that the loads pass through the base and not the cap. Deviations from this arrangement for practical reasons shall be subject to approval and accompanied by design calculations.

Bearing housings shall be of cast steel, good quality cast iron or fabricated to specification and accurately machined where necessary. Housings shall be mounted on machined surfaces and located and fixed by permanent devices.

Design allowance shall be made for keyways and combined bending and torsion stress. Suitable fillet radii shall be provided at changes in diameter and shaft ends shall be chamfered. Changes in diameter and keyways shall not coincide.

Light duty shafting shall be hot rolled polished mild steel or cold rolled mild steel. Cold rolled shafting shall be subject to approval.

All shafts shall be metric and shall be supplied with key seats and keys or feathers in accordance with BS 4235 Part 1: 1986 unless a fastening method other than by key is used. Any such proposed fastenings shall be submitted to the responsible Engineer together with design calculations for approval.

All couplings shall be fitted with a removable guard unless the machine is already guarded in such a manner as to make a separate guard unnecessary.

Brakes shall be adequately sized for the load characteristics and heat dissipation.

M16.5

LUBRICATION

Lubricants and lubrication fittings shall be in accordance with the following standards:-

- SANS 053:1972 : Viscosity Classification of Industrial Lubricating Oils
- SANS 344:1974 : Calcium Base Lubricating Grease
- SANS 351:1974 : Sodium Base Lubricating Grease
- SANS 406:1974 : Lithium Base Lubricating Grease
- SANS 1014:1974 : Multi-Purpose Lubricating Grease
- BS 1486:1982 : Lubricating Nipples Parts 1 & 2
- BS 1399 Parts 1 to 3:1970 : Rotary Shaft Oil Seal Units

All equipment suppliers shall submit a specification of the lubrication requirements for their equipment, which shall include the following:-

- (i) Approximate quantities required for the initial fill.
- (ii) The expected rate of consumption of the lubricant and the recommended intervals for a complete change of lubricant.
- (iii) A lubrication chart indicating all lubricating points, periods for lubrication, oil and filter changes.
- (iv) A list of South African based suppliers of the recommended lubricants.

All Plummer blocks shall be sealed against the ingress of moisture or dirt by means of a double

lip seal or a Labyrinth seal.

Where wet or extremely dirty conditions occur, a flinger shall be used in addition to seals.

For vertical shafts, a flinger shall be installed above the upper bearing seal. Lubrication of equipment, such as gearboxes, compressors, etc. shall conform to the recommendation of the equipment manufacturer.

All equipment, which normally contains lubricant and is despatched without such lubricant, shall be sprayed internally with a suitable moisture inhibitor to prevent deterioration during transport and storage. All machinery and equipment shall be checked for cleanliness and lubrication prior to testing or start-up.

Any special requirements for flushing and cleaning shall be stated by the manufacturer.

Such equipment shall carry clear legible tags indicating that there is no lubricant contained therein.

Gearing and chain drives shall have fully enclosed oil bath lubrication except where a low peripheral velocity requires grease lubrication. Where the peripheral velocity of gearing exceeds 750 m/min, forced feed lubrication shall be provided.

All lubrication points shall be easily accessible from the normal maintenance/operating zones of the equipment. If necessary, lubrication points shall be extended by means of pipes or tubing to a location that is both convenient and safe for access during normal equipment operation.

M16.6 BASEPLATES

Baseplates shall be designed to prevent undue deflection or failure under any conditions of loading likely to be encountered.

Baseplates shall be rigidly constructed, generally of cast steel or fabricated steel. For light duty, cast iron bases may be used.

Where practical, the prime mover and the gears, bearings, or other equipment shall be mounted on a common base plate.

Mounting pads and base plate feet shall be machined true and parallel. Allowance shall be made on the prime mover mounting pad for 5 mm maximum and 1 mm minimum shimming.

Where baseplates are fabricated they must be stress relieved before machining.

Baseplates shall incorporate jack screws with lock nuts to assist with aligning of the prime mover in relation to the gearbox, bearings or other equipment.

M16.7 PLATEWORK

Where bins, chutes, liners and skirts are supplied as an integral part of mechanical equipment they shall be designed such that:-

- (a) They allow for the fast, smooth flow of material and avoid abrupt changes of direction which invite material build-up and subsequent plugging.
- (b) They have a minimum of throat constrictions.
- (c) They are firmly supported, manufactured from a minimum of 6 mm plate to SANS 1431 Gr. 300 WA and are suitably stiffened and supported to deal with loads and forces

imposed on them.

- (d) Their valley angles are conservative and suitable for the materials handled.
- (e) Falling material does not impact directly on sensitive receiving equipment but rather on the sloping bottom of chutes.
- (f) Chutes and hoppers shall be provided with bolted flange connections in order to simplify installation and maintenance.
- (g) All nozzles to be fabricated from scheduled piping, wall thickness to match plate work thickness. Flanges will be specified on the relative data sheets.
- (h) All plate work and chutes to be trial assembled and match marked by the fabricator before delivery to site.
- (i) Bins, chutes, etc. and support structure (where required) shall be designed for a maximum static load when all full of mineral sand or slurry at a design bulk density as specified. Subassemblies or components shall be fitted with lifting lugs designed with adequate safety factors to lift the subassembly or components. Travelling members to be fitted (where required) to avoid distortion. Fabricator to supply spreader bars for components requiring such.
- (j) Where equipment such as scrapers, rappers and squeezers, spray units, etc. are housed within the chutes, they must be able to be removed without disturbing the main assembly.
- (k) Where material is in contact with the chutes, suitable liner plates shall be installed which shall be fastened by means of nib head countersunk bolts and waterproofed where necessary. Such liner plates shall be designed to allow for interchange ability and not to exceed 30 kg in mass.
- (l) Equipment subject to abrasive slurry particle contact shall be protected against such abrasive materials by a minimum 6 mm thick natural rubber lining. All lining is to be returned around flange faces for sealing. Rubber lining shall be done in accordance with BS 6375-5: 1985 and SANS 1198: 1978.
- (m) The maximum deflection of any plate shall be less than 1 mm in 300 mm.

UNLESS OTHERWISE STATED ON THE DRAWING, LINER PLATES SHALL BE ARRANGED IN A BRICK PATTERN WITH A GAP OF NOT MORE THAN ONE LINERPLATE THICKNESS OR 10 mm (WHICHEVER IS THE LEAST) BETWEEN ADJACENT LINERS

M16.8 DUCTING AND SHEET METALWORK (DUST COLLECTION AND VENTILATION)

Ducting, flanges, gates, etc. shall conform to details shown by the Industrial Ventilation Manual of Recommended Practice issued by the American Conference of Governmental Industrial Hygienists.

Ducting shall be checked after fabrication to ensure that:-

- No pin-holes or slag inclusions which would cause leaks during service are present in any welds.
- Inside diameters are to drawing, and ducts are concentric within 5 mm on diameter.
- Supports shall be designed and spaced so that sagging does not occur, allowing for a normal dust load, and shall be structurally adequate allowing for a dust filled plugged duct.
- After erection of ducting and the installation of dust extraction units, the complete system

shall be tested, balanced and blast gates locked or tack-welded in place.

- All ducting and bends shall be manufactured from mild steel with a minimum thickness of 3 mm.
- All ducting shall have flanges welded to each end of each piece; such flanges shall be of a suitable thickness for the diameter but shall not be less than 3 mm.
- All flanged connections shall be complete with matching gaskets made from material suitable for the needs of the process.

M16.9 WIRE ROPE, CHAINS AND FITTINGS

All ropes, whether fixed suspension or for general use, shall comply with all relevant Acts and Statutory Regulations.

Hoist ropes and fittings shall comply with the regulations of the Mines and Works Act and the Machinery and Occupational Safety Act of the Republic of South Africa.

Rope fittings shall be securely attached to the ropes, preferably with terminal splicing standard spelter fittings or approved swaged fittings. All rope slings shall be tested to twice the required working strength. Spelter fittings shall not be used for high temperature applications. Where rope clips are specified, a minimum of three rope clips and a thimble shall be correctly fitted to make the connection.

All lifting tackle shall be supplied with test certificates.

Rope slings for general use shall be fitted with a metal tag indicating the safe working load.

Sockets, thimbles, rigging screws, stretching screws, eyebolts, etc., shall have a safe working load of no less than that for the attached rope or chain. Wire rope and fittings that are a stationary part of a machine, and fixed guys shall be galvanized.

Chains shall comply with all relevant Acts and Statutory Regulations and shall be stamped indicating the safe working load.

M16.10 FASTENERS

When bolting onto parallel surfaces, all nuts shall be fitted with plain parallel washers except where the machinery is subject to vibration or movement. Then, springs washers, nylon insert locknuts or tack welding shall be used as indicated by the design. Adjustable nuts (e.g. bearing take-up), castellated nuts with split cotter pins shall be used. For thread diameters of 10 mm and under, the use of tab washers is permitted.

High strength friction grip bolts shall be installed in accordance with:-

- SANS 094:1982 Bolted Friction-Grip Joints
- BS 3294 Part 1:1960 Structural Steelwork (Metric Units)

Precision bolts and nuts shall be supplied in accordance with:-

- SANS 136:1985 ISO Metric Precision Hexagon-Head Bolts, Screws and Nuts (Metric Units)
- SANS 646:1962 Precision Bolts, Screws and Nuts

Black bolts and nuts shall be supplied in accordance with:-

- SANS 135:1985 ISO Metric Black Bolts, Screws and Nuts Hexagon and Square (Metric

Units)

- SANS 1143:1977 Mushroom and Countersunk Head Bolts and Nuts

Washers shall be supplied in accordance with SANS 1149 – Flat and Tapered Steel Washers.

Black bolts shall be installed in accordance with the following assembly requirements:-

- (a) All bolt heads and nuts shall make contact, bearing on parallel plan surfaces perpendicular to the bolt axis.
- (b) A tapered washer shall be correctly positioned under the bolt head or the nut whenever the surfaces contacted are not parallel and perpendicular to the bolt axis. It shall be used against the sloping surface.
- (c) A flat washer or a tapered washer shall be used under the bolt head or nut, whichever is to be rotated during tightening operations. Washers shall be of adequate size and thickness to prevent their distortion, for any reason, during tightening.
- (d) After assembly and proper tightening, bolts shall project through nuts for a minimum distance of three (3) full threads.

When assembled, all HSFG bolted joint surfaces shall be free of dirt, loose scale, burrs and other defects that would prevent solid seating of the parts. All contact surfaces shall be free of oil, paint and lacquer or galvanising.

All HSFG bolts shall be torqued using load-indicating washers of an approved type to ensure correct tension is achieved.

Plate liners, unless otherwise specified, shall be fitted with nib-headed countersunk bolts, and spring washers shall be used under the nuts.

M16.11 OPERATION AND MAINTENANCE

Operation and maintenance of mechanical equipment shall be carried out strictly in accordance with the Equipment Manufacturer's recommendations.

The Equipment Manufacturer shall supply Operation and Maintenance instructions which shall include full details and recommended frequencies of periodic maintenance checks, adjustments, running clearances and lubrication requirements.

M16.12 PLANT LAYOUT

The following criteria shall apply for plant layouts:-

Buildings and conveyor transfer towers shall be positioned to make use of the natural slope of the contours at the site where possible, i.e. to minimise building heights and conveyor lifts.

Major mechanical equipment shall be positioned to facilitate removal with overhead cranes in the event of breakdown or maintenance. For smaller equipment, or where equipment cannot be reached by cranes, due to the nature of the plant layout, hoists and crawl beams will be used for maintenance purposes.

All sump pumps shall be suitably guarded for personal safety, as well as protection against the ingress of large objects.

The layout of the plant shall allow sufficient access for personnel engaged in operational and

maintenance duties.

M16.12.1 Platforms and walkways

Platforms and walkways shall be provided wherever access is required for regular inspection, lubrication or operation of machinery or equipment.

Walkways shall be clear 600 mm wide as a minimum.

Access to all valves, instruments and equipment lubrication points will be provided either from the ground floor or from a platform.

A minimum clearance of 2100mm shall be provided under equipment and steelwork.

Stairways shall be provided rather than ladders except in extreme cases where space is not available or usage will be very infrequent.

Stairway slope shall be between 38° and 42°, maximum slope.

A walkway will be provided along one side of each belt conveyor.

Access ladders shall be provided to all crane bridges.

Vendors to specify maintenance clearance requirements for equipment supplied, these clearances to be incorporated into layouts.

M16.13 **ROTATING EQUIPMENT**

The direction of rotation of all rotating non-reversing equipment will be clearly and indelibly marked on the casing or nameplate.

M16.14 **STAIRWAYS AND PLATFORMS**

Stairways, platforms, access ladders and landings shall be provided as necessary and shall conform to relevant Building Regulations, or International Design Standard. Stairway slope shall be between 38° and 42° maximum.

M16.15 **HANDRAILS**

Handrails shall be provided around all permanent openings, the edges of elevated platforms and access ways abutting edges to all internal side wall sheeting and walls, and to each stairway stringer and where required for safety.

M16.16 **EQUIPMENT ERECTION**

All equipment shall be erected in accordance with the requirements of the Mechanical Erection Specification, and in accordance with Equipment Manufacturer's Installation Instructions.

M16.17 **EQUIPMENT NAME PLATES**

All equipment shall have permanent nameplates of material suitable for corrosive conditions on which the equipment number and description shall be clearly marked. This will facilitate equipment identification during construction and commissioning.

M16.18 OVERHEAD CRANES, LIFTING BEAMS AND HOISTS

Overhead cranes shall be sized for maintenance duties as apposed to installation duties. The overhead cranes will be sized for the heaviest regular maintenance lift required.

Lifting beams, hoists and cranes shall be provided for ease of servicing and removal of equipment. Adequate space shall be provided for rigging, removal and set down. Lifting beams and crane rails shall be designed to the relevant standards and test certificates shall be provided. Beams shall be stamped with the appropriate SWL. Lifting beams shall be equipped with a trolley from which to attach the hoists.

M16.19 SAFETY

M16.19.1 General

All mechanical designs shall ensure that the relevant regulatory and statutory requirements are met.

M16.19.2 Guards

All rotating parts that are accessible shall be guarded. Shield guards or guard railing shall be provided at all belts, pulleys, gears, or moving parts.

Handrails, toe boards, and nonslip surfaces shall be provided on all elevated platforms, walkways, stairways and ramps.

All nip points shall be adequately guarded to prevent injuries

M16.19.3 Signs

Signs shall be provided to alert all personnel of the need for protective clothing such as steel caped boots, hard hats, and safety glasses.

Signs shall be provided where a specific exists, such as live conductors, high noise levels, low head clearance, trip hazards, hot surface prevails.

M16.19.4 Clothing

Special footwear, masks and clothing for areas with high dust levels or surface area contamination shall be used.

Non-slip footwear, gloves, helmets, face protection, leggings and other protective equipment, as necessary, for work near high temperature materials shall be used.

Where there is a risk of flying chips or sparks, or where intense light is generated, eye protection shall be used.

Protective clothing and goggles shall be used in areas where highly corrosive materials are handled.

Emergency eyewash stations and safety showers shall be installed as required.

The mechanical design shall ensure that priority is given to all project safety and ergonomic aspects, including plant layout, constructability, maintainability and operability.

M16.20 SPARES AND TOOLS

The Tenderer must submit on the appropriate schedule a priced list of spare parts which nit is recommended should be kept by the water treatment plant for maintenance of the plant. Spares which the Management decides to order must be manufactured simultaneously with the rest of the equipment and be subject to the same tests for dimensions, tolerances, strength, etc. All spares must be packed separately and the cases appropriately marked. All spares must be new and unused.

A full range of spares must be kept available for not less than 15 years.

Tenderers must submit a provisional price (where applicable) for a complete set of spanners, keys and tools required for the operation, adjustment and overhaul of the plant supplied. All spanners, keys and tools shall be new and unused.

M16.21 PROOF OF MAINTENANCE

The period of maintenance will extend over a period of 12 months calculated from the Completion as defined in the Appendix. However, should a portion or all of the plant and equipment fail / or require rectification during this period, the Engineer reserves the right to extend the Period of Maintenance in respect of such portion or all of the plant and equipment for a further period of not more than 12 months calculated from the date of Commissioning of such plant and equipment after rectification

M16.22 METAL PREPARATION AND CORROSION PROTECTION

Refer to Particular Specification G02: Corrosion Protection

M16.23 COLOUR CODES

The standard final colour codes for equipment supplied under this Contract shall be in accordance with Particular Specification G01: Colour Codes.

M16.24 QUALITY MANAGEMENT (QM) AND QUALITY ASSURANCE

QM shall be categorised as 'critical and major' for this section of the Project.

M16.24.1 Manufacture

Tenderers shall submit with their tender a detailed Project Quality Plan, stating how they control the flow of paperwork from commencement of the Project through final handover to the Client, a sample of their Quality Control Plan, (QCP) and Project Quality Plan, (PQP) both during the course of the Project, manufacture and finally, installation.

The successful Tenderer shall submit a QCP covering all aspects of the manufacturing process, indicating held points to allow the Engineer opportunities to evaluate the equipment for compliance to this specification.

All items of equipment shall be subject to inspections by the Engineer during design and manufacture per these QCP's.

In general, it is anticipated that this Project shall be in accordance with the relevant ISO 9000 requirements.

M16.24.2 Installation

The successful Tenderer shall submit a QCP covering all aspects of the installation of each item of equipment to be installed under this Project. The Engineer shall be afforded every opportunity to certain stages of completion of the installation to ascertain compliance with the Specifications and to witness the Contractor's site activities at the Engineer's discretion.

M16.25 SYSTEM PERFORMANCE

M16.25.1 Works testing

Each item of equipment shall be subject to inspection and testing prior to despatch from the works. All performance test results shall be made available to the Engineer for verification or when the QCP's require intervention or hold points for inspection.

In the case of gearboxes, they shall be subject to testing under operating conditions for at least 12 hours on the test bed. All results shall be available for inspection

M16.25.2 Before commissioning

- Check for correct oil level in gearboxes and that motors are greased properly.
- Ensure all HD bolts are torqued down correctly.
- The alignment and levelling of each assembly shall be checked and the results shall be available for inspection by the Engineer.
- The electrical functions and control shall be checked by a responsible inspector prior to attempting to start any motor on this Project.

M16.25.3 After Initial Commissioning

- Ensure all oil pumps and flow or pressure switches are functional
- Ensure that all transfer points are operating satisfactory with no spillage.

M16.25.4 Before Expiry of the Defects Liability Period

The Engineer requires the Contractor to visit the site every quarter to inspect for the correct operation of the installed equipment. A report after each visit shall be submitted in writing

M16.26 MEASUREMENT AND PAYMENT

Payment under scheduled items shall be made per complete installation as specified, electrical connections, civil preparation, coring and grouting, etc. Measurement and payment will distinguish between supply / delivery and installation / commissioning of the conveyor equipment required.

The tendered rates or sums shall cover the cost of design, drawings, manufacture, supply, testing at the manufacturers works, delivery to site, off loading, installation, site testing, setting into operation, the supply of O & M manuals, commissioning and maintenance during the warranty period of all equipment specified and also for anything not specifically mentioned but obviously required, (e.g. all ancillaries, including all bolts, fastenings and brackets, safety guards and any work or material required for the proper installation of such equipment) to enable the equipment to be installed and/or function safely and correctly as specified. No claims whatsoever for extras will be allowed on the grounds that a necessary piece of equipment or a part thereof is not specifically mentioned.



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PARTICULAR SPECIFICATION

M17: MECHANICAL ACTUATOR EQUIPMENT

4	2013/10/23	Control updates and re-issued	J Ritchie	
3	2012-07-30	General update and re-issue	J Ritchie	
2	2010-02-16	General review	J Ritchie	
1	2009-05-12	Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance		
Rev	Date	Description	Signature: JW Wastewater Partnership	Signature: Approval from Johannesburg Water

PARTICULAR SPECIFICATION M17: MECHANICAL ACTUATOR EQUIPMENT

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M17.1	SCOPE	

This specification covers the detailed design parameters, manufacture, supply, installation, test

and commissioning of actuators. The Particular Specification shall be read in conjunction with the Project Specification.

M17.2 INTERPRETATIONS

M17.2.1 Abbreviations

In this Specification the following abbreviations will apply:-

ANSI	:	American National Standards Institute
ASTM	:	American Society for Testing and Materials
BS	:	British Standards Institution
SANS	:	South African National Standards
SIS	:	Swedish Institute of Standards
DIN	:	Deutsch Industry Normen
ISO	:	International Organisation for Standardization
ASME	:	American Society of Mechanical Engineers
SAECC	:	South African Electrolytic Corrosion Committee
AGMA	:	American Gear Manufactures Association
IEC	:	International Electrotechnical Commission

M17.2.2 Standards

All design standards for the actuators shall be subject to the latest amendments and editions of the following standard specifications:-

BS 5304	:	Code of practice for safeguarding of machinery
SANS 9096-1: 1994	:	Testing of welders, where applicable to the type of welding required
BS 292 Part 1: 1987	:	Dimensions of ball bearings, cylindrical and Spherical roller bearings
SANS 10162-4	:	Structural use of Steel Part 4: The design of cold-formed stainless steel structural
SANS 10044-3	:	Welding Part 3: The fusion of steel (including stainless steel): Tests for the approval of welding procedures
SANS 10044-4	:	Welding Part 4: The fusion welding of steel (including austenitic stainless steel): Tests for the approval of welders working where weld procedure approval is not required.

M17.2.3 General Requirements

This specification must be read in conjunction with the following specifications:-

E01: Particular Specification for Electric Motors

G01: Particular Specification for Colour Codes

G02: Particular Specification for Corrosion Protection

M17.3 DESIGN OF ACTUATORS

M17.3.1 General Design Parameters

Actuators shall be designed such that the following requirements are met:-

- To facilitate manufacture, inspection, installation, maintenance, cleaning and repairs,

- To ensure safe and satisfactory operation and an acceptable life expectation under the ambient conditions prevailing at the Site,
- To prevent undue stresses being produced by expansion due to temperature changes.
- To keep maintenance costs to a minimum,
- To comply with the legal requirements in respect of safety as well as the prevention of water and air pollution,
- To satisfy any specific requirement contained in the statutory codes and legislation, and
- To be suitable for operation 365 days per year, 24 hours per day under specified design conditions.

M17.4 ACTUATORS

M17.4.1 Design Parameters

Actuators shall be designed for a minimum maintenance free life of 10 000 open/close/open cycles, assuming the maximum seating torque at the end of each stroke.

The running torque shall be designed for the specific conditions of the Gate/Valve, with a minimum safety factor of 1.0 for clean water and wastewater of the maximum unseating/seating torque during each stroke.

The torque charts supplied by the manufacturer shall provide values for the unseating torque, the run torque and the open torque.

The available torque transmitted through an electric actuator to the valve output shaft, shall be rated to include the safety factor (25% for water treatment and 75% for wastewater treatment of the maximum unseating torque) in addition to the maximum torque required to fully open or close the gate/valve under the maximum working pressures and prevailing flow conditions.

The maximum output speed for the actuators shall be 90 rpm.

Operation

Actuators shall have a function to hold the gate/valve in any fixed position for a given amount of time. All gates/valves shall be capable of being opened and closed under unbalanced pressure equal to the nominal pressure.

Performance

The actuator must be self-locking so that the actuator stays in its last position. The self-locking feature must stay active if the actuator is changed into handwheel mode. The actuator must be able to be fitted in mounting orientations.

The Contractor shall submit drawings and/or calculations used for specifying the gate/valve torque at tendering stage. All actuators shall be complete with provision for manual operation.

M17.4.2 Life Tests

Actuators shall be stalled against a solid object 25 times in order to prove durability.

The standard life test is based on 25 000 open/close/open cycles at 75% rated torque rising to 100% at each end of travel. 10% of actuators installed shall be subjected to these tests.

M17.4.3 Actuator Housing

The actuator shall be enclosed in a double sealed, water tight enclosure and shall afford the protection to IP68. All the joints shall be O-ring protected. Provision shall be made for a weep hole to release any seepage water from the gate/valve in order to protect the gearbox/actuator from contamination.

M17.4.4 Gearing

All gearing shall be lubricated and designed to withstand the full stall torque of the motor. The actuator shall be directly mounted on the gearbox. The gearing shaft bearings, torque limiting clutch mechanism and limit switches shall be enclosed and adequately lubricated. A seal shall be provided on the input shaft of the gearbox to prevent water from entering the gearbox.

M17.4.4.1 *Lubrication*

The gearbox lubricants shall be such that the gearbox can be mounted at any angle without any lubricant leaking from the gearbox enclosure. The gears shall be fully covered with lubricant in order to prevent corrosion.

M17.4.5 Actuator Mounting and Setting

Actuators shall be mounted directly onto the gate/valve body or gearbox. Should a particular application require an adaptation device, any such device shall be a specific proprietary design for a particular type of gate/valve. A comprehensive design of any such adaptation shall be submitted to the Engineer for approval.

The attachment of the actuator to the gate/valve body shall be such that the actuator may be detached without disturbing the valve position.

The gate/valve manufacturer shall ensure that there is no visible movement of the actuator on the mounting adaptor or gate/valve body when the actuator is in operation.

M17.5 **ACTUATOR CONTROLS**

The actuator controls shall be housed in such a way as to prevent breathing and condensation build-up. One plug and socket connection shall be used for the connections between the actuator and control housing for easy access and removal.

The control housing shall be designed so that it can rotate against the actuator in 90 degree steps or can be mounted remotely from the actuator.

All actuators shall have the following controls:

- Programmable signal relays
- Non-intrusive settings with wireless programming interface for connecting programming device or all settings done in a non-intrusive manner i.e. all settings must be possible without opening or removing covers.
- Monitoring and diagnostics of faults displayed on a LCD display.
- Logging of operating data.
- Integral Motor Starts
- Integral Pushbutton starters:
 - Local/off/remote selector switch
 - Open/stop/close pushbutton station
- Reversing starters
- Control transformer
- Phase discriminator
- Monitor relay

- Position Indicators
- Limit switches
- Torque Switches

All digital signals for PLC monitoring and controls must be via potential free contacts capable of switching at least 500 mAmps at 230 Volts A.C.

M17.5.1 Integral Motor Starters

Integral or remote mounted actuators and control stations will be acceptable.

The reversing contactor starter shall be mechanically and electrically interlocked and rated appropriately to the motor size and suitably for 50 starts per hour.

M17.5.2 Integral Pushbutton starters

A pad-lockable local control station with a selector switch for PLC/Manual control (provided by others) shall be part of the control for all actuated valves or penstocks.

In Manual control the actuator shall be controlled by external open/close pushbuttons.

The contacts for this control are voltage-free.

M17.5.3 Position Indicators

Actuators shall be fitted with a mechanical continuous indicator showing gate/valve opening position. The scale of the position indicator shall clearly indicate the opening and closing position as well as the degree of opening in mid-position of the gate/valve. Installation of an electronic current feedback must be possible. They shall be driven by a gearing selected in a way that at least 83% of the possible travel is used. The feedback drive must be fully assembled by the actuator manufacturer.

M17.5.3.1 Limit Switches

The actuator shall have two limit switches which shall be directly geared to the output shaft of the actuator without any slippage clutch device. One limit switch shall be for the open end position and the other limit switch for the close end position.

The limit and torque switches shall be independent of one another. The limit switches shall be set up to trip the actuator before the actuator torque limit switches are activated.

The limit switches shall be adjustable, allowing adjustment to the travelling gate/valve shaft. Adjustment of the limit switches must be possible without opening or removing covers.

The addition of switches must be possible without opening the lubricated main gear case. The limit switches must be driven by a self-lubricated counter gear drive designed for high repeatability and easy adjustment.

Limit Switch Housing

The limit switch housing shall be manufactured from non-corrosive material. No plastic parts shall be used for the drive mechanism for torque and limit switches as well as for the position indicator.

M17.5.3.2 Torque Switches

The actuator shall contain two torque switches, one at each end of travel. The torque switches shall be designed to trip when the gate/valve load exceeds the torque setting. The torque

switches shall be calibrated in Nm for easy reading and resetting.

Adjustment of the torque switches must be possible without opening or removing covers.

M17.5.4 Programming

Within the control it shall be possible to program the function of the end position switching, i.e. torque switch or limit switch dependent. It must also be possible to program the control for the opening and closing directions independent of each other.

Actuators shall be local and remote electrically operated. All torque and turn settings as well as configurations shall be effected using a hand held a non-intrusive infra red setting tool.

M17.5.5 Internal Wiring

All internal connections within the integral control and between the different boards should be made by plug and socket connections except for motor power cables. All plugs and sockets shall be sized differently in order to prevent confusion.

M17.5.6 External Wiring Connection

The external wiring connection shall be done by one plug and socket for all control and motor wires. Provisions shall be made for three cable entries, one for the motor cable, one for the control cable and one for the possible feedback signal. All conduit entries shall have standard metric screw threads.

The compartment into which the cables are terminated shall be sealed from the balance of the actuator so that in the event of leakage through the cable glands no damage will occur to the actuator.

Cable entries shall be sealed against the ingress of water by means of tapped steel plugs. The use of plastic plugs for this purpose is not acceptable.

M17.5.7 Interfacing for External Wiring must be provided as Follows

- a) For all on/off, open/close, circulate/by pass (i.e. all non-modulating valves) the following interfacing must be provided:
 - Potential free N/O contacts for:
 - Opened position
 - Closed position
 - Remote selection
 - Digital Inputs from an external source for:
 - Open
 - Close
 - Manual selection
- b) For all modulating valves, the following interfacing must be provided:
 - Potential free N/O contacts for:
 - Opened position
 - Closed position
 - Remote selection
 - Digital Inputs from an external source for:
 - Open
 - Close
 - Manual selection. If this "Manual" selection is made, the digital "Open" and "Close" inputs must control the valve operation and the analogue input for position control must have no effect and must not interfere with the digital inputs.

- An active 4 – 20 mA output from the valve, to be supplied to an external load of max 500Ω. This output from the valve is for position indication.
- Input of 4 – 20 mA from an external source for position control.

M17.6 MANUAL OVER-RIDE

The actuator shall have a manual over-ride hand wheel. All valves shall be capable of being opened or closed under unbalanced pressure equal to the nominal pressure. The effort required to open or close the gates/valves under unbalanced pressure shall not exceed 90 N. The maximum time for any valve or penstock to be manually turned to the fully open or close position shall be 5 minutes or not more than 600 turns on the hand wheels.

The manual operation shall be via power gearing in order to minimise the required rim pull and to facilitate the change over from the motor to manual operation. A seized or inoperable motor shall not prevent manual operation.

M17.7 ELECTRIC MOTOR

Modulating actuators shall be designed for up to 1200 starts per hour and non-modulating actuators for up to 60 starts per hour.

The actuator shall be fitted with a low inertia high torque electric motor. The electric motor shall have a minimum duty rating of four consecutive complete cycles or a continuous operation of 15 minutes, whichever is more onerous.

The motors shall be time rated IEC 34 at a nominal motor load and at least 33% of maximum valve torque for 15 min. The motors shall be protected by thermostats embedded in the motor windings, one for each phase which shall have a facility for being overridden for emergency shutting off of the gate/valve.

Each electric motor shall be fitted with a suitable reduction gearing design to unseat the gate/valve under 75% of the test pressure and to operate the valve while the water flowing through the gate/valve reaches velocities of up to 5 m/s.

Refer to Particular Specification E01: Electric Motors for a detailed specification for Electric motors.

M17.7.1 Heater

A self-regulating anti-condensation heater shall be provided in the motor housing.

M17.7.2 Output Drive

The output drive shall be in accordance to ISO 5210. The output drive shall be separate from the main actuator housing in order to remove the complete actuator from the gate/valve while the gate/valve is kept in position by the output drive of the actuator.

M17.7.3 Motor Housing

The electric motor shall be totally enclosed in one non-ventilated, insulating cast iron casing.

M17.8 POWER SUPPLY

The actuator shall be designed to operate from a 400V three-phase or 230V single phase 50Hz A.C power supply. The actuator shall be capable of operating at the rated duty with a 15%

variation of the applied voltage measured at the actuator.

The actuator shall be provided with necessary auxiliary equipment to provide low voltage power required by its control circuits.

M17.8.1 Transformers

Each actuator shall have its own power supply. Easily replaceable fuses shall protect the primary and secondary windings. Two separate coil chambers shall separate the primary and secondary side of the transformer. The power supply shall incorporate a phase discriminator as to prevent the incorrect direction of travel as well as a phase failure device to ensure no actuator operation when the incoming phase fails.

The power supply shall be rated for the supply of starter coils, the heater integral to the actuator and for signals of voltage-free contact from the remote control of the actuator. The signal from the phase discriminator and phase failure device shall be separated from the other controls by an opto-coppler in order to avoid any noise from the incoming lines being transmitted into the logic.

M17.9 **SPARES AND TOOLS**

The Tenderer must submit on the appropriate schedule a priced list of spare parts which is recommended should be kept by the water treatment plant for maintenance of the plant.

Spares which the Management decides to order must be manufactured simultaneously with the rest of the equipment and be subject to the same tests for dimensions, tolerances, strength, etc. All spares must be packed separately and the cases appropriately marked. All spares must be new and unused.

A full range of spares must be kept locally for not less than 15 years.

Tenderers must submit a provisional price (where applicable) for a complete set of spanners, keys and tools required for the operation, adjustment and overhaul of the plant supplied. All spanners, keys and tools shall be new and unused.

M17.10 **PROOF OF MAINTENANCE**

The period of maintenance will extend over a period of 12 months calculated from the date of the handover Certificate. However, should a portion or all of the plant and equipment fail / or require rectification during this period, the Engineer reserves the right to extend the Period of Maintenance in respect of such portion or all of the plant and equipment for a further period of not more than 12 months calculated from the date of Commissioning of such plant and equipment after rectification

M17.11 **METAL PREPARATION AND CORROSION PROTECTION**

Refer to Particular Specification G02: Corrosion Protection

M17.12 **COLOUR CODES**

The standard final colour codes for equipment supplied under this Contract shall be in accordance with Particular Specification G01: Colour Codes.

M17.13 **QUALITY MANAGEMENT (QM) AND QUALITY ASSURANCE**

QM shall be categorised as 'critical and major' for this section of the Project.

M17.13.1 Manufacture

Tenderers shall submit with their tender a detailed Project Quality Plan, stating how they control the flow of paperwork from commencement of the Project through final handover to the Client, a sample of their Quality Control Plan, (QCP) and Project Quality Plan, (PQP) both during the course of the Project, manufacture and finally, installation.

All items of equipment shall be subject to inspections by the Engineer during design and manufacture per these QCP's.

In general, it is anticipated that this Project shall be in accordance with the relevant ISO 9000 requirements.

M17.13.2 Installation

The successful Tenderer shall submit a QCP covering all aspects of the installation of each item of equipment to be installed under this Project. The Engineer shall be requested to attend certain stages of completion of installation to ascertain compliance with the Specifications and to witness the Contractor's site inspections at the Engineer's discretion.

M17.14 **SYSTEM PERFORMANCE**

Works testing

Each item of equipment shall be subject to inspection and testing prior to despatch from the works. All performance test results shall be made available to the Engineer for verification or when the QCP's require intervention or hold points for inspection.

In the case of gearboxes, they shall be subject to testing under operating conditions for at least 12 hours on the test bed. All results shall be available for inspection

Before commissioning

- Check for correct oil level in gearboxes and that motors are greased properly.
- Ensure all HD bolts are torqued down correctly.
- The alignment and levelling of each assembly shall be checked and the results shall be available for inspection by the Engineer.
- The electrical functions and control shall be checked by a responsible inspector prior to attempting to start any motor on this Project.

After Initial Commissioning

- Ensure all oil pumps and flow or pressure switches are functional
- Ensure that the equipment is operating smoothly and that all limit switches are operating.

M17.14.1 Before Expiry of the Defects Liability Period

The Engineer requires the Contractor to visit the site every quarter to inspect for the correct operation of the installed equipment. A report after each visit shall be submitted in writing

M17.15 **OPERATION MANUALS**

The Contractor must compile and provide copies of a complete operation and maintenance manual for the equipment provided. The manual shall contain comprehensive information as set out hereafter.

- A complete recommended spares list
- A lubrication and maintenance schedule showing all maintenance and lubrication operations, their recommended frequency and the grades of lubricant required

- A maintenance brochure describing all maintenance, adjustment and replacement procedures
- All dismantling and reassembly procedures
- Maintenance procedure for corrosion protection painting systems
- The Contractor shall amplify and amend such drafts until the Engineer is satisfied that they will fulfil the purpose of ensuring that the Employer's staff is adequately instructed to operate and maintain the works. Once the drafts have been approved by the Engineer, the Contractor shall prepare suitably bound copies and deliver them to the Engineer.

The manuals shall be drawn up in English.

M17.16 MEASUREMENT AND PAYMENT

Measurement and payment will distinguish between supply/delivery and installation/commission as well as per installation point.

The respective tender rates shall cover all costs from supply to commission of each actuator but excluding the electrical power supply and electrical cable connection.

The tendered rates or sums shall cover the cost of design, drawings, manufacture, supply, testing at the manufacturers works, delivery to site, off loading, installation, site testing, setting into operation, the supply of O & M manuals, commissioning and maintenance during the warranty period of all equipment specified and also for anything not specifically mentioned but obviously required, (e.g. all ancillaries, including all bolts, fastenings and brackets, safety guards and any work or material required for the proper installation of such equipment) to enable the equipment to be installed and/or function safely and correctly as specified. No claims whatsoever for extras will be allowed on the grounds that a necessary piece of equipment or a part thereof is not specifically mentioned.



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PARTICULAR SPECIFICATION

M18: MECHANICAL CENTRIFUGAL PUMPS

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PARTICULAR SPECIFICATION M18: MECHANICAL CENTRIFUGAL PUMPS

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M18.1 SCOPE

This specification covers the detailed design parameters, manufacture, supply, installation, test and commissioning of Centrifugal Pumps. The Specification shall be read in conjunction with that of the Project Specification.

M18.2 INTERPRETATIONS

M18.2.1 Abbreviations

In this Specification the following abbreviations will apply:-

ANSI	: American National Standards Institute
ASTM	: American Society for Testing and Materials
BS	: British Standards Institution
SANS	: South African National Standards
SIS	: Swedish Institute of Standards
DIN	: Deutsch Industry Normen
ISO	: International Organisation for Standardization
ASME	: American Society of Mechanical Engineers
SAECC	: South African Electrolytic Corrosion Committee
AGMA	: American Gear Manufactures Association

M18.2.2 Standards

All design standards for the centrifugal pumps shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 10400	: National Building Regulations
BS 5304	: Code of practice for safeguarding of machinery
SANS 9096-1: 1994	: Testing of welders, where applicable to the type of welding required
BS 292 Part 1: 1987	: Dimensions of ball bearings, cylindrical and spherical roller bearings
SANS 10162-4	: Structural use of Steel Part 4: The design of cold-formed stainless steel structural
SANS 1044-3	: Welding Part 3: The fusion of steel (including stainless steel): Tests for the approval of welding procedures
SANS 10044-4	: Welding Part 4: The fusion welding of steel (including austenitic stainless steel): Tests for the approval of welders working where weld procedure approval is not required.
SANS 10064	: The preparation of steel surfaces for coating
SANS 10102-4	: Selection of pipes for buried pipelines Part 1: General Provisions
SANS 10104	: Hand railing and balustrading (safety aspects)
SANS 10111-2-1	: Engineering Drawing Part 1: General principles Engineering Drawing Part 2: Geometric Tolerancing Section 1

SANS 10341	:	Installation and maintenance of bearings – General guidelines
SANS 1700-5-9	:	Fasteners Part 5: General requirements & material properties Section 8: Corrosion resistant stainless steel fasteners-Bolts, Screws & Studs
SANS 1700-5-10	:	Fasteners Part 5: General requirements & material properties Section 8: Corrosion resistant stainless steel fasteners-Nuts
BS EN ISO 14847:1999	:	Rotary positive displacement pumps. Technical requirements
BS EN 734:1995	:	Pumps and pump units for liquids. Common safety requirements
BS EN 12162:2001	:	Liquid pumps. Safety requirements. Procedure for hydrostatic testing
BS EN 60041:1995	:	Field acceptance tests to determine the hydraulic performance of hydraulic turbines, storage pumps and pump-turbines.
BS EN 60994:1993	:	Guide for field measurement of vibrations and pulsations in hydraulic machines (turbines, storage pumps and pump-turbines)
BS EN 22858:1993	:	End-suction centrifugal pumps (rating 16 bar). Designation, nominal duty point and dimensions
BS EN 23661:1993	:	End-suction centrifugal pumps. Baseplate and installation dimensions
BS EN 733:1995	:	End-suction centrifugal pumps, rating with 10 bar with bearing bracket. Nominal duty point, main dimensions, designation system
SANS 1123	:	Pipe Flanges
ISO 281	:	Rolling bearings -- Dynamic load ratings and rating life
BS 4999	:	General requirements for rotating electrical machines. Specification for standard dimensions
SIS 05 59 00	:	Pictorial Surface Preparation Standards for Painting Steel Surface
BS 5316 Part 2	:	Pump test codes

M18.2.3 General Requirements

This specification must be read in conjunction with the following specifications:-

M08: Particular Specification for Gearboxes

M21: Particular Specification for Pressure Pipework

E01: Particular Specification for Electric Motors

G01: Particular Specification for Colour Codes

G02: Particular Specification for Corrosion Protection

Automation and Control Design Standards Volume 8: Flow Measurement

Automation and Control Design Standards Volume 11: Temperature Measurement

M18.3 **PUMPS**

M18.3.1 Design Parameters

Centrifugal pumps shall have stable non-overloading characteristics and the shaft speed shall not exceed 1500 rpm.

The pumps shall be of the highest quality and shall be suitable for continuous operation over long periods with a minimum amount of maintenance at high-sustained efficiency.

In all applications, with exception of clear water pumps, non-clogging impellers must be used. Pumps shall be designed as to remove the impeller cover without moving the pump, pipe work or motor. Each pump shall have a drip tray with a 20 mm diameter galvanised drain pipe to the nearest drainage point.

The pump design shall make adequate provision for the balancing of residual axial thrust. Pumps shall be supplied complete with suction and delivery pressure gauges complete with air-bleed and isolating cocks, shaft couplings and guards, gland leakage piping, base plates, foundation bolts and other necessary equipment.

Detailed performance curves for the pump type shall be provided at the time of tendering.

The curves shall indicate the following:

- Head (metres) vs. flow (litres/second) - 0% to 120% duty flow
- Power absorbed in kW - 50% to 120% of duty flow
- Pump efficiency – 0% to 120% duty flow
- Net positive suction head curves required by the pumps at the specified flow rate.

The efficiency curve shall be flat over a wide range in order to provide efficient working at various pump operating conditions.

Pumps shall be able to operate without cavitation over a full range as specified without throttling. Pumps are required to operate continuously at an ambient temperature of 40°C.

The following quantities shall be guaranteed by the Contractor:

- Minimum flow rate of the pump at the specified total head.
- Maximum power demand at the specified total head.
- Minimum efficiency at the specified total head.
- Maximum net positive suction head required by the pump at the specified flow rate.

Multiple Units

Unless specified arrangements incorporating multiple units coupled in series in order to achieve the duty specified for each complete pump set shall only be offered as an alternative.

The mechanical equipment to be supplied under this Contract shall be installed, tested and commissioned on concrete structures, constructed by others, to the dimensions indicated on the construction detail drawings.

M18.3.2 Pump Casing

The pump casings shall be manufactured from cast iron or cast steel depending on the stresses corresponding to the required test pressures. Unless otherwise stated the dimensions and drilling of the suction and discharge flanges shall be SANS 1123 to the design pressures as specified but with a minimum of 10 Bar.

The pressure rating of the flanges shall at least be equal to the maximum static pressure plus the pump shut-off pressure.

Casings shall be designed for not less than the following working pressures or 1.5 times the actual working total discharge pressure, whichever is the greater.

Horizontal Split casing	:	1000 kPa
End Suction type	:	1000 kPa
Vertical Split Casing	:	600 kPa
Multistage	:	1.5 times working pressure.

End suction pumps

End suction pumps are arranged with a central suction connection and a tangential discharge connection. Both these connections shall be suitably flanged.

The casings shall be split at right angles to the shaft to enable the easy withdrawal of the impeller assembly. The volute casing shall be preferably a separate casing from the pump bearing and base assembly, but bolted and spigoted thereto.

For end suction pumps of more than 5.5l/s and not more than 70 l/s capacity, the casing shall be arranged to have a removable casing cover on the motor side so that the pump may be dismantled without disturbing the suction or delivery piping.

Horizontally split casings

These shall be double entry type casings, which are split on the axial centreline. The suction and delivery branches must be cast integral with the part of the pump incorporating the pump base.

The other half of the casing must be easily removable for an internal examination of the pump without the necessity of disturbing either the suction or delivery pipe work or rotating assembly.

The casing shall be fitted with suitable renewable corrosion resisting wearing rings and bushes in all positions where fine clearances require to be maintained. Wearing rings shall be made of high quality bronze or stainless steel.

All casings must be fitted with ceramic or stainless steel neck rings where fine clearances must be maintained between stationary and moving parts, to suit the fluid pumped.

Semi-concentric back pull-out design casings

The pump casing shall be semi-concentric back pull-out design, with the first half of the circumference after the pump outlet being cylindrical. The remaining circumference shall spiral outwards towards the flanged centreline discharge. The casing shall be manufactured from cast iron.

All casings shall be provided with the following tapping's as a minimum requirement:-

- One suction pressure gauge tapping
- One discharge pressure gauge tapping
- One bleeder cock tapping
- One filling point tapping
- Suitable tapping or, where possible, internal drilling to provide water for the glands.

All casings shall be heavily ribbed and strengthened as necessary to resist hydraulic forces, and internal passages shall be smoothly finished to minimize hydraulic forces.

M18.3.3

Pump Impeller

Each impeller after machining and dressing shall be independently statically balanced and the

complete rotating assembly with coupling shall be dynamically balanced.

All impellers shall be of a non over loading design.

Impellers shall be securely keyed and fixed to the shaft by means of suitable shaft nuts and locking sleeves.

All bolting devices must be securely locked so that they cannot accidentally come loose. Bolting devices shall be made of corrosion resistant materials.

M18.3.4 Pump Shaft

The pump shafts shall be of sufficient dimension in order to avoid excessive torsional or bending stresses and deflection.

The pump shaft shall be designed so that the critical speed of the rotating assembly is well above the maximum pump operating speed.

The impeller shall be secured to the shaft in such a way that it can be readily removed without any damage to the impeller and the shaft.

The shafts shall be protected by replaceable sleeves manufactured from non-corrosive material. The shaft shall be manufactured from stainless steel.

M18.3.5 Shaft Coupling

The pump and motor shall be connected by a flexible coupling in such a way as to prevent them from uncoupling regardless of which way the impeller may be rotating.

The coupling shall accommodate small axial, lateral and angular misalignments without imposing undue stresses on the shaft and bearings. The coupling shall be enclosed in a stationery solid-plate guard to the Engineers satisfaction.

M18.4 **BEARINGS**

All bearings shall be suitable for shaft rotation in both directions. All bearings shall be designed for a life of at least 100 000 hours at an (L10) rating. Bearings for the output shaft shall be designed to withstand bending, up thrust, down pull, thermal expansion and radial loads imposed by the impeller.

The rotating assembly shall be positively located in the axial direction and thrust bearings will therefore be required.

For ease of lubrication all bearing grease pipes must be piped to grease nipples on the outer cover of the pump support frame.

M18.4.1 Bearing Housing

The bearing housing shall be manufactured from cast iron and shall be oil bath lubricated. Oil level sight glasses shall be provided with level markers for running and filling minimum and maximum positions respectively. These shall be arranged for easy viewing and shall take into account the angle of mounting.

The bearing housing and motor stool design shall provide accurate, self-aligning mounting for the flanged electric motor.

M18.4.2 Lubrication

In the case where oil lubrication is required, adequate provision shall be made for the cooling of

the oil. The bearings shall be required to operate at temperatures no higher than 60°C.

Oil reservoirs of sufficient capacity shall be fitted with easily accessible oil level indicators, which are to be clearly marked in order to indicate the oil standing and running levels.

M18.5 GLANDS AND SEALS

Low pressure glands of the stuffing box pattern shall allow repacking without having to dismantle the pump.

If mechanical seals are offered they shall be manufactured from 316 SS to prevent the pump from leaking and shall be cartridge-type seals with O-rings and silicon carbide or tungsten carbide faces.

The cartridge seal shall be pre-assembled and pre-tested, requiring no adjustments and settings from the installer. Any springs required to push the seal faces together shall be shielded from the fluid that is to be pumped. The cartridge shall include a heat treated sleeve and an iron seal gland.

Full details of the seals and glands indicating the materials, finishes, clearances etc. shall be submitted with the Tender.

A spare mechanical seal for each size and type shall be supplied.

M18.6 VENT COCKS

Vent cocks shall be fitted at all high points to the pump casing. These cocks shall be adequately sized in order to allow the trapped air to be released freely.

An automatic air vent shall be fitted to each pump casing if specified. This device shall be suitable for the remote operation of an indicator to show the open and closed positions of the air vent.

M18.7 BASE PLATE

The base plate of the pump and motor shall be rigid. The pump and motor shall be situated on the upper face of each base plate, which shall be machined flat and smooth to ensure that the pump and motor are bedded properly without the use of spacers.

The pump/motor base plate shall be completely aligned prior to grouting and provision shall be made to grout within the base plate itself to facilitate vibration-free operation.

Base plates which have a mass greater than 200 kg shall have two jacking bolts at right angles with a lock nut at every corner of the unit.

M18.8 DRIVE UNIT

The pump shall be driven by a fixed electric speed motor and a speed reducer. Refer to Particular Specification E01: Electric Motors for a detailed specification for Electric motors.

M18.8.1 Gearbox / Motor Coupling

The coupling shall be fully rated to transmit the motor full load power and tested to prove the above features together with static and dynamic balance. The motor shall be coupled to the gearbox input shaft with either a V-belt or a flexible coupling. V-belts and couplings are to be provided with protective cover guards.

M18.9 GEARBOX

Refer to M08: Volume M08: Mechanical Specification for Gearboxes.

M18.10 MONITORING DEVICES

Full detail of all monitoring devices offered must be submitted with the Tender.

M18.11 PRESSURE GAUGES

Pressure gauges shall be fitted with an isolating cock, shall be vibration and shock resistant and shall be calibrated to read with an accuracy of $\pm 1\%$ of the indicated pressure. Three 20mm minimum diameter ball valves shall be employed to zero the gauge, to isolate it and to vent to atmosphere. A chemical seal shall be used to insulate the gauge from the media being measured.

The faceplate diameters of the pressure gauges shall be at least 100 mm. The gauges shall indicate the water pressure in kilopascal and shall have a range of a maximum of 50% higher than the normal maximum working pressure. All gauge glass must conform to internationally recognized standards. These standards include DIN 7081, BS 3463 and JIS B 8211.

A calibration certificate is to be provided with each pressure gauge.

M18.12 TEMPERATURE DETECTORS

If required oil lubricated bearings and glands offered shall be fitted with temperature detectors. The temperature detectors shall be PT100 – RTD's

If grease lubricated bearings are offered, the Tenderer will indicate in his Tender if temperature detectors can in fact be used. If temperature detectors are not feasible, an alternative means of monitoring bearings must be offered.

M18.13 NO-FLOW PROTECTION

- (a) Each pump shall be protected against no flow by a flow meter installed in the discharge line from the pump.

M18.14 INDICATOR ON AUTOMATIC AIR VENT

If an automatic air vent is required for the pump casing, it shall be fitted with an indicator to indicate the open and closed positions of the air vent. The air vent shall be suitable for remote operation and air vent control shall be mounted on the control panel inside the pump station.

M18.15 GLAND LEAKAGE

If a gland leakage device is required in order to monitor the gland leakage it shall be supplied and fitted with adjustable alarm contacts designed to close when gland leakage rises to a pre-set value.

M18.16 PIPEWORK

All suction and delivery pipes shall be connected to the pump casing by means of flexible connections. All flexible connections shall be installed as close to the pump's casings as possible, and in any event, shall be between the suction valve and the pump casing and delivery non-return valve and the pump casing. In all cases the flexible connection shall be in the section of piping of smallest diameter.

Double Victaulic joint are generally preferred for flexible connections, but approved re-enforced rubber bellow units are acceptable for low-pressure services.

All valves and pipework external to the pump casing and separated there from by means of flexible connections shall be securely anchored to prevent movement.

Refer to Particular Specification M21: Volume M21 Pressure Pipework for a detailed specification on pipework.

M18.17 HOLDING DOWN BOLTS

The contractor shall be responsible for the supply of all necessary holding down bolts for the machines supplied by him/her. The holding down bolts shall be manufactured from 316 SS.

All bolts necessary for assembling all equipment shall be supplied by the contractor.

M18.18 VIBRATION AND NOISE

The pumps as well as the motors will comply with the requirements of BS 4999. The Contractor may be requested by the Engineer to carry out vibration tests. The noise level shall not exceed 85 dBA at 1m.

M18.19 CORROSION PROTECTION

Refer to Particular Specification G02: Corrosion Protection

M18.20 DESIGNATION AND INFORMATION PLATES

Each pump shall be supplied with an information plate secured to the pump casing in a visible position indelibly marked with the following details:-

- Maker's name, pump type and serial number
- Year of manufacture
- Rated duty of pump in litres per second
- Head in metres at rated duty
- Pump speed in r/min
- Mass of completely assembled pump in kilogram

M18.21 INTERCHANGEABILITY

Where two or more similar pump units are required, these units will be identical in all respects.

All similar parts of items supplied will be interchangeable without any additional machining or fitting.

M18.22 RECOMMENDED SPARE PARTS

The Tenderer must submit details of spare parts recommended to be kept in store by the Employer with his Tender.

The detail will include a full description of the parts, part identification, number required, guaranteed delivery time and total price delivered to Site.

M18.23 OPERATION AND MAINTENANCE MANUAL

The Contractor shall hand over to the Engineer four sets of the Operation and Maintenance

Manual compiled for each installation not later than at the time of commissioning of the installation. These manuals are a prerequisite for final take-over of the plant.

The Operation and Maintenance Manual will contain the following:

- (a) Brief description of the plant and installation.
- (b) Concise operating instructions.
- (c) Routine maintenance instruction.
- (d) Precautionary measures, elementary trouble location, rectifying measures and emergency actions.
- (e) Detailed information on equipment.
- (f) Lists of spare parts including names and addresses of suppliers.

M18.24 DRAWINGS

The drawings included in the Tender Documents are the Engineer's proposal for the plant layout. Should the Tenderer offer alternative layouts, he shall submit drawings with his Tender in order for it to be evaluated.

Before the Contractor carries out any work, he will submit detailed working drawings to be approved by the Engineer. Approval of these drawings does not relieve the Contractor from his responsibility for the correctness of the drawings.

M18.25 INSTALLATION

The pump and motor shall be aligned to within ± 0.025 mm full indicator movement on dial gauge, regardless of the coupling type. After the pump and motor feet are tightened down, and pipework erected and tightened, both angular and parallel alignment shall be checked and recorded at each quarter revolution. These readings shall be submitted to the Engineer and is a prerequisite for handover.

Upon completion, dowel pins shall be fitted to facilitate relocation at any future time.

M18.26 INSPECTION, TESTING AND COMMISSIONING

M18.26.1 Testing by Manufacturer

The Manufacturer will carry out all tests on materials, quality control tests, dimensional checking and routine tests on parts to ensure that the pumps and materials conform to the requirements of the relevant SANS or BS specifications and to this Specification. The Engineer will not necessarily attend these tests but records must be kept and all test results will be made available to the Engineer.

M18.26.2 Witnessed Testing

In addition to the above, a number of performance tests will also be carried out in the testing facility of the supplier before equipment is transported to Site. These tests can be carried out in the workshop of the manufacturer/supplier if it is suitably equipped or another approved test facility.

The Engineer may witness these tests and the Contractor will notify the Engineer two weeks in advance of the date and place at which the equipment may be inspected and tested. When tests and inspections have met the satisfaction of the Engineer a certificate of workshop

acceptance will be issued. These certificates are a prerequisite before payment for "Materials on Site" can be passed. The Engineer's acceptance will in no way relieve the Manufacturer of any of his obligations to design, manufacture and supply pumps strictly in accordance with the Specification.

Performance tests shall include:-

- (a) Hydraulic tests on the pump casing. The test pressure will be equal to 1½ times the maximum working pressure at the delivery end of the pump. The testing will be done with blank flanges bolted onto the flanges. The pressure will be maintained for at least 15 minutes. No sign of sweating, leaking, undue deformation and stressing or defect of any kind will be evident during the test period.
- (b) Tests to prove that the rotating parts are dynamically balanced.
- (c) Performance tests on pump and driving unit.
- (d) NPSH requirements if called for in the Project Specifications.

A performance test shall be carried out in accordance with BS 5316 Part 2 - Class B tests if specified. Unless otherwise stated, the Contractor will be required to conduct the performance test on the combined pump/motor unit.

If a performance test of the pump and its driving unit is not possible at the manufacturer's works, this shall be stated in the Tender with reasons to allow the Engineer opportunity to make alternative proposals.

M18.26.3 Testing by an Independent Facility

The Employer may require that an independent testing facility or institution such as the South African Bureau of Standards carry out performance tests. A separate item for performance testing will be provided in the Schedule of Quantities to allow for this.

M18.26.4 Failure to Pass Performance Test

Should the pump unit fail the performance test, whether performed at the manufacturer's works or at an independent institution, the Engineer shall authorise any amendments to the plant which may be considered necessary to meet the guaranteed quantities within the permissible tolerances laid down in BS 5316 Part 2 - Class B tests and prove with further test that the equipment conform to the Specification.

All costs involved in the re-testing of pump units will be borne by the Contractor.

Should the pump unit fail to pass the test with more than 5% variation on the actual guaranteed figures; the engineer will reject the pump unit and request the Contractor to replace the unit so rejected.

Should the pump unit still fail to pass the test, but the actual figures do not vary by more than 5% from the actual guaranteed figures, the Engineer may :-

- (a) Request the Contractor to carry out amendments to ensure the compliance of the unit with the Specification; or
- (b) Accept the equipment but impose a penalty for non-compliance on the Contractor. A sum will be calculated based on the additional energy used over the life expectancy of the equipment and this will be deducted from the Contract price for each pump set for every kilowatt by which the gross demand exceeds the guaranteed figure with permissible tolerances.

M18.26.5 **Commissioning**

On completion of the installation the Contractor will check all items for satisfactory functioning. He will then inform the Engineer of his intention to commission the plant. The Engineer may request control measurements on pump alignment at this stage.

A detailed programme of his proposed commissioning procedures will be submitted not later than two weeks prior to the commissioning date.

After a successful running period of 4 hours (to be witnessed by the Engineer) the Contractor will hand over the installation to the Employer as well as the Operation and Maintenance Manuals. The Completion Certificate will only be issued after the units have been in successful operation for 14 consecutive days and the acceptance tests successfully completed.

During the first 14 days of operation, the Contractor will rectify any problems with the units on Site within 24 hours of being telephonically notified. During the remainder of the maintenance period, the Contractor will, within 14 days of being notified, commence rectifying any possible problems that the Employer may encounter with the equipment supplied under this Contract.

Should the Contractor fail to meet the above requirements, the Employer may appoint others to undertake the necessary repair work at the Contractor's cost.

M18.26.6 **Tests at the Site of the Works**

The Engineer may require that site tests are performed to verify performance figures guaranteed by the Contractor. Flow rate, total head and power input to the pump/motor units shall be determined, as accurate as Site conditions permit, for one or more points on the pump curves close to the specified duty point. The Contractor shall provide suitable instruments with recent calibration certificates.

Should these measured and calculated quantities differ from those guaranteed by more than the tolerances allowed by BS 5316 Part 1 - re-testing of the unit at any testing facility, or the recalibration of the measuring instruments.

Should the subsequent test results still fall outside the allowable tolerances, Clause M18.28.4 shall apply, and all costs shall be borne by the Contractor. In the event of the subsequent test being successful, costs shall be borne by the Employer.

M18.27 **COLOUR CODES**

The standard final colour codes for equipment supplied under this Contract shall be in accordance with Particular Specification G01.

M18.28 MEASUREMENT AND PAYMENT

Payment under scheduled items shall be made per complete installation as specified, electrical connections, etc and grouting, etc. Measurement and payment will distinguish between supply / delivery and installation / commissioning of the equipment.

The tendered rates or sums shall cover the cost of design, drawings, manufacture, supply, testing at the manufacturers works, delivery to site, off loading, installation, site testing, setting into operation, the supply of O & M manuals, commissioning and maintenance during the warranty period of all equipment specified and also for anything not specifically mentioned but obviously required, (e.g. all ancillaries, including all bolts, fastenings and brackets, safety guards and any work or material required for the proper installation of such equipment) to enable the equipment to be installed and/or function safely and correctly as specified. No claims whatsoever for extras will be allowed on the grounds that a necessary piece of equipment or a part thereof is not specifically mentioned.



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PARTICULAR SPECIFICATION

M20: MECHANICAL VALVES: MANUFACTURE AND SUPPLY

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PARTICULAR SPECIFICATION M20: MECHANICAL VALVES: MANUFACTURE AND SUPPLY

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M20.1 SCOPE

This Specification covers the manufacture, testing and supply of sluice, butterfly, air, gate, reflux, diaphragm, flow limiter and pressure reducing valves for use in pressure pipelines for the conveyance of raw or potable water at ambient temperatures.

M20.2 INTERPRETATIONS

M20.2.1 Abbreviations

In this Specification the following abbreviations will apply:-

ANSI	: American National Standards Institute
ASTM	: American Society for Testing and Materials
BS	: British Standards Institution
SANS	: South African National Standards
SIS	: Swedish Institute of Standards
DIN	: Deutsch Industry Normen
ISO	: International Organisation for Standardization
ASME	: American Society of Mechanical Engineers
SAECC	: South African Electrolytic Corrosion Committee

M20.2.2 Standards

For the purposes of this Specification the latest issues of the following standard specifications will apply:-

SANS 1700	: Fasteners
SANS 135	: Isometric Bold Screws and Nuts (Lexagon & square/coarse thread free fit series)
SANS 136	: Isometric Precision Hexagon Head Bolts and Screws and Hexagon Nuts (coarse thread medium fit series)
SANS 144	: Cast Iron Single-door Reflux Valves
SANS 191	: Cast Steel Gate Valves
SANS 192	: Cast Steel Single-door Reflux Valves
SANS 664	: Cast Iron Gate Valves for Waterworks and heavy Industrial Purposes
SANS 936	: Cast Iron Spheroidal Graphite Iron Castings
SANS 1431	: Steel
BS 3100	: Cast Steel
BS 4504	: Flange Drilling
BS 5155	: Cast Iron and Carbon Steel Butterfly Valves
SIS 05 59 00	: Pictorial Surface Preparation Standards for Painting Steel Surfaces
ISO 2441	: Pipe Line Flanges for General use - Shapes and Dimensions of Pressure Tight Surfaces
SANS 1123	: Steel Pipe Flanges

M20.2.3 General Requirements

This specification must be read in conjunction with the following specifications:-

G01: Particular Specification for Colour Codes

G02: Particular Specification for Corrosion Protection

M20.3 GENERAL REQUIREMENTS

Satisfactory temporary end cover shall be provided to protect threads, flanges and prepared ends of valves from damage during transportation and handling on site.

Valves shall be so transported, stored and handled as to prevent damage. Valves damaged in any way shall be removed from the site.

The Contractor shall satisfy the Engineer as to the sufficiency of the place of manufacture regarding manufacturing, testing and inspection equipment to ensure that the production of valves is strictly in accordance with this Specification.

M20.3.1 Pressure Rating

The design pressure for the valve is specified in the Tender Document either in/or the Project Specification, Drawings and Schedule of Quantities. The minimum pressure rating for valves shall be 10 Bar. Valves shall be capable of withstanding the applicable test pressure as specified in SABS 664. Test pressure shall be maintained for 5 minutes and the valve bodies shall be watertight in all aspects.

M20.3.2 Wastewater Liquids and chemicals

Various different chemicals are used to treat wastewater. These include:-

- Ferric chloride
- Chlorine
- Polymer (Polyelectrolytes)
- Ammonium bromide

Valves used for the above mentioned chemicals shall be manufactured from highly non-reactive polymer such as Polyvinylidene Fluoride (PVDF) and PVC.

Valves which encounter raw wastewater, treated wastewater and sludge shall be manufactured from corrosive resistant material.

M20.3.3 Guarantee

All valves shall be guaranteed against faulty design, materials and workmanship until the end of the maintenance period on the Main Contract. During this period the Contractor shall be required to attend to and rectify any defects, which occur due to faulty design, materials or workmanship at his own cost.

M20.3.4 Operating and Maintenance Manuals

A copy of the Operating and Maintenance Manual for each valve type and different valve manufactures shall be bound in with the Operating and Maintenance Manual for the project. The manual shall be A4 size and properly bound. Drawings larger than A3 size shall be contained in separate plastic pockets.

M20.3.4.1	Contents • A copy of the signed factory test certificate shall be bound in with the manual, while the original shall be handed to the Engineer. • Operating instructions • Maintenance instructions • Lubrication instructions • Spare parts list • Drawings • Brochures
M20.3.5	<u>Jointing Material</u> Jointing material shall comply with SANS 1700. Valves shall be supplied complete with bolts, nuts, washers (2 per bolt) and gaskets for joining up to adjacent mating flanges. Bolts shall be of stainless steel in all open applications (e.g. in valve chambers, reservoirs, etc.) and galvanised when buried provided the flanges are protected with DENSO mastic and tape. The bolt shall be long enough to allow at least two screw threads to protrude from the nut when the assembly is fully tightened. A washer must be provided both under the bolt head and the nut.
M20.3.6	<u>Contact between Dissimilar Metals</u> When flanges of dissimilar metals are bolted together, the internal epoxy coating shall cover the contact area of the flange without any break. Suitable insulation material shall be used between the contact faces of dissimilar metals of which the potential difference exceeds 0,3 V. Where corrodible metal is welded to a corrosion resistant metal, the protection coating specified shall overlap onto the latter by at least 5 mm.
M20.4	FABRICATION
M20.4.1	<u>General</u> (a) <u>Marking of Valves</u> The design pressure in Mpa shall be hard stamped on the edge of flanges to valves, to be visible from the top of valves. (b) <u>By-passes</u> Where indicated in the Project Specification or the Schedule of Quantities, valves shall be supplied with by-passes. Such by-passes shall be bolted on to the body of the valve and not to the adjoining pipework. (c) <u>Hand wheels and Direction of Closure</u> Where valves are required to be supplied with hand wheels, the rims of such hand wheels shall be machined to a smooth finish if specified. Arrows shall be cast on the hand wheels together with the wording "TO OPEN" or "TO CLOSE" - Closing being by the clockwise rotation of the spindle unless otherwise specified. (d) For cap top valves an aluminium disc of at least 100 mm diameter with the same wording and arrows shall be slipped over the spindle and retained by the cap. If specified in the Project Specification, valves shall be fitted with indicators representing

the valve status, showing fully open, fully closed and intermediate positions. Such indicators shall be corrosive proof and of robust design.

(e) Flanges

Unless otherwise indicated flanges shall conform, in all respects, to the requirements of SANS 1123 appropriate for the class of valve specified.

Should required sizes fall beyond the range of SANS 1123, flange dimensions shall confirm to the requirements as specified.

The Contractor shall obtain written confirmation of required flange drilling from the Engineer prior to the commencement of manufacture.

Sufficient clearance shall be allowed between the body of the valve and the flange to enable proper tightening of bolts. Tapped holes shall only be allowed in exceptional cases and with the Engineer's written consent.

(f) Information to be Supplied

Complete details of each valve offered must be provided at the time of tendering. This information will include at least the following:-

- Description
- Manufacturer's figure number
- Flange drilling
- Maximum working pressure (in kPa)
- Maximum unbalanced pressure (in kPa)
- Test pressure (in kPa)
- Material of components
- Gearing
- Accessories

M20.5 BUTTERFLY VALVES

Butterfly Valves shall be of the full-bore type and NOT reduced bore type with flanged ends. Valves larger than 200mm shall be fitted with gearboxes.

M20.5.1 Opening and Closing

All valves shall be capable of being opened or closed by hand under an unbalanced pressure equal to the design pressure without any difficulty. The disc shall close with a positive action with no possibility of slamming shut during any stage of the closing operation and the valve shall be capable of operating at any opening without variation of disc position or flutter of the disc.

The direction of the spindle rotation for valve closing shall be clockwise.

M20.5.2 Valve Body

Valve bodies shall be manufactured from cast iron or cast steel depending on test pressures and as specified.

The valve body shall have integral hubs for shaft bearing housings. Valves shall be provided with supporting feet and lifting rings where specified. A flow direction arrow shall either be cast into the body or shall be a brass plate screwed onto the body with brass screws.

M20.5.3 Discs

Discs shall be manufactured from cast iron or cast steel depending on test pressures and as specified. Discs shall be a single casting having a smooth streamlined design to minimize resistance to water flow.

The disc shall be off-set in the body to ensure simultaneous contact around its perimeter and shall have a positive non-slamming closing action.

M20.5.4 Seats and Seals

The profiles of the seats shall be smooth and continuous and shall provide adequate “lead in” for the resilient seal during closure of the disc to prevent excessive seating torque requirements. The seats shall be fixed to the valve body with stainless steel countersunk screws to facilitate replacement.

The seals shall be of the resilient type with non-weathering, non-sticking, long life properties. Seals shall be replaceable and shall be secured to the edge of the disc by means of a retaining ring. Sealing rings and seal retaining rings shall be manufactured from stainless steel.

The design of the seat and seal shall allow replacement thereof without removing the valve from the line.

M20.5.5 Shafts

Valve shafts shall be of high grade stainless steel. Valve shafts shall either be continuous through the disc or of a stub shaft design as described in the Project Specification and will be horizontal to the installed valve position. In the case of the sub-shaft type, each stub shaft shall extend into the disc hub for a distance of at least 1.5 times the shaft diameter.

All keys, dowel pins and taper pins used to attach the shaft to the disc shall be mechanically secured. The shaft shall be so sealed that the only two wetted parts shall be the disc and the seat.

M20.5.6 Bearings

Class 16 (1600 kPa) valves or valves with diameters of 350 mm or bigger shall be fitted with two-way adjustable bearings in order to permit precise disc-to-seat positioning at all times.

Positive bearing retention shall also be provided so that the bearing will not shift under operating conditions. The valve shall be capable of being installed and operated in any position.

The bearings shall be self-lubricating, long lasting sleeve-type bearings shall be fitted in the hubs of the valve body and at least one set of thrust bearings shall be provided.

M20.5.7 Gearboxes

Where it is necessary or where it is specified valves shall be operated via manually operated gearboxes

Gearboxes shall be self-locking and capable of holding the disc in a fixed position for any extended period of time.

Gearboxes shall be geared to be operated against the maximum unbalanced pressure with an effort not exceeding 200 N with each hand on the rim of a standard hand wheel. (Total effort = 400 N).

Gearboxes shall also be fitted with mechanical stops to prevent excessive turning and shall be

provided with replaceable shear pins. One spare shear pin shall be provided with each valve.

All gearboxes shall be equipped with position indicators, adjustable travel stops and indications of the "open" and "closed" positions.

The design of the gearbox shall readily allow for conversion to motorised drive at a later stage if required.

M20.6 AIR RELEASE VALVES

M20.6.1 Water works anti-shock and air release

Air valves shall be manufactured from cast iron or stainless steel depending on the test pressures and the project specification and of the single chamber design with cylindrical solid polymer control floats incorporating anti-shock design during high velocity air discharge.

The orifice plate, internals and body bolts shall be of stainless steel. All components of the valve shall be easily replaceable. All internals made of stainless steel that will be in contact with the fluid shall be lined or coated with a polyurethane paint to prevent cathodic action.

The design of the valve shall be such as to preclude the loss of water or the possibility of the float being blown shut by the passage of air when the accumulation of air in the pipeline is being released.

The valves shall be positive in the action to admit a free and full supply of air when the pipeline is being emptied or when the operating conditions demand.

Valves shall respond to the presence of accumulated air under normal working conditions by discharging it through a small orifice at any pressures within the specified design range.

Valves shall react immediately to pipeline drainage by full opening of the large orifice to allow unrestricted air intake. Valves shall not exhibit leaks or weeping past the large orifice seal at the maximum working pressure.

M20.6.2 Air Valves (Sewage)

Where air valves are required on sewage or industrial effluent pumping mains, they shall be specifically designed for such usage. Ordinary waterworks pattern air valves will not be acceptable.

Air valves shall be installed with an isolating valve on the inlet.

Full details of the air valves offered shall be provided at the time of tendering.

M20.6.3 Air Valves (Water Mains)

The following types of air valves as indicated on the Drawings and/or listed in the Schedule of Quantities are required.-

Type SO	:	Small orifice, single ball, lever type air valve which permits the escape of air from the pipe under working pressure.
Type LO	:	Large orifice, single ball air valve which allow air to enter the pipe when the pipe is being emptied and permit air to escape from the pipe when it is being filled.
Type DO	:	A combined small and large orifice air valve, the small orifice operating as the type SO and the large orifice as type LO above.

The size of the air valve shall be specified on the Drawings or in the Schedule of Quantities by the inlet diameter.

Air valves shall be suitable for the working pressure indicated on the Drawings or stated in the Schedule of Quantities.

All air valves shall be flanged and fitted with an isolating valve on the inlet pipe and a drain cock unless otherwise stated.

The air valves should be so designed that the balls are prevented from sticking.

Cover plates shall allow free discharge or intake of air, but shall prevent the ingress of foreign matter.

Valves shall be drop tight on shut-off and the design of the valve shall prevent balls from sticking.

When discharging large volumes of air at high rates the ball must not be caught up in the escaping air stream and close before all air has been released.

Tenderers shall submit full particulars of the air valves tendered on with the tender.

M20.6.4 Special Valves

All valves other than sluice and air valves shall be classified as special valves. The general requirements, pressure ratings, protective layers, flanges, markings, tests, etc. as specified in this Section will be applicable to the special valves. The particular valve will be further specified in the Project Specification.

M20.7 **GATE VALVES**

All gate valves shall comply with the requirements of SABS 664 and shall carry the SABS mark. Gate valves shall completely clear the bore of the valve in the fully open position. The direction of closing shall be clearly marked on the bonnet of the valve. Valves shall be drip-tight from zero to maximum working pressure under test conditions.

M20.7.1 Wedge Gate Valves

Valve seat and gate rings shall be manufactured from bronze to BS 1400 LG2.

Valves except flange faces shall be coated externally and internally with self-etching primer followed by one or more coats of fusion bonded epoxy material to give a total film thickness of at least 250 microns all applied in accordance with the manufacturer's specifications.

Valves where specified shall be supplied with fully enclosed, grease-packed, single-train spur gearboxes with a 3:1 or 4:1 ratio as specified.

Where required bronze gate guides and shoes shall be fitted as additional.

Integral mounted by-pass assemblies shall be fitted as additional where required.

M20.7.1.1 Auxiliary Fittings

Wedge gate valves of 300 mm diameter and larger shall be fitted with the following auxiliary fittings:-

- Drain Plugs

300 mm diameter valves and larger shall be supplied with gunmetal drain-plugs screwed into the lowest point of the valve and the valve body shall be suitably drilled and tapped to accept the drain-plug. The plug must be in position when the test pressure is applied.

- Ball Bearing thrust Collars

300 mm diameter valves and larger shall be fitted with ball-races on the top and bottom of the thrust collars. The ball-races shall be totally enclosed in a grease-packed cover, which shall be sealed to prevent the egress of grease. Provision must be made for lubricating the ball-races and the lubrication arrangement shall allow for re-greasing while the valve is under pressure.

M20.7.2 Knife Gate Valves

The valve body shall be cast iron with soft rubber lining. Spindle and blade are to be manufactured from stainless steel. Valve seals are to be re-packable and reversible made from Nitrile rubber with PTFE scrapers, to withstand solid particles and grit associated with wastewater and sludge.

Hand wheels shall be rising spindle types. Knife gate valves shall be installed vertically at all times.

M20.7.3 Resilient Seal Valves

Resilient Seal valves ensure tight compression sealing without wear and shall be used as isolating valves. Valve bodies shall have unobstructed, pocket-free, bores i.e. no seating protrusions or gate well, with inclined seats and gate guides to eliminate deposits in the valve body.

The spindle seal shall have at least two Nitrile Butadine rubber to DIN 3770 O-rings located in a corrosion-resistant housing and a wiper ring to prevent ingress of dirt. A back seal shall permit replacement of spindle seats under pressure, with the gate in the fully open position.

The cast iron gate shall be fully covered with a Nitrile Butadine rubber sheath fully bonded to the gate by vulcanising.

Valves shall be smooth bore and shall operate without the use of any wedging action, which may scuff or damage the rubberised gate.

Valves shall be coated with a fusion bonded epoxy coating of minimum thickness 200 microns.

M20.8 **NEEDLE VALVES**

Type NLV1 needle valves of sizes 50 NB and under shall be used for flow control of dilution water. Needle valves shall be manufactured from stainless steel and shall adhere to ASTM A 351.

The valve shall be hand operated and the ends of the body shall be screwed to BSP.

M20.9 **SPECIAL VALVES**

All valves used for special operations and conditions shall be carefully selected.

Tenderers are required to submit full details of the valves offered and the final selection shall be subjected to the approval of the Engineer. The valves offered shall not be accepted as substitutes for the standard valves specified.

M20.10 REFLUX/NON RETURN VALVES

Valves used for sewage effluent or sludge shall be self-cleansing at the base of the gate. The interior shall be smooth and free from any projections.

Valve bodies shall be of cast iron or cast steel depending on the test pressures and the project specification.

Valve doors shall be of cast steel or cast iron. Body rings, door rings and spindles shall be manufactured from stainless steel.

The following types of reflux valves as specified shall be supplied:-

- (a) Single sloping swing door for sizes up to 400 mm.
- (b) Double sloping swing door for sizes larger than 400 mm and up to 800 mm.
- (c) Multiple sloping swing doors for sizes larger than 800 mm.

Valve bodies and seals shall be free of pockets that will allow dirt accumulation.

Valve doors shall be designed to prevent fluttering and shall allow rapid but non-slamming closure on reversal of flow. The gate shall swing free in the body and in fully open position shall not obstruct the flow.

Valves shall seal effectively under all operating conditions and the design shall be such that the gate rests against the seat in the absence of flow or of differential pressure without the aid of springs or external counterweights.

Where specified in the Project Specification, valve doors shall be balanced by attaching counterweights and levers, or hydraulic dampers to the extended valve spindle.

Where valves are fitted to buried pipe lines, only hydraulic dampers shall be used.

M20.11 DIAPHRAGM VALVES

The valve is to be able to handle sludge's, rags and grit as expected in waste treatment works. The valve body must be designed to minimise turbulence and give 100% leak tight closure.

The valve must have a smooth bore and minimise wear from abrasion and allow for rodding when sludge's set in the pipeline.

The valve operating mechanism must be sealed from service and atmosphere.

The diaphragm must be manufactured from tough, resilient type natural rubber of sufficient grade to handle abrasives, acids and alkalis as expected in sewage works.

The valve body is to be cast iron with sufficient corrosion and erosion protection to last the useful life of the valve.

M20.12 BALL VALVES

M20.12.1 Type BLV1

This type is used for general purposes for sizes of 50 NB and under. The ball and stem shall be manufactured from 316 SS and the body shall be 304 SS.

The seat and the gland shall be PTFE material. The valve body shall be of the reduced bore type with ends screwed to BSP. The valve shall be lever operated.

M20.12.2 Type BLV2

BLV2 type ball valves are used for sludge lines. The valve shall be short pattern reduced bore type, fully lined with a Polypropylene or fluorocarbon resin liner.

All interior surfaces including the ball, stem and collar shall be lined to ensure that there is no contact between the metallic components and the lined media. The liners shall be securely retained by means of dovetail grooves within the bore and shall extend over the flange faces.

M20.12.3 Valve Body

The body of the valves shall be manufactured from ductile iron and all external bolts, nuts and gland followers shall be grade 316 material.

M20.13 PRESSURE REDUCING VALVE ANGLE/GLOBE PATTERN TYPE

The pressure reducing valve shall maintain a constant downstream pressure regardless of changing flow rate and/or inlet pressure.

M20.13.1 Main Valve

The valve shall be hydraulically operated, pilot-actuated, single or double chamber globe or angle patter. The valve shall consist of three major components: the body, with seat installed; the cover, with bearings installed; and the diaphragm assembly.

The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure form line pressure.

Packing glands and/or stuffing boxes are not permitted and there shall be no pistons operating the main valve or pilot controls.

M20.13.2 Main Valve Body

The valve body and cover shall be of cast material. Ductile iron is standard and other materials shall be available. No fabrication or welding shall be used in the manufacturing process.

The valve shall contain a resilient, synthetic rubber disc, with a rectangular cross-section contained on three and one-half sides by a disc retainer and forming a tight seal against a single removable seat inset. No O-ring type discs shall be permitted as the seating surface. The disc guide shall be of the contoured type to permit smooth transition of flow and shall hold the disc firmly in place. The disc retainer shall be of a sturdy one-piece design capable of withstanding opening and closing shocks. It must have straight edges and a radius at the top edge to prevent excessive diaphragm wear as the diaphragm flexes across its surface.

M20.13.2.1 Diaphragm

The diaphragm assembly containing a non-magnetic 304 stainless steel stem with sufficient diameter to withstand high hydraulic pressures shall be fully guided at both ends by a bearing in the valve cover an integral bearing in the valve seat. No centre guides shall be permitted. The stem shall be drilled and tapped in the cover and to receive and affix accessories as may be deemed necessary.

The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve separating operating pressure from line pressure.

The diaphragm shall consist of nylon fabric bonded with synthetic rubber compatible with the operating fluid. The centre hole for the main valve stem must be sealed by the vulcanised

process or a rubber grommet sealing the centre stem hole from the operating pressure.

The diaphragm must withstand a Mullins Burst Test of a minimum of 4000 kPa per layer of nylon fabric and shall be cycle tested 100 000 times to insure longevity. The diaphragm shall not be used as the seating surface. The diaphragm shall be fully supported in the valve body and cover by machined surfaces which support no less than one-half of the total surface area of the diaphragm in either the fully opened or fully closed position.

M20.13.2.2 Valve Cover

The main valve seat and the stem bearing in the valve cover shall be removable. The cover bearing and seat in 15 mm and smaller size valves shall be threaded into the cover and body. The valve seat in 200 mm and larger size valves shall be retained by flat head machine screws for ease of maintenance. The lower bearing of the valve stem shall be contained concentrically within the seat and shall be exposed to the flow on all sides to avoid deposits.

To insure proper alignment of the valve stem, the valve body and cover shall be machined with a locating lip. No pinned covers to the valve body shall be permitted. Cover bearing, disc retainer, and seat shall be made of the same material. All necessary repairs and/or modifications other than the replacement of the main valve body shall be possible without removing the valve from the pipeline. Packing glands and/or stuffing boxes shall not be permitted.

M20.13.2.3 Valve Manufacturer

The valve manufacturer shall warrant the valve to be free of defects in material and workmanship for a period of three year from date of shipment, provided the valve is installed and used in accordance with all applicable instructions. Electrical components shall have a one year warranty.

The valve manufacturer shall be able to supply a complete line of equipment from 32 mm through to 600 mm sizes and a complete selection of complementary equipment. The valve manufacturer shall also provide a cavitation chart which shall show flow rate, differential pressure, percentage of valve opening, Cv factor, system velocity and if there will be cavitation damage.

M20.13.3 Material Specification

Valve Size	: 50-300 mm
Main valve body and cover	: Cast Iron
Main valve trim	: Stainless steel
End detail	: SABS 1123 table 1600/3 or 2500/3 as specified
Pressure rating	: 0-50°
Coating	: Fusion bonded epoxy

Desired options:-

- X43 "y" strainer or equivalent on pilot piping
- Three ball valves on pilot piping, inlet, outlet and line to cover chamber
- 63 mm diameter pressure gauge, glycerine filled, fitted with 10 mm stainless steel ball valve on Tee-piece on inlet and outlet pilot piping.

M20.13.4 Pilot Control System

The pressure reducing pilot control shall be direct-acting, adjustable, spring-loaded, normally open, diaphragm valve designed to permit flow when controlled pressure is less than the spring setting. The pilot control is held open by the force of the compression on the spring above the diaphragm and it closes when the delivery pressure acting on the underside of the diaphragm exceeds the spring setting.

The pilot control system shall include a fixed orifice. No variable orifices shall be permitted. The pilot system shall include opening speed control on all valves 100 mm and smaller.

Three-way pilot controls will not be acceptable if the connection of TECHNOLOG "Autowat" or "Ecowat" controllers is specified.

The pilot control shall have a second downstream sensing port which can be utilised to install a pressure gauge.

A full range of spring settings shall be available in the range of 0 to 3000 kPa.

A direct factory representative shall be made available for the start-up service, inspection and necessary adjustments.

M20.13.5 Material Specification for Pilot Control

Pressure rating	: 1600 kPa or 2500 kPa as specified
Trim	: Stainless Steel
Tubing and Fittings	: Brass compression fittings with copper tubing
Adjustment range	: 200 to 2000 kPa or 100 to 500 kPa
Operating fluids	: Water

M20.14 PRESSURE REDUCING VALVE (SINGLE DIAPHRAGM LINER-OPERATED TYPE)

M20.14.1 Function

The pressure reducing valve shall maintain a constant downstream pressure regardless of changing flow rate and/or inlet pressure.

M20.14.2 Main Valve

The valve shall be hydraulically operated, pilot activated automatic control valve for pressure reducing service. The valve shall consist of two parts: stainless steel body and an elastomeric liner. The valve shall be positioned in line and be controlled via an external pilot control valve.

M20.14.3 Material Specification

Valve Size	: 50-300mm
Main valve Body	: 316 Stainless steel
End Detail (50 to 100 mm)	: Wafer pattern
End Detail (150 to 300mm)	: SABS 1123 Table 1600/3 or 2500/3 as specified
Pressure rating	: 1600 kPa or 2500 kPa as specified
Temperature range	: 0 to 70°
Liner Material	: Natural Rubber

Liner retainer	: 316 Stainless Steel
Coating	: Fusion bonded epoxy

Desired options:-

- X43 "y" strainer or equivalent on pilot piping
- Three ball valves on pilot piping, inlet, outlet and line to cover chamber
- 63 mm diameter pressure gauge, glycerine filled, fitted with 10 mm stainless steel ball valve on Tee-piece on inlet and outlet pilot piping.

M20.14.4 Pilot Control System

The pressure reducing pilot control shall be direct-acting, adjustable, spring-loaded, normally open, diaphragm valve designed to permit flow when controlled pressure is less than the spring setting. The pilot control is held open by the force of the compression on the spring above the diaphragm and it closes when the delivery pressure acting on the underside of the diaphragm exceeds the spring setting. The pilot control system shall include a fixed orifice. No variable orifices shall be permitted. The pilot system shall include opening speed control on all valves 100 mm and smaller.

Three-way pilot controls will not be acceptable if the connection of TECHNOLOG "Autowat" or "Ecowat" controllers is specified.

The pilot control shall have a second downstream sensing port which can be utilised to install a pressure gauge.

A full range of spring settings shall be available in the range of 0 to 3000 kPa.

A direct factory representative shall be made available for the start-up service, inspection and necessary adjustments.

M20.14.5 Material Specification for Pilot Control

Pressure rating	: 1600 kPa or 2500 kPa as specified
Trim	: Stainless Steel
Tubing and Fittings	: Brass compression fittings with copper tubing
Adjustment range	: 200 to 2000 kPa or 100 to 500 kPa
Operating fluids	: Water
Desired Options	: -

M20.15 FLOW LIMITER VALVES

M20.15.1 Screwed type limiter valves

The limiter valve shall consist of a screwed fitting with a rubber control ring orifice insert, which affects a consistent flow control within $\pm 10\%$ of the rated flow for a differential pressure across the valves over a range extending from 100 kPa to 1100 kPa.

The body of the limiter valve shall be made of uPVC plastic and shall female screwed at both ends to B.S.P.

The control rings shall be made of flexible nitrile elastomer rubber and must be able to move on a tapered seat in the body as the flow increases and be replaceable. The valve must be complete with control rings for the specified initial flow, which may be replaced in the future

(post-contract) for the final flow settings. The flow settings for the flow limiter valves are indicated in the Project Specification.

The screwed type limiter valve must be stamped with the flow in litres per minute and with an arrow to indicate the direction of flow.

A flow test must be conducted at the suppliers factory or test facilities, on one sample each of 20 mm, 25 mm and 32 mm flow limiter valve as prepared for use in the contract, over the following differential pressures:

Differential Pressure (kPa)	Tolerance limit on rated flow
50	± 50%
100	± 10%
150	± 10%
200	± 10%
300	± 101%
1000	± 10%

The measurement of flow rates must be to the satisfaction of the Engineer. If any one of the samples should fail to provide a flow rate within the tolerances specified, then all valves for installation on the contract must be tested for a selection of pressures on the contract must be tested for a selection of pressures up to the static pressures to be expected at installation sites, all to the satisfaction of the Engineer.

M20.15.2 Wafer type limiter valves

The limiter valves shall consist of a wafer pattern with a rubber control ring orifice insert, which affects a consistent flow control within ± 10% of the rated flow for a differential pressure across the valve over a range extending from the 100 kPa to 110 kPa.

The body of the limiter valve shall be made of uPVC plastic.

The control rings shall be made flexible nitrile elastomer rubber and shall be able to move on a tapered seat in body as the flow increases and be replaceable. The valve shall be complete with control rings for the specified initial flow, which may be replaced in the future (post-contract) for the final flow settings. The flow settings for the flow limiter valves are given in the Project Specification.

The limiter valve must be stamped with the flow in litres per minute and with an arrow to indicate the direction of flow.

A flow test must be conducted at the suppliers factory or test facilities, on one sample each of 50 mm and 80 mm flow limiter valve as prepared for use in the contract, over the following differential pressures:-

Differential Pressure (kPa)	Tolerance limit on rated flow
50	± 50%
100	± 10%
150	± 10%
200	± 10%
300	± 101%
1000	± 10%

The measurement of flow rates must be to the satisfaction of the Engineer. If any one of the samples should fail to provide a flow rate within the tolerances specified, then all valves for installation on the contract must be tested for a selection of pressures on the contract must be tested for a selection of pressures up to the static pressures to be expected at installation sites, all to the satisfaction of the Engineer.

M20.16 VALVE GEARBOXES

Gearboxes shall not be an integral part of the main body but shall be separate unit mounted to the body for easy removal. All gears shall be machine cut and fully enclosed and the lubrication shall be of the permanent type.

Positive stops shall be provided to prevent over opening or over closing of the units and visual indication of the point of travel at all positions in the open/close cycle shall be provided.

Torque limiting devices shall be fitted to prevent damage to gears and casings due to over tightening. Design of valves and gearboxes shall be such that leakage from the valve along the shaft cannot enter the gearbox.

M20.17 PROTECTION OF VALVES

M20.17.1.1 Internal Protection

Internal surfaces of valve bodies and discs shall be grit blasted to a Sa ½ of SIS 05 59 00 finish. Successive coats of an approved non-toxic epoxy resin paint suitable for spray application (Copon EP2300 or similar) shall then be applied to give a final dry film thickness of 300 µm. Drying times between successive layers will depend on environmental conditions and will be strictly in accordance with the requirements of the paint manufacturer.

As an alternative to the protection as specified above, the Contractor may be required to use either a solvent-less epoxy paint system or a fusion bonded epoxy powder coating. For fusion-bonded epoxy, a final dry film thickness of 250 µm is required.

Details of the protection required shall be given in the Project Specification.

M20.17.1.2 External Protection

External surfaces of valve bodies and discs shall be grit blasted to a Sa 2½ of SIS 05 59 00 finish. Successive coats of an approved non-toxic epoxy resin paint suitable for spray application (Copon EP2300 or similar) shall then be applied to give a final dry film thickness of 400 µm. Drying times between successive layers will depend on environmental conditions and will be strictly in accordance with the requirements of the paint manufacturer.

Where the specification does not call for an external surface consisting of an epoxy coating, the following shall apply:-

External surfaces of valve bodies shall be wire brushed to a Sa 3 of SIS 05 59 00 standard and painted with one layer zinc chromate primer to SANS 679 Type I (dried film thickness 50 µm). This shall be followed by two alkyd-based undercoats (each coat 25 µm thick) and one alkyd-based enamel finishing coat to SANS 630 Grade I (dried film thickness 25 µm). Final colour shall be as specified by the Engineer.

Machined flanges shall be painted with a protective coating of shellac or similar.

Refer to Particular Specification G02: Corrosion Protection

M20.18 TOLERANCES

The tolerances as specified in the appropriate SANS or BS standards shall apply to this Contract.

M20.19 COLOUR CODES

The standard final colour codes for equipment supplied under this Contract shall be in accordance with Particular Specification G01.

M20.20 TESTING AND INSPECTION

M20.20.1 Testing by Manufacturer

The Manufacturer shall carry out all tests to ensure that valve materials conform to the requirements of the relevant SANS or BS Specification. The Engineer shall not necessarily attend these tests but records must be kept and all test results and tests certificates must be provided to the Engineer.

M20.20.2 Testing by Independent Body

The Engineer may appoint an independent recognised body to conduct control tests. The Manufacturer shall provide samples required for such tests free of charge and the independent body in accordance with the relevant SANS or BS Specification shall do sampling.

The cost of such control tests shall be borne by the Employer.

M20.20.3 Inspection

Visual, operational and dimensional inspection of valves as well as inspection of protective coatings shall be carried out by the Engineer and/or the Manufacturer in the Manufacturer's workshop prior to the despatch of valves to site.

The Engineer's inspection will in no way relieve the manufacturer of any of his obligations to design, manufacture and supply valves strictly in accordance with the Specification.

M20.20.4 Hydrostatic Testing

The Engineer shall witness all hydrostatic tests and the Manufacturer shall give at least one week notification to the Engineer of the proposed dates for such tests.

Valve bodies shall be close ended tested to 2 x working pressure. Test pressures shall be maintained for at least 5 minutes and valve bodies shall be water tight in all respects.

Assembled valves shall be open-ended tested to 1.5 x working pressure for material strength and soundness. Valves shall be drop tight over the complete range of pressures from 0 to 1.5 x working pressure.

Each valve shall be supplied with a test certificate certifying that it complies in all respects with the requirements of this Specification.

M20.21 MEASUREMENT AND PAYMENT

Payment under scheduled items shall be made per complete installation as specified. Measurement and payment will distinguish between supply / delivery and installation / commissioning of the equipment.

The tendered rates or sums shall cover the cost of design, drawings, manufacture, supply, testing at the manufacturers works, delivery to site, off loading, installation, site testing, setting into operation, the supply of O & M manuals, commissioning and maintenance during the warranty period of all equipment specified and also for anything not specifically mentioned but obviously required, (e.g. all ancillaries, including all bolts, fastenings and brackets, safety guards and any work or material required for the proper installation of such equipment) to enable the equipment to be installed and/or function safely and correctly as specified. No claims whatsoever for extras will be allowed on the grounds that a necessary piece of equipment or a part thereof is not specifically mentioned.



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PARTICULAR SPECIFICATION

M21: MECHANICAL PRESSURE PIPEWORK

4	2013-10-23	Minor updates and re-issued	J Ritchie	
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Rev	Date	Description	Signature: JW Wastewater Partnership	Signature: Approval from Johannesburg Water

PARTICULAR SPECIFICATION M21: MECHANICAL PRESSURE PIPEWORK

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M21.1 SCOPE

This specification covers the detailed design parameters, manufacture, supply, installation, test and commissioning of pipework, pipe items, protective coatings and describes methods for laying and jointing of pipes. The Particular Specification shall be read in conjunction with the Project Specification.

M21.2 INTERPRETATIONS

M21.2.1 Definitions

For the purposes of this Specification the following definitions shall apply:-

(a) Cut Lengths

Where this term is used in the Specifications, on the Drawings or in the Schedule of Quantities it shall be taken to mean a pipe of differing length from the standard length for pipes as supplied by the manufacturer.

Cut lengths are required as closure pieces between standard pipe lengths, between the ends of a pipe fitting or between pipe fittings.

(b) Plain End

This term refers to a pipe end that has been cut, machined or finished in a manner suitable for coupling to a pipe with a similar end as specified.

M21.2.2 Abbreviations

For the purpose of this Specification the following abbreviation shall apply:-

ASTM	:	American Society for Testing and Materials
API	:	American Petroleum Institute
BS	:	British Standard
SANS	:	South African National Standards
SIS	:	Swedish Institute of Standards
uPVC	:	Unplasticised Polyvinyl Chloride
ISO	:	International Standards Organisation
DIN	:	Deutsches Institut für Normung
HDPE	:	High Density Polyethylene
MPVC	:	Modified Polyvinyl Chloride Pipes

M21.2.3 Standards

All design standards for the pressure pipework shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 10400	:	National Building Regulations
SANS 9096-1: 1994	:	Testing of welders, where applicable to the type of welding required
SANS 10064	:	The preparation of steel surfaces for coating
SANS 10102-4	:	Selection of pipes for buried pipelines Part 1: General Provisions
SANS 10111-2-1	:	Engineering Drawing Part 1: General principles Engineering Drawing Part 2: Geometric Tolerancing Section 1
SANS 1700-5-9	:	Fasteners Part 5: General requirements & material properties Section 8: Corrosion resistant stainless steel fasteners-Bolts, Screws & Studs
SANS 1700-5-10	:	Fasteners Part 5: General requirements & material properties Section

8: Corrosion resistant stainless steel fasteners-Nuts

SANS 455 : Covered electrodes for the manual arc welding of carbon and carbon manganese steels

DWS 1110 : Construction of pipelines

M21.2.4 General Requirements

This specification must be read in conjunction with the following specifications:-

G01: Particular Specification for Colour Codes

G02: Particular Specification for Corrosion Protection

M21.3 **CLASS DESIGNATION**

Pipe classes indicated on Drawings and in the Specification should have the following meaning:-

Working Pressure (kPa)	Steel Pipes
300	
600	6
900	
1 000	10
1 200	
1 500	
1 600	16
1 800	
2 100	
2 400	
2 500	25

M21.4 **MATERIALS**

The type, ability and condition of the equipment and material are subject to the Engineer's approval.

Covered electrodes of mild steel or medium high tensile steel for hand welding must comply with SANS 455 and carry the SANS mark.

The Contractor must submit full particulars off all electrodes he intends using to the Engineer. All electrodes must be supplied by the Contractor and the consignment number submitted to the Engineer. Should a different consignment be used on the works, the Engineer may alter the welding procedure.

M21.4.1 Standards

M21.4.1.1 uPVC Pipes

Requirements:-

- SANS 966 : uPVC Type I Pressure Pipes and Fittings for Cold Water Services
- SANS 967 : Unplasticised poly(vinyl chloride) (PVC-U) soil, waste and vent pipes and pipe fittings
- ISO 4422 : Pipes and fittings made of unplasticised poly (vinyl chloride) (PVC-U) for water supply – Specifications
- SANS 1123 : Pipe flanges
- SANS 791 : unplasticised poly(vinyl chloride) (PVC-U) sewer and drain pipes and pipe fittings
- SANS ISO 4427 : Components of Unplasticised Polyvinyl Chloride (uPVC) Pressure

	Pipe Systems for potable water
SABS 0112	: The installation of polyethylene and unplasticised polyvinyl chloride pipes
BS 3505	: Unplasticised polyvinyl chloride pressure pipes for cold potable water
DIN 8061	: A1:1991 Unplasticised polyvinyl chloride pipes: General quality requirements and testing
ISO 1167	: Plastic pipes for the transport of fluids: determination of the resistance to internal pressure.
ISO 1628	: Plastics determination of viscosity number and limiting viscosity number. Part 2: PVC resins.
ISO 4422	: Pipes and fittings made of unplasticised polyvinyl chloride for water supply specifications

125 & 140mm sizes are not recommended for uPVC pipes due to the lack of standard fitting.

M21.4.1.2 HDPE

Requirements:-

SANS ISO 4427	: Black polyethylene pipes for the conveyance of liquids

M21.4.1.3 Mild Steel

Requirements:-

SANS 719 grade B	: Electric welded low carbon steel pipes for aqueous fluids (large bore)
SANS 62	: Steel pipe and pipe fittings up to 150 mm nominal bore

M21.4.1.4 Cast Iron

Requirements:-

BS 2035	: Cast Iron flanged pipes and flanged fittings.
SANS 509	: Malleable cast iron pipe fittings.
SANS 664	: Cast Iron gate valves.
SANS 746	: Cast-iron pipes and pipe fittings for use above ground in drainage installations

M21.4.1.5 Stainless Steel

Requirements:-

SANS 1044-3	: Welding Part 3: The fusion of steel (including stainless steel): Tests for the approval of welding procedures
SANS 1044-4	: Welding Part 4: The fusion welding of steel (including austenitic stainless steel): Tests for the approval of welders working where weld procedure approval is not required.
SANS 10162-4	: Structural use of Steel Part 4: The design of cold-formed stainless steel structural

M21.4.1.6 Ductile Iron

Requirements:-

SANS 1835	: Ductile iron pipes, fittings, accessories and their joints, for use in high and low pressure systems for potable and foul water
SANS 50545	: Ductile iron pipes, fittings, accessories and their joints for water pipelines - Requirements and test methods
SANS 50598:1994	: Ductile iron pipes, fittings, accessories and their joints for sewerage application - Requirements and test methods

M21.4.2 Steel (Other than Galvanised)

M21.4.2.1 Manufacturing Specifications

- SANS 62 : Steel pipe and pipe fittings up to 150 mm nominal bore
- SANS 719 : Electric welded low carbon steel pipes for aqueous fluids
- SANS 1123 : Standard Specification for steel pipe flanges
- BS 4504 : Flanges and bolting for pipes, valves and fittings

M21.4.2.2 Welding Specifications

- BS 1965 : Butt-welding pipe fittings.
- BS 2633 : Metal-arc welding of steel pipe lines and pipe assemblies for carrying fluids.
- BS 4504 : Flanges and bolting for pipes, valves and fittings.
- API 5L : Specification for line pipe.
- API 5LS : Specification for spiral-weld line pipe.
- API 1104 : Standard for welding pipe lines and related facilities.

M21.4.2.3 Protective Coatings

- SANS 763 : Hot-dipped (galvanised) zinc coatings.
- SANS 0129 : Code of Practice for plastic tape wrapping of steel pipe lines.
- SANS 1117 : Plastic wrapping for the protection of steel pipe lines.
- SANS 1130 : Glass fibre reinforcing material for pipe wrapping.
- SANS 1136 : Cold applied bitumen primer for steel pipe line protection.
- SANS 1137 : Hot applied bitumen for steel pipe line protection.
- SANS 1138 : Cold applied coal tar primer for steel pipe line protection.
- SANS 1139 : Hot applied coal tar enamel for steel pipe line protection.
- SANS 1178 : The production of lined and coated steel pipes using bitumen or coal tar enamel.
- SIS 05 59 00 : Pictorial surface preparation standards for painting steel surfaces.

M21.5 **UPVC PIPES AND FITTINGS**

All manufacturers of uPVC and MPVC pipes, fittings and couplings must be quality listed by the South African Bureau of Standards to comply with SABS ISO 9002.

All exposed uPVC piping shall be protected against ultra-violet degradation by the application of two coats of white PVA paint after degreasing.

Where flanged ends are required, the end of the pipe shall be prepared with a solvent welded stub adaptor to accommodate a galvanised steel backing flange.

All sludge and polyelectrolyte pipework shall be uPVC and rated 9 bar pressure and shall adequately supported to prevent sagging.

M21.5.1 Handling

Care shall be taken when handling uPVC pipes to ensure that pipes are not dropped or mishandled. Piping in transit shall be adequately secured using straps to prevent abrasion and surface damage.

During transport, handling and storage, the Contractor shall ensure that the pipes lie on a smooth surface and are not in contact with sharp objects and are not subjected to point or linear loads.

Yield (MPa) at 28° C	Tensile Modulus (GPa) 23°C	Max Temperature	Design Stress (MPa) at 20°C	Minimum Safety factor at 50 years

55	2.7-3.0	60	10,000	2.1

M21.6 HDPE PIPING

Flange couplings shall be kept to a minimum. Where the standard length of pipe is less than the required length, butt weld or flanged connections shall be used.

HDPE stub ends and loose flange connections may be butt welded and the bead formed inside the pipe shall be removed to avoid restrictions and product build-up. All flanges and bolts shall be galvanised.

Pipe work shall be adequately supported depending upon the size and class to prevent pipe sag. Where pipework is exposed directly to the environment, provision shall be made for suitable horizontal expansion joints.

M21.6.1 Handling

Care shall be taken when handling HDPE pipes to ensure that pipes are not dropped or mishandled. Piping in transit shall be adequately secured using straps to prevent abrasion and surface damage.

During transport, handling and storage, the Contractor shall ensure that the pipes lie on a smooth surface and are not in contact with sharp objects and are not subjected to point or linear loads.

The maximum stacking height for class 6-10 pipes shall not exceed 2m. All pipes exhibiting damage shall be rejected.

Yield (MPa) at 28° C	Tensile Modulus (GPa) 23°C	Max Temperature	Design Stress (MPa) at 20°C	Minimum Safety factor at 50 years
20	0.7-0.95	80	5,0	1.3

M21.7 MILD STEEL

All mild steel pipework and fittings other than steam tubing and screwed and socketed pipe, larger than 150 mm diameter shall comply with the requirements of SABS 719 grade B and shall have a minimum wall thickness as follows:

Normal Bore mm	Min Wall Thickness mm
Less than 400 mm	4
400-500	5
600-700	6
750-900	8
950-1100	10
1100-1500	12
1600-1800	14

Pipework other than screwed and socketed of sizes up to and including 150 mm nominal bore, shall comply with the requirements of SABS 62. These pipes shall be heavy class with flanged joints and suitable for a minimum working pressure of 1.6 MPa.

All screwed and socketed pipes shall comply with the requirements of SABS 62 Medium class and shall be "hot dip" galvanised. Unless otherwise specified screwed and socketed pipes shall not be used for the conveyance of steam, gas and compressed air. Compressed air pipelines of diameter 25 mm or less may be screwed and socketed.

Plain ends of pipes and fittings shall be protected against damage while being transported from the factory to the site. Details of the proposed protection system shall be submitted by the Engineer for approval.

M21.8 CAST IRON PIPES

All cast iron fittings shall be factory coated internally and externally with one coat bitumen paint to BS 3416 Type II leaving a dried film thickness of not less than 25 µm.

- (a) All Exposed pipes and fittings except pipes installed in potable water retaining structures. Method of corrosion protection shall be specified in the project specification.
- (b) After installation paint with one further coat as per factory coat.

M21.9 STAINLESS STEEL PIPES

Stainless steel shall be ANSI Type 304L or 316L as stated in the detailed specification. Where no welding is required Type 304 or 316 may be used. Manufacturers test certificates shall be provided for each material and each stainless steel item supplied shall be clearly and permanently marked with the grade of stainless steel and cross referenced to the applicable test certificate.

Welding of stainless steel shall be carried out using welding electrodes most suitable for the material and its applications by reference to the manufacturer's recommendations. Special precautions shall be taken to ensure that the strength and corrosion resistance of the material is not impaired by prolonged heating of the welds. All welds and adjacent areas shall be cleaned and pickled to remove the area of discolouration with a nitric and hydrofluoric acid formulation as recommended by the material suppliers.

After cleaning pickling all areas shall be thoroughly washed with clean water and re-passivated thereafter with a proprietary passivating solution of 10 per cent – 20 per cent nitric acid in aqueous solution recommended by the material suppliers.

M21.10 3CR12 PIPES

Test certificates and marking shall be used for 3CR12 as per stainless steel.

All 3CR12 shall be supplied "passivated" and upon completion of fabrication welds and other areas where the passivating layer has been removed or damaged and are contamination with mild steel or discoloured shall be cleaned and pickled using nitric acid and hydrofluoric acid formulation as recommended by the material suppliers. After cleaning/pickling all areas shall be thoroughly washed with a proprietary passivating solution of 10 per cent – 20 per cent nitric acid in aqueous solution recommended by the material suppliers.

Welding of 3CR12 steel shall be carried out under controlled conditions using stainless steel 309L welding rod or similar approved and recommended by the material suppliers. All welds shall be continuous and crevice free.

Where a fabricator has shops that deal with both carbon steel and stainless/ 3CR12 fabrications these shops are to be totally separated and no grinding wheels, etc., shall be interchanged between shops.

M21.11 DUCTILE IRON PIPES

Ductile iron pipes and fittings shall comply with ISO 2531. The nominal diameters of ductile iron are 80 to 2000mm.

The pressure rating of ductile iron is K9 range, with the nominal pressure of 3200 kPa. A safety factor of 4 times the working pressure shall be used for ductile iron pipes.

An integral rubber ring socket and spigot is used for the jointing. Ductile iron pipes shall have a inner lining of alumina cement mortar.

M21.12 STEEL PIPES, SPECIALS AND FITTINGS

M21.12.1 General

Protective coatings shall be either "factory" implying coating prior to delivery from the factory to Site, or "Site" implying coating on the Site after the item has been installed.

Undercoats shall be coloured differently to ensure complete coverage with each coat.

External protections other than specified in this clause e.g. coal, tar, enamel and proprietary types of tape wrapping shall when called for in the Schedule of Quantities be carried out as specified.

M21.12.2 Materials

Materials used for spun bitumen lining and bitumen fibre glass wrapping of pipes and the method to be followed shall comply with SANS 720.

Epoxy resin paint shall be approved by the Engineer and shall not break down chemically with time or affect the potability or cause discolouration of potable water in any way and the primer used with such paints shall be zinc rich epoxy type compatible with the paint. Bitumen based aluminium paint to be to SANS 802.

Undercoat for alkyd based enamel paint to be to SANS 681 Type II, and colour to match final decorative paint. Alkyd based enamel paint to be to SANS 630 Grade I.

Zinc chromate primer to be to SANS 679 Type I.

Bitumen paint to BS 3416 (Type II where specified).

M21.12.3 Types of Protection

Pipe work and fittings will be protected in accordance with the Particular Specification G02: Corrosion Protection.

M21.13 PIPE CONSTRUCTION

M21.13.1 General

Pipes shall be tested hydraulically in accordance with SABS 719 and test certificates shall be submitted to the Engineer before the pipes leave the manufacturers workshops.

M21.13.2 Marking of Pipes

The following markings shall be legibly and indelibly marked on each pipe and coupling:-

- (a) The name, trade name or registered trade mark of the manufacturer.
- (b) The nominal internal diameter.
- (c) The class of pipe and colour code (marked at each end).

- (d) The wall thickness (for steel pipes).
- (e) Length of pipe (if different from the standard length)
- (f) Pipe items, specials and valves shall be legibly and indelibly marked with the item number corresponding to the item number given in the Item Lists on the Drawings, or where Item Lists are not provided, the item number in the Schedule of Quantities.

M21.13.2.1 Information to be Supplied:-

The following information shall be made available to the Engineer prior to the award of the Contract:-

- (a) Make and types of pipe offered.
- (b) The friction loss formula applicable to the types of pipe offered.
- (c) Standard pipe length.
- (d) Thickness of pipe wall.
- (e) Type of coupling and degree of maximum safe deflection permissible with the coupling.

Where the Contract calls for the supply, delivery and laying of the piping, the unit rate tendered for straight pipes shall include for one complete coupling (i.e. including rubber rings, insertion, bolts, etc.) per pipe length and shall include for the protection of the coupling.

Where the Contract calls for the supply and delivery only of the piping, the unit rate tendered for straight pipes shall include for one complete coupling per pipe length together with sufficient material for protecting the coupling.

Where the Contract calls for taking delivery of and laying the piping the unit rate tendered for straight pipes shall include for the labour necessary for protecting the couplings.

M21.14 WELDED STEEL PIPES

M21.14.1 General

Welders must be successfully tested in accordance with SANS 044 Part V by a certificate institution defined by SANS 044 Part V. The Contractor is responsible for the competency certificates of the welders. The Contractor must issue each welder with such equipment so that a welder can identify his joints. A list of identification marks must be kept by the Contractor and made available to the Engineer.

Should two joints of a particular welder not withstand the prescribed test, the welder may not undertake any more welds.

Pipes shall be manufactured by an approved welding process and shall not incorporate more than one longitudinal seam for pipes up to and including 1 000 mm diameter or two longitudinal seams for pipes bigger than 1 000 mm diameter.

Pipe specials shall be manufactured strictly as shown on the Drawings and described in the Documents. Plate thickness shall be such to ensure that the maximum stress shall not be higher than for an uncut pipe in the same pipeline.

The maximum angle between butt-ends of segments for gusseted bends shall be $22\frac{1}{2}^\circ$.

M21.14.2 Pipe Ends

Pipe ends must be thoroughly cleaned of all rust, grease and protection which may affect the quality of the weld. For cut lengths the ends must be bevelled to 30E with the end of the pipe and the roof surface prepared all at the Contractor's own cost. Should laminating, splitting of ends or any other defect occur during welding, the Contractor must cut the defective areas from the pipe.

M21.14.3 Handling

Pipes shall be brought in position in such a manner that damage to the pipes is avoided. Should the pipes have a longitudinal joint, the pipes must be placed so that this joint lies in the top third of the completed line. These longitudinal joints must be staggered at 20E from each other.

M21.14.4 Clamps

Internal clamps must be used to keep the pipes in position during the welding. The root opening must be between 1,5 and 3,0 mm and the pipes may not deviate more than 1,5 mm from the concentric.

Clamps may be removed only after 50 % of the root weld has been completed in equal sections around the perimeter of the pipes.

M21.14.5 Welding

Root welding may at no place be thicker than two thirds of the pipe wall and must be without defects.

Welding must be thoroughly cleared of slag, scale and oxide before the next weld is applied. Weld joints must consist of at least two welds to ensure the specified reinforcing.

Complete penetration must be ensured by letting the weld reinforcement protrude 1,5 mm on the inside of the pipe. No other protrusions will be allowed on the inside of the pipe.

Weld joints must be built up until the weld reinforcement protrudes between 0,8 mm to 1,6 mm above the pipe. The cover weld must be 3,2 mm wider than the original groove width.

In order to avoid cracks, the second or "warm" weld must be applied immediately after the root weld has been cleaned and prior to the cooling of the pipe at the joint.

The internal weld bead on welded seams shall protrude a maximum of 1,0 mm into the barrel of the pipe. For butt-welded pipelines the weld bead shall be ground flush with the pipe body at each pipe end.

The Contractor must submit with his tender a Qualification of Welding Procedures as set out in Section 2 of API Std 1104 including a procedure specification as set out in paragraphs 2.3a, d, e, f, g, h, i, j, k, l, m, n, p, q and r of above specification. The Contractor must demonstrate that this proposed procedure will produce an acceptable pipeline. Should tests reveal that an acceptable result cannot be obtained; the Contractor shall alter his procedure and qualification so that the desired result is obtained.

No welding may take place should inclement weather including rain, sand and wind result in bad joints. If practical, shelters may be erected. The Engineer's representative will decide if the weather is suitable for welding or not.

M21.15 **BONDING OF PIPELINE**

It may be necessary as a result of tests to be carried out by the Employer, for the pipeline to be

bonded across couplings for electrical continuity.

The bonds shall consist of lengths of 16 mm² PVC sheathed cable secured to the pipeline by thermal welding. Each and every flexible and flanged coupling will be bonded across except in the case of valve chambers where the bonding will take place in the form of a bypass around the outside of the chamber. At flexible couplings two fastenings to the pipe (one on either side of the coupling) and one to the barrel of the coupling shall be made. The external protection of the pipe shall be made good by filling the space cleared of wrapping for the connection with bitumen as used for wrapping the pipe, such that the depth of bitumen thus applied is equal to the depth of the wrapping.

The bonding shall be carried out as soon as possible after installation of the piping and before joints are protected and backfilled. The cables shall be installed in accordance with the requirements of the supplier and to the satisfaction of the Engineer.

Bonding of pipes shall be measured per joint unit. This price shall include for supplying of materials, transporting on Site and installing bonds and making good of pipe wrapping all as described in this Clause.

M21.16 BEDDING AND SUPPORTING OF PIPEWORK

In all cases buried pipes shall be laid on a 50 mm thick bedding layer, surrounded and covered to a height 150 mm above the pipe with selected fill material complying with the requirements of standardized specification unless otherwise indicated on the Drawings or ordered by the Engineer.

Bedding material shall be to the same Specification as selected fill.

Exposed pipework shall be adequately supported on concrete pads and fastened down with approved metal straps with rag-bolts cast into the concrete or with holder bats or as indicated on the Drawings or directed by the Engineer.

M21.17 LAYING OF PIPES

Only qualified workmen shall be employed for the laying and jointing of pipes and proper tools shall be used for the execution of the works. Care shall be taken during construction that the ends of pipes are not hit against each other and pipe ends are damaged in this way.

Once a sufficient length of trench has been excavated and trimmed to the required levels and grades, the pipes shall be lifted and carefully lowered into the trench and placed on the prepared bedding layer (where gravel bedding layers are called for).

Immediately prior to laying the pipe or fitting, it shall be carefully examined both externally and internally for any damage or defect, and all foreign matter shall be removed from inside of the pipe.

Pipes shall be laid evenly on the prepared bedding layer that shall be free of hollows, bumps or other irregularities. Where any such irregularities occurring in this layer prevent the pipe barrel from bearing on the bedding layer for its full length between joint holes, the pipe shall be lifted out of the trench or moved to one side while the bedding layer is trimmed in the specified manner, and where such filling or trimming is necessary as a result of any fault or omission on the part of the Contractor responsible for excavating the trenches, the additional handling of the pipe and trimming shall be to his own cost.

A guideline shall be strung parallel to the centre-line of the pipe and at the height of the centre-line of the pipe. Alternatively the Contractor may make use of a laser beam grade indicator.

All pipes and fittings shall be laid to the true lines and levels indicated on the drawings or as instructed by the Engineer. Pipes and fittings shall be positioned concentrically correct so as to obtain a thoroughly uniform joint. Where possible pipes shall be laid by commencing at the lower end of the grade and working uphill, and in the case of spigot and socket pipes, the socket end of the pipe shall face uphill.

In order to prevent foreign matter entering pipes already laid, a properly fitting wooden or other approved type plug or cap shall be used to cover the end of the last pipe laid whenever laying of pipes is interrupted.

Under no circumstances will the Contractor be permitted to use stones, corrugated iron or cement bags to cover the open end of closed pipes.

An approved pipe "cleaner" attached to a sturdy rope and left in the mouth of the pipe already laid and jointed, shall be pulled forward through the pipeline as each successive pipe is laid. The scraper and ropes used must be of soft material, which will not damage the inner surface of the pipes.

M21.18 DAMAGED PIPES

Damaged or defective pipes or fittings may not be used but shall be placed to one side for inspection by the Engineer who will determine and decide whether the damage is of such a nature that the pipe or fitting shall be rejected or whether it is so slight that it may be repaired on the Site. The decision of the Engineer with regard to the rejection of the damaged or defective pipes and fittings shall be final. Pipes and fittings shall be replaced or repairs undertaken by the Contractor at his own cost to the full satisfaction of the Engineer. In the case of pipes and fittings provided by the Employer, the responsibility of the Contractor for the repair and replacement of damaged pipes and fittings will commence once the Contractor has taken delivery of the material from the Employer. Before taking over any material from the Employer, he shall thoroughly inspect all material and immediately report any damage or defects therein to the Engineer.

The Engineer shall have the right to order the removal of any defective or damaged pipe or fitting that has not been repaired or approved as described above, from the pipe line, irrespective of whether such pipe or fitting has been laid and joined in the pipe line or not, and the Contractor must then undertake the removal and replacement of such pipe or fitting to the complete satisfaction of the Engineer, at his own cost.

M21.19 SIGHT RAILS

In all cases pipes are to be laid to definite lines and levels and sight rails shall be erected after setting out, at changes in direction and grade and at intermediate positions such that the distance between sight rails does not exceed 50 m or as the Engineer may require.

Sight rails for bulk excavation of trenches may be temporary to suit the Contractor's requirements but for purpose of final trimming and pipe laying sight rails shall be of sturdy construction, firmly planted and have the cross-arm neatly and clearly painted black and white.

Boning rods shall be well constructed with the cross-arm painted red or other colour contrasting with the sight rail. Sight rails and boning rods shall be maintained in a clean and sound condition and shall be subject to the approval of the Engineer at all times.

M21.20 STORAGE OF PIPES AND PREFABRICATED SECTIONS

Unless specifically stated to the contrary, the Contractor shall supply, deliver and install, as shown on the Drawings and in the Schedule of Quantities, all pipes, prefabricated sections and accessories required under each particular Section of the various Sections of the Contract.

Unless the pipes, prefabricated sections and accessories are off-loaded on the side of the excavated trench, the Contractor shall stack such pipes, prefabricated sections and accessories on an approved site. The cost involved in the transport from such storage place to the section of the trench where the drain or pipe line has to be built, shall be included in the construction cost.

During transport, handling, stacking and placing, the prefabricated units shall be protected against damage.

The Engineer reserves the right to restrict the height to which pipes may be stacked. Pipes larger than 300 mm diameter may not be stacked at all.

M21.21 JOINTING OF PIPES

Only suitably qualified workmen will be permitted to lay and join pipes and suitable equipment must be used for the execution of work.

Before they are joined together, the ends of pipes and all fittings and flanges shall be inspected and cleaned.

(a) Flanged Joints

Where flanged pipework, valves, etc., are to be connected, the insertion material shall be cut to the correct size and provided with bolt holes. The insertion material shall be positioned immediately prior to the two flanges being brought together and the whole joint must then be bolted together by tightening diametrically opposite bolts in sequence.

(b) Flexible Joints (Viking Johnson Type)

The flanges must be placed in position first; one over each end of the pipe, and the rubber rings must then be inserted by pulling them over the ends of the pipes or by using special pointed plugs, the point of which has been placed in the end of the pipe. Any twists in the rubber rings must be removed by rolling the rings along the outside of the pipe and they must then be brought into position so that the distance from the end of the pipe to the ring is equal to half the length of the detachable collar. The collar shall be placed over the end of one of the pipes and the two pipe ends shall be brought together in such a way that the collar is placed centrally over the joint. The bolts must then be placed through the flanges and carefully and evenly tightened to the required torque, thus ensuring a watertight joint.

(c) Flexible Joints (Loose Collar Type)

The pipe barrel shall be thoroughly cleaned over the area to be covered by the coupling. The coupling shall be installed strictly in accordance with the manufacturer's instructions - a copy of which shall be kept by the Contractor on Site.

(d) Screwed Joints

Screw threads on pipes and in sockets shall conform to the relevant standards. Threading on Site will be subject to the approval of the Engineer. PTFE tape only shall

be used for thread sealing. Sockets shall not be over tightened and the pipes shall be screwed the same distance into the socket on either side.

(e) Spigot and Socket Joints

For spigot and socket joints the ring shall be placed around the spigot end of the pipe, perpendicular to the centre-line and as near as possible to the end. The ring shall be clean, dry and not twisted. The joint is made by pushing the pivot in the socket by means of a crowbar or block and tackle. If the pipe is inclined to creep out of the joint, it is a sign that the ring is not rolled on evenly and it must be redone.

(f) Open Joints

For open joints the pipes shall be laid close together and any gap larger than 3 mm on the inside as well as outside shall be filled completely with 3:1 cement mortar and on the outside covered with one layer of jute material soaked in the same mortar. The jute material must overlap the joint by at least 75 mm on both sides.

M21.22 COUPLING DIFFERENT TYPES OF PIPING

The following methods shall be used for connecting different types of pipe together:-

Cast iron flange adaptors or steel flange and spigot pieces to suit the types of piping shall be coupled with a flexible coupling on one end and bolted to a flange on the other end which may, in the case of steel piping, be welded or screwed on.

Where a steel pipe is to be connected to an asbestos cement pipe with a larger outside diameter, without the use of a flange adaptor to the end of steel pipe shall be furnished with a steel ring welded on or, in the case of galvanised piping, a special galvanised steel socket shall be screwed on such that the outside diameters of the pipes match and the pipes may then be joined with a flexible coupling.

M21.22.1 Making of Openings

Where drains have to be joined to existing structures or existing drains or newly constructed prefabricated box culverts in such a way that it was not possible for the Contractor to leave openings for the joining or building in of prefabricated units, such openings shall be made according to the instructions of the Engineer.

The Contractor shall supply the necessary equipment and labour to make the openings according to the dimensions and/or requirements directed by the Engineer without damaging the rest of the structure or drain. If the openings are made too large or the rest of the structures or drain is damaged in any way, the Contractor shall repair it at his own expense to the satisfaction of the Engineer.

Blasting to make openings will only be permitted in exceptional circumstances.

Where necessary, parts of the existing structure or drain shall be propped until the junction of the new drain is completed.

The prefabricated units must be built into the openings or the other drains joined thereto as directed by the Engineer and the joint shall be finished neatly so that a minimum of obstruction is caused to the flow of water. The Contractor must provide all material, tools and labour to make the new junction.

M21.22.2 Positioning of Valves and Fittings

All valves and fittings shall be correctly positioned as indicated on the Drawings, and where necessary shall be supported by concrete pads. Spindle guides and anchors shall be fixed to the brickwork or concrete and carefully adjusted to ensure correct operation of the spindle.

M21.22.3 Thrust Blocks

Unless otherwise ordered by the Engineer, concrete Class 25/19 MPa thrust blocks shall be cast as a support for bends, tees and caps and at valves. The size of the thrust will depend on the strength of the soil, the pipe diameter, the working pressure and the type of item to be supported.

All thrust blocks shall be cast against undisturbed soil and in such a manner as to leave all couplings accessible and such that the bearing area is in accordance with the table given below, which table is based on the assumption that the safe bearing capacity of the soil is at least 100 kN/m². The Engineer will determine in each case the safe bearing capacity for the soil, and the bearing area of the thrust block may then be interpolated from the table. The areas are given in square metres.

Thrust blocks and pipework supports inside buildings shall be constructed to the dimensions given on the Drawings or as directed by the Engineer after the piping and fittings are installed in position.

Note: Bearing area of thrust blocks for pipe diameters, working pressures and bends not stated in the table below, shall be interpolated from the values given.

Nominal Pipe Diameter (mm)	Working Pressure KPa	Bends				End Caps and T-pieces
		11.25°	22.50°	45.00°	90.00°	
100	300	0.010	0.020	0.035	0.065	0.045
	900	0.025	0.050	0.100	0.185	0.130
	1 500	0.045	0.085	0.165	0.305	0.215
	2 100	0.060	0.120	0.230	0.425	0.300
200	300	0.035	0.070	0.135	0.245	0.175
	900	0.107	0.200	0.395	0.725	0.515
	1 500	0.170	0.335	0.655	1.210	0.855
	2 100	0.235	0.470	0.915	1.695	1.195
300	300	0.080	0.150	0.295	0.545	0.385
	900	0.230	0.450	0.885	1.630	1.150
	1 500	0.380	0.750	1.475	2.720	1.920
	2 100	0.530	1.050	2.060	3.805	2.685
400	300	0.135	0.265	0.515	0.950	0.670
	900	0.395	0.785	1.540	2.845	2.005
	1 500	0.660	1.310	2.565	4.740	3.340
	2 100	0.920	1.895	3.590	6.635	4.675
500	300	0.210	0.420	0.820	1.510	1.065
	900	0.630	1.250	2.455	4.530	3.195
	1 500	1.050	2.085	4.085	7.550	5.325
	2 100	1.465	2.915	5.720	10.565	7.450
600	300	0.305	0.600	1.180	2.175	1.535
	900	0.905	1.800	3.530	6.521	4.600
	1 500	1.510	3.000	5.885	10.870	7.665
	2 100	2.110	4.200	8.235	15.215	10.730
800	300	0.540	1.070	2.095	3.865	2.725

Nominal Pipe Diameter (mm)	Working Pressure KPa	Bends				End Caps and T-pieces
		11.25°	22.50°	45.00°	90.00°	
	900	1.610	3.200	6.275	11.595	8.175
	1 500	2.680	5.335	10.460	19.320	13.625
	2 100	3.750	7.465	14.640	27.050	19.070
1 000	300	0.840	1.670	3.270	6.040	4.260
	900	2.510	5.000	9.805	18.110	12.770
	1 500	4.185	8.050	16.340	30.185	21.285
	2 100	5.855	11.660	22.875	42.260	29.795

M21.23

CUT PIPES AND PREFABRICATED SECTIONS

Cut pipes may only be used with the Engineer's permission and the ends shall be cut square to the length of the pipe and finished smooth and evenly so that the cut ends is not inferior to that of an uncut pipe.

The Contractor shall measure the length required for a cut length, cut the pipe, prepare the end for the required coupling and install the cut length. The cutting and end-finishing operations shall be done with special tools available for the particular type of piping such that the cut end is not inferior to the factory made end. In the case of asbestos cement piping particularly, an end cutting machine as supplied by the pipe manufacturers only, shall be used for cutting and preparing the end.

In the case of steel pipes since the ends only are truly circular, it is necessary that cut lengths be factory made and prepared. The prices tendered for cut lengths for various types, classes and diameters of piping shall include for the cutting and end finishing operations but exclude the actual pipe length used as this will be measured and paid for under the item provided for supplying and/or laying of straight pipes. The price shall however, include for one coupling as required, and for any possible wastage.

In the case of sewer pipes, cut pipes may only be used at manholes and the cut end shall wherever possible be built into the manhole. Prefabricated units may only be trimmed or cut where they join structures or other drains.

Box culvert sections may only be trimmed or cut perpendicular to the direction of flow to obtain the correct length and units of the correct skew shall be obtained from the manufacturer where the box culvert drain joins at a skew and in such cases the second last unit shall be trimmed or cut to obtain the correct length.

The ends of pipes to be built in shall be trimmed or cut to the correct skew to be finished smoothly on the inside face of the wall into which it is built.

Units shall be cut in such a way that the edges are not shattered or cracks are not caused in the concrete where the structural strength of the unit causes it to break. When it is trimmed it shall be cut or sawn to obtain the correct length and skew end.

The necessary openings for junctions shall be left when structures or drains are constructed. If the Contractor neglects to leave such openings, he shall, at his own expense, make such openings afterwards or remove the building work and reconstruct it with openings, all according to the Engineer's directions.

Units must fit neatly into the openings provided for them and must be firmly concreted or built in without any obstruction to the flow of water.

M21.23.1 Sterilizing of Pipelines

Pipelines that are to be used for potable water shall be sterilized over its complete length before it is taken into use.

The pipe shall be filled with potable water chlorinated to a concentration of 10 mg of chlorine per litre of water which shall remain with the inner surface of the pipe line for a period of not less than 24 hours. The pipeline is to be filled for sterilizing in such a manner that no shock is created or air trapped in the pipeline.

The Contractor shall at least 14 days prior to the commencement of sterilizing, submit full details of the proposed method of sterilizing the pipe line to the Engineer for his approval.

The Contractor shall provide all necessary tools, equipment and labour necessary to sterilize the pipeline. After sterilizing the pipe line the Contractor shall, at no extra cost empty the pipe lines and dispose of the water in a manner approved by the Engineer.

The Contractor may use the following products as a source of chlorine:-

- (a) Chloride of Lime to SANS 295 yielding one third by weight free chlorine.
- (b) Calcium Hyper Chloride to SANS 295 yielding 70% by weight free chlorine.
- (c) Chlorine gas applied by chlorinator.

The unit rates tendered under the items in the Schedule of Quantities for sterilizing pipe lines shall include for all materials (including water) and labour necessary and shall also include for all arrangements the Contractor may have to make in order to obtain water and fill the pipe line.

M21.23.2 Route Markers

In certain instances concrete pipe route markers may be required. Such markers shall be detailed fully in the Project Specification.

M21.23.3 Protective Layers on Pipes and Fittings

Unless otherwise indicated on the Drawings or stated in the Schedule of Quantities, pipes, specials and fittings shall be protected as shown here-under. Note that preparation of metal surfaces shall be done as specified for steel and other metal work.

PVC, Polythene, galvanised and Chromed Piping

Pipes and fittings manufactured from the above materials shall receive no treatment except as follows:-

- (a) Exposed galvanised steel piping shall be thoroughly cleaned and coated with one layer of etching primer, one coat zinc chromate primer and finishing coats as for exposed steel piping when called for in the Schedule of Quantities.
- (b) The exposed threads and where galvanising has been damaged shall be thoroughly cleaned and all traces of oil removed with an appropriate solvent. One coat of zinc chromate primer to SANS 679 Type 1 followed by one undercoat to SANS 681 Type II to a total dried film thickness of 50 µm shall be brush applied to all surfaces.
- (c) Buried galvanised steel piping shall, when called for in the Schedule of Quantities, be protected by wrapping with pressure sensitive tape or butyl rubber laminated tape.
- (d) Identification bands shall be painted on exposed PVC, Polythene and chromed piping in accordance with instructions of the Engineer.

M21.23.4 Flexible and Flanged Couplings

The couplings shall first be cleaned by removing all loose scale, rust, extraneous matter such as mud, by means of wire brushing and removing possible excess water by wiping with a dry cloth.

After cleaning, the whole of the coupling shall be well primed with a paste of saturated petroleum hydrocarbons (petrolatum), insert fillers and passivating agents, leaving a thin film on flanges and sleeves and a liberal amount around the bolt heads, narrow cavities, etc. A mastic plate of petrolatum, insert fillers and mineral fibres shall then be applied to cover all the bolt heads on the outside of the flanges (also between flanges to give approximate 5 mm cover over the sleeve). The mastic shall then be moulded up to, but not to completely cover the bolts and flanges.

A glass fibre, felt coated tape saturated with petrolatum with insert siliceous fillers shall then be applied circumferentially, starting and finishing on top of the coupling, care being taken to form the tape well into the angle between the flange and the pipe. Care shall be taken to smooth the tape down and ensure conformability to the underlying mastic. The tape should be "fed" onto the coupling and not stretched.

Two complete turns of 0,15 mm thick polyethylene sheeting shall be applied over the coupling. The sheeting shall be wide enough to cover the entire coupling and overlap by 150 mm on top of the coupling. The sheeting shall be secured onto the pipe barrel each side of the coupling by means of self adhesive tape overlapping 25 mm on the pipe barrel and 75 mm on itself.

The tendered unit rate for wrapped couplings shall include all materials, labour, transport, etc. to complete the protection of the coupling in any position along the pipeline.

M21.24 COLOUR CODES

The standard final colour codes for equipment supplied under this Contract shall be in accordance with Particular Specification G01.

M21.25 TOLERANCES

Pipes shall be laid to the lines, grades and levels as specified on the Drawings

- (a) Vertical deviation from the straight line between two consecutive levels shall not be more than the value of "d" as calculated from the following formula :-

$$d = 5 + \frac{L^{1/2} D^{1/2} S^{1/2}}{60}$$

Where :
d = tolerance in millimetre
L = length of pipe between control point in millimetre
D = nominal pipe diameter in millimetre
S = slope of pipe taken as the difference in level of control points in millimetre divided by L

- (b) The horizontal deviation from the specified direction and line between two consecutive control points shall not be more than the maximum vertical deviation as calculated under (a) above.

Pipe items and specials shall be manufactured to the dimensions as specified in the pipe lists or shown on the Drawings

Maximum allowable deviation from the specified dimensions shall be as follows:-

- (a) Straight pipes and tapers :-

Length (mm)	Tolerance (face to face) (mm)
Up to 1 800	± 16
1 800 to 2 700	± 24
2 700 to 3 600	± 32
Longer than 3 600	± 40

(b) Bends and Tees :-

Diameter (mm)	Tolerance (centre to face) (mm)
Up to 300	16
300 to 600	24
600 to 1 200	40

M21.26 TESTING

M21.26.1 Steel Pipes and Pipe Fittings

M21.26.1.1 *Testing and Inspection at Manufacturer's Works*

Where factory inspection and supervision of tests are required by the Engineer, such tests and inspections shall be carried out at the manufacturer's works at the expense of the Contractor who shall provide free of charge all necessary testing facilities, labour, instruments, etc. that may be required.

An independent inspector such as the SABS may be appointed to act on behalf of the Engineer. Fees payable to such an inspector, however, will not be to the account of the Contractor.

M21.26.2 Non-Destructive Tests

(a) Visual Inspection

All pipes and pipe specials shall be visually examined, shall be free of defects, such as cracks, laminations and arc burns and shall comply fully with the dimensions as specified.

A penetrant dye shall be used for the visual inspection of welding.

(b) Ultrasonic Inspection

All longitudinal or spiral welds on straight steel pipes shall be checked ultrasonically with approved equipment capable of continuous and uninterrupted inspection of weld seam - all in accordance with API 5L.

(c) Radiographic Inspection

As an alternative to (b) above, 20% of all longitudinal or spiral welds on straight pipe, and up to 100% of all butt-welds on straight pipes and up to 100% of all welds for pipe specials shall be checked radiographically in accordance with API 5L.

(d) Hydrostatic Testing

All pipes and pipe specials shall be subjected to hydrostatic testing at a test pressure determined from the following formula:-

$$P = \frac{1500 Yt}{D}$$

Where P = Hydrostatic test pressure in kPa
Y = Minimum Yield stress of material in Mpa
t = Nominal wall thickness in mm
D = Nominal outside diameter in mm

All leaks on sweating shall be considered as defects.

(e) Visual Inspection of Linings and Coatings

Linings shall have a smooth glossy finish, free from ripples, runs, pinholes, bubbles, laminations, disbanding, fraying or other blemishes.

Coatings shall be free of crazing, laminations, disbanding, pinholes, craters, bridging across and weld beads, or any sign of physical damage and shall have an acceptable smooth finish.

(f) Holiday Testing of Linings and Coatings

The entire lining and coating of each pipe shall be tested by the Contractor to the Engineer's satisfaction with an approved holiday detector fitted with the following heads:

- (i) For epoxy linings and coatings - with a wet sponge detector head.
- (ii) For bitumen or coal tar linings and coatings - with a copper bristle search head.
- (iii) For wrapped coatings - with a rolling ring detector around the pipe.

(g) Thickness of Linings and Coatings

The thickness of linings and coatings shall be measured by means of a magnetic or eddy current instrument suitable for measuring non-metallic films on curved magnetic surfaces.

(h) Delamination Test and Disbonded Areas

Refer to SANS 1178 Clauses 7.2.3 and 7.2.4.

M21.26.3 Destructive Tests

Destructive tests on steel pipes and specials shall be carried out in accordance with SANS 719 and SANS 1178.

M21.26.4 Testing and Inspection on Site

M21.26.4.1 Site Welding

The Contractor must appoint an inspector from a certified institution in accordance with SANS 044 Part V at his own cost. An incompetent inspector must be replaced by a competent person. A copy of all inspection reports must be provided at no cost to the Engineer.

Inspection and test of welds must be carried out in accordance with API Std 1104 chapter 5 and the standard required must be according to chapter 6. All results must be tabulated.

Radio graphical tests in accordance with chapter 8 of above specification must be carried out. The numbers of welds of each welder that must be tested are: the first three joints, then every third joint to a total of 6 joints and then one out of every 10 joints. Should one joint fail the prescribed tests, the above procedure must be repeated starting from the before last joint.

The Contractor must keep a complete record of the position of every radio graphical tested joint and provide a copy at no cost to the Engineer.

All joints, which fail the prescribed test of API Std 1104, must be repaired in accordance with chapter 7 of above specification.

M21.26.4.2 Linings and Coatings

Linings and coatings shall be visually inspected on Site prior and after installation for any sign of physical damage.

All repairs to linings and coatings undertaken on Site shall be to the Engineer's approval who also reserves the right to order pipes and pipe specials to be returned to the factory for repairs to linings and coatings.

For bitumen linings and coatings the following procedure shall be followed:-

Weld spatters must be removed and steel surfaces must be wire brushed to ST 3 of SIS 0559 and all dust must be removed. Damaged bitumen primers, bitumen and lime layers must be scraped and/or brushed until steel or good bitumen is reached to a point at least 100 mm from the point of repair.

Bitumen primer must be cold applied to steel and exposed bitumen surfaces and left to dry for at least 4 hours but not more than 4 days.

For the repair of linings bitumen applied hot in an acceptable manner shall be used.

One layer of warm bitumen to a thickness of 1.5 mm followed by two layers bitumen saturated glass fibre cloth applied by means of a warm iron to ensure complete affixion and bitumen saturation must be applied as wrapping. Above must be followed by one layer of 1 mm thick warm applied bitumen on one layer of white lime over the joint area. The thickness of the wrapping must be at least a thick as the original and edges must fit to the original protection.

Bitumen must be heated in closed kettles to a maximum of 235EC. Local overheating must be prevented by stirring.

M21.26.4.3 Hydrostatic Testing of Pipe Line

Pipe joints shall in general be left exposed until the pipeline has been successfully tested and passed by the Engineer. All open excavations at joints shall be adequately and safely protected. Should the Engineer order any joints to be backfilled prior to testing, the responsibility for re-exposing the joints for the purpose of repair of leaks after testing shall be entirely the Contractor's own and he shall not be entitled to extra payment for such work.

The Contractor shall provide and maintain in good condition the equipment necessary to carry out the test. Where temporary pumping equipment is used for testing, the equipment shall consist of a force pump with the suction end in a suitable container of water, and connected to the pipe line by means of high pressure hosing in good condition and/or piping and all the necessary flanges, connections, couplings, etc. and a pressure gauge suitably calibrated and in good condition. The equipment and method of assembly for testing shall be subject to the approval of the Engineer.

The entire pipe line or portion of the pipe line between closed valves and/or blank flanges may be tested at any one time provided that no section of the pipe line is subject to a higher pressure than one and a half times the working pressure for the particular class of pipe and fitting.

Prior to commencing the test the Contractor may, if he so desires, keep the pipeline full of water for as long a period as he considers necessary. The Contractor shall, at least 14 days prior to the first test being carried out, submit full details of the procedure he intends to follow, to the Engineer for approval.

For the purpose of the test the pipeline shall be filled with water in such a manner that no shock

is created or air trapped in the portion to be tested.

Once the pipe line is completely full of water, the pressure shall be brought up to one and a half times the maximum working pressure for all parts of the portion of pipe line under test as the water level in the container at the suction end of the pump noted. The initial application of the test pressure shall be done in the presence of the Engineer.

The pressure shall be maintained at the test level for 4 hours.

The quantity of water which has to be added to the container at the suction end of the pump during the 4 hours that the pipe line is under test in order to bring the water level back to the initial level at the start of the test, shall be carefully recorded. No water may be added to the container except in the presence of the Engineer.

Should the quantity of water thus added not exceed the following limit, the pipeline shall be deemed to be successfully tested.

Limit of leakage permitted over 4 hours:-

(a) For pipeline with flexible joints

50 ml per 10 mm of pipe diameter per 1 000 m of pipe length per 10 m maximum test head for the portion of pipeline tested. All joints must be inspected while the test is in progress to ensure that there are no visible leaks.

(b) For pipeline with welded joints

10 ml per 10 mm pipe diameter per 1 000 m of pipe length per 10 m maximum test head for the portion of pipeline tested. Should the leakage be more than 3 l/km of pipe tested, the Contractor must prove that no single leak exceeds 0,2 l in 4 hours.

M21.26.5 Other Pipe Materials

Visual inspections and hydrostatic tests shall be carried out on Site as described for steel pipes. Factory inspections and tests shall be as specified in the relevant SANS Specification for the pipe material concerned.

M21.27 MEASUREMENT AND PAYMENT

Payment under scheduled items shall be made per complete pipework system installation as specified. Measurement and payment will distinguish between supply / delivery and installation / commissioning of the equipment.

The tendered rates or sums shall cover the cost of drawings and instructions for anything not specifically mentioned but obviously required for the proper installation to enable the system as described to be installed and/or function safely and correctly as specified. No claims whatsoever for extras will be allowed on the grounds that a necessary piece of equipment or a part thereof is not specifically mentioned



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PARTICULAR SPECIFICATION

M26: MECHANICAL DOSING PUMPS

4	2013-10-23	General update and re-issued	J Ritchie	
3	2012-07-30	General update and re-issue	B Van Den Berg	
2	2010-02-16	General review	J Ritchie	
1	2009-05-12	Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance		
Rev	Date	Description	Signature: JW Wastewater Partnership	Signature: Approval from Johannesburg Water

PARTICULAR SPECIFICATION M19: DOSING PUMPS

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M26.1 **SCOPE**

This specification covers the detailed design parameters, manufacture, supply, installation, test and commissioning of Dosing Pumps. The Specification shall be read in conjunction with the Project Specification

M26.2 **INTERPRETATIONS**

M26.2.1 **Abbreviations**

In this Specification the following abbreviations will apply:-

ANSI	:	American National Standards Institute
ASTM	:	American Society for Testing and Materials
BS	:	British Standards Institution
SANS	:	South African National Standards
SIS	:	Swedish Institute of Standards
DIN	:	Deutsch Industry Normen
ISO	:	International Organisation for Standardization
ASME	:	American Society of Mechanical Engineers
SAECC	:	South African Electrolytic Corrosion Committee
AGMA	:	American Gear Manufactures Association

M26.2.2 **Standards**

All design standards for the dosing pumps shall be subject to the latest amendments and editions of the following standard specifications:-

BS 5304	:	Code of practice for safeguarding of machinery
SANS 9096-1: 1994	:	Testing of welders, where applicable to the type of welding required
SANS 1044-3	:	Welding Part 3: The fusion of steel (including stainless steel): Tests for the approval of welding procedures
SANS 10064	:	The preparation of steel surfaces for coating
SANS 10102-4	:	Selection of pipes for buried pipelines Part 1: General Provisions
SANS 10111-2-1	:	Engineering Drawing Part 1: General principles Engineering Drawing Part 2: Geometric Tolerancing Section 1
SANS 1700-5-9	:	Fasteners Part 5: General requirements & material properties Section 8: Corrosion resistant stainless steel fasteners-Bolts, Screws & Studs
SANS 1700-5-10	:	Fasteners Part 5: General requirements & material properties Section 8: Corrosion resistant stainless steel fasteners-Nuts
SANS 1123	:	Pipe Flanges

- BS 4999 : General requirements for rotating electrical machines. Specification for standard dimensions
- SIS 05 59 00 : Pictorial Surface Preparation Standards for Painting Steel Surface)
- BS 5316 Part 2 : Pump test codes

M26.2.3 General Requirements

This specification must be read in conjunction with the following specifications:-

M20: Particular Specification for Valves

M21: Particular Specification for Pressure Pipework

E01: Particular Specification for Electric Motors

G01: Particular Specification for Colour Codes

G02: Particular Specification for Corrosion protection

M26.3 DOSING PUMPS

M26.3.1 General Design Parameters

Dosing pumps shall be designed such that the following requirements are met:-

- To facilitate manufacture, inspection, installation, maintenance, cleaning and repairs,
- To ensure safe and satisfactory operation and an acceptable life expectation under the ambient conditions prevailing at the Site,
- To prevent undue stresses being produced by expansion due to temperature changes.
- To keep maintenance costs to a minimum,
- To comply with the legal requirements in respect of safety as well as the prevention of water and air pollution,
- To satisfy any specific requirement contained in the statutory codes and legislation, and
- To be suitable for operation 365 days per year, 24 hours per day under specified design conditions.

M26.3.2 General

This Contract calls for the supply, delivery, installation and commissioning of ferric chloride, ammonium bromide, chlorine and polymer dosing pumps. The pumps shall be utilised for dewatering, phosphate removal and to reduce BOD as well as removing heavy metals, larvae eggs, pathogenic content, suspended solids and colloidal content.

The mechanical equipment to be supplied under this Contract shall be installed, tested and commissioned on concrete structures, constructed by others, to the dimensions indicated on the construction detail drawings.

Any handling of ferric chloride, chlorine, polymer and ammonium bromide shall be done in accordance with the safety rules and regulations as stipulated per chemical.

The flow rate shall be controlled by setting the dosing pump speed to obtain the desired flow.

M26.3.3 Design Parameters

Double diaphragm dosing, self-priming pumps shall be used to dose the reactor with ferric chloride, chlorine, polymer and ammonium bromide. The speed of the pumps shall not exceed 800 rpm. The dosing rate of the pumps shall be 0.5 l/s at 6m or as specified.

M26.3.4 Welds and fasteners

All flanges, bolts, nuts and other steel components are to be galvanized or 304 or 316 SS.

M26.4 DOSING PUMP PARAMETERS

The flow rate of the ferric chloride, chlorine, polymer and ammonium bromide shall be controlled by setting the dosing pump speed to obtain the desired flow. Provision shall be made to lock a setting once selected to the sludge flow rate to achieve a constant ferric chloride, polymer and ammonium bromide to sludge volume ratio. The dosing system shall be integrated into the SCADA system.

M26.4.1 Diaphragms

The pump diaphragms shall & seals be manufactured from a material that has excellent resistance to aggressive fuels and chemicals and cuts, such as Teflon (PTFE) and Fluoro-elastomer/viton (FPM).

M26.4.2 Drive Unit

The drive unit consists of a motor coupled to a stroke mechanism which shall be housed in cast iron. It shall be manufactured from a material that can withstand extreme operating conditions and corrosive chemicals such as cast iron.

M26.4.3 Motor

The motor shall be able to withstand the dosing rate of the pump. The motor shall be electrically driven and shall be directly coupled to the pump. Refer E01: Volume E01: Particular Specification for electric motors.

The housing shall be manufactured from corrosion resistant and durable material.

M26.4.4 Gearbox

Refer M08: Volume M08: Particular Specification for Mechanical Gearboxes.

M26.4.5 Pump Head and Valves

The pump head, pressure valve and suction valve shall be manufactured from highly non-reactive polymer such as Polyvinylidene Fluoride (PVDF) and PVC. The pressure relief discharge shall be piped back to the storage tank on the suction side of the pumps.

The positive displacement pump shall be protected from excess discharge pressure by means of a spring loaded relief valve or by other proprietary safety equipment.

All relief valves shall be positively locked at the pressure setting and protected against accidental adjustment by wiring or other obvious suitable means. All relief valves shall be constructed in such a way that the pressure setting is preserved when the valve is dismantled for inspection. Refer to particular Specification M20: Volume 20 for detail on valves.

M26.5 Pipes

Each dosing line is to be fitted with a flow indicator of flow range 0 to 1.0 l/s.

Bends and branches shall provide non-turbulent flow conditions and the layout of the pipe work shall be such as to facilitate dismantling and inspection.

Plastic pipes with glass fibre reinforcement or PVC lining shall be used to transport the ferric chloride, chlorine and ammonium bromide. Polyelectrolytes shall be transported in stainless steel pipes. Refer to Particular Specification PMP for a detailed specification on pipes.

The pipes are to be properly supported and arranged so that all the stresses created in the pipeline by static and dynamic forces will be taken up by suitable anchors.

Where specific size is not given, pipework shall be sized so as to limit the maximum flow velocities to 1.5 m/s on the suction and 2 m/s on the delivery pipework. Refer to M21: Volume M21: Particular Specification for Pressure Pipework for a detailed specification on pipes.

M26.6 Pulsation Dampeners

Where not included in the pump specifications, pulsation dampeners shall be included in all dosing pipework. This item shall be included under the quotation for pipework.

M26.7 AREA AROUND CHEMICAL DOSING PUMPS

This area is subject to spillage of chemical solution due to leaking glands, cleaning of filters, etc. the area around the chemical dosing tanks. The area will be delineated as indicated on the drawings by building a concrete plinth around it.

M26.8 TRANSFER POLYELECTROLYTE PUMP

The chemical transfer pumps that will deliver the chemicals from the storage facility shall be centrifugal pumps lined with acid resistant material and adequately protected internally. The pumps must be self priming and shall be seal less plastic pumps or equivalent, with a throttling valve.

The lined acid material shall be a thermoplastic layer moulded onto the pump housing. The transfer rate of the pumps shall be 8 l/s at 6m or as specified. The speed of the pumps shall not exceed 800 rpm.

Refer to Mechanical Specification M18: Volume M18: Centrifugal Pumps.

M26.9 PIPING FOR TRANSFER OF CHEMICALS

- All piping to be used for the transfer of concentrated or diluted chemicals shall be either rigid uPVC or rubber suitable for handling highly corrosive suspensions. The diameter of pipes shall be as indicated on the drawings.
- All piping to be used for potable water in the buildings and surrounding area shall be of stainless steel.
- All plastic piping running along walls or ceilings shall be supported continuously, for example in suitably protected lightweight metal channels.

M26.10 PRESSURE GAUGES

Pressure gauges shall be fitted with an isolating cock, shall be vibration and shock resistant and shall be calibrated to read with an accuracy of $\pm 1\%$ of the indicated pressure. Three 20mm minimum diameter ball valves shall be employed to zero the gauge, to isolate it and to vent to atmosphere. A chemical seal shall be used to insulate the gauge from the media being measured.

The faceplate diameters of the pressure gauges shall be at least 100 mm. The gauges shall indicate the water pressure in kilopascal and shall have a range of a maximum of 50% higher than the normal maximum working pressure. All gauge glass must conform to internationally recognize standards. These standards include DIN 7081, BS 3463 and JIS B 8211.

The pipe socket requirements shall be included.

Pressure gauges are to be accompanied with calibration certificates.

M26.11 **PIPEWORK**

The following items shall be supplied and installed by the contractor:-

- (1) The dosing pump pipework
- (2) The storage tank pipework
- (3) The transfer pump pipework

The pipework shall be manufactured from PVC unless specified otherwise in the project specification.

M26.12 **CORROSION PROTECTION**

Refer to Particular Specification G02: Corrosion Protection

M26.13 **COLOUR CODES**

The standard final colour codes for equipment supplied under this Contract shall be in accordance with Particular Specification G01: Colour Coding.

M26.14 **TESTING**

M26.14.1 **Works Testing**

Before delivery of the pumps a works test, to be witnessed by the Engineer or his representative, is to be carried out to the approval of the Engineer. The motors to be supplied with the pumps shall be used in the tests.

During the test of the pumps careful records are to be kept of the power consumed, the quantity delivered and the pumping head. From these records the capacities and efficiencies of the plant shall be calculated to determine whether they are in compliance with the guaranteed figures submitted by the Contractor.

The Contractor shall be responsible for the costs incurred in works testing and shall be included in the tendered price.

M26.15 **MEASUREMENT AND PAYMENT**

Measurement and payment will distinguish between supply/delivery and installation/commission as well as per installation point. The respective tender rates shall cover all costs from supply to commission of each pump but excluding the electrical power supply and electrical cable connection.

The tendered rates or sums shall cover the cost of design, drawings, manufacture, supply, testing at the manufacturers works, delivery to site, off loading, installation, site testing, setting into operation, the supply of O & M manuals, commissioning and maintenance during the warranty period of all equipment specified and also for anything not specifically mentioned but obviously required, (e.g. all ancillaries, including all bolts, fastenings and brackets, safety guards and any work or material required for the proper installation of such equipment) to enable the equipment to be installed and/or function safely and correctly as specified. No claims whatsoever for extras will be allowed on the grounds that a necessary piece of equipment or a part thereof is not specifically mentioned.



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PARTICULAR SPECIFICATION

M30: MECHANICAL POLYELECTROLYTE HANDLING, STORAGE, MAKE UP AND DOSING EQUIPMENT

Rev	Date	Description	Signature: JW Wastewater Partnership	Signature: Approval from Johannesburg Water
3	2013-10-23	Minor updates and re-issued	J Ritchie	
2	2012-07-30	General update and re-issue	B Van Den Berg	
1	2010-02-17	First Issue	J Ritchie	

PARTICULAR SPECIFICATION M30: POLYELECTROLYTE HANDLING, STORAGE, MAKE UP AND DOSING EQUIPMENT

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M30.1 SCOPE

This Specification covers the design parameters, manufacture, supply, installation, testing and commissioning of equipment for the handling, storage, make-up and dosing of Poly Aluminium Chloride and Organic Polymers (Polyelectrolyte) for use in water and wastewater treatment processes.

This Specification shall be read in conjunction with the Scope of Works. Clarifications to this specification are set out in the Scope of Works, which shall precede this specification in the Contract Document.

The requirements set out herein are the minimum anticipated and the Contractor shall satisfy himself that the equipment offered is suitable in all respects for the duties specified in the Scope of Works.

The plant will operate either manually or automatically on a supply and demand basis, controlled from equipment under an inclusive or separate instrumentation / electrical contract as specified in the Scope of Works.

M30.2 INTERPRETATIONS

The following Interpretations relating to this specification shall form part of the Contract Document:

M30.2.1 Abbreviations

In this Specification the following abbreviations will apply:-

ANSI	: American National Standards Institute
ASTM	: American Society for Testing and Materials
BS	: British Standards Institution
SANS	: South African National Standards
SIS	: Swedish Institute of Standards
DIN	: Deutsch Industry Normen
ISO	: International Organisation for Standardization
ASME	: American Society of Mechanical Engineers
SAECC	: South African Electrolytic Corrosion Committee
AGMA	: American Gear Manufactures Association

M30.2.2 Standards

All design standards for the dosing of chemicals shall be subject to the latest amendments and editions of the following standard specifications:-

BS 5304	: Code of practice for safeguarding of machinery
SNAS 310-1:2007	: Storage tank facilities for hazardous chemicals Part 1

M30.2.3 General Requirements

This specification shall be read in conjunction with the following specifications:-

M20: Particular Specification for Valves

M21: Particular Specification for Pressure Pipework

G01: Particular Specification for Colour Codes

G02: Particular Specification for Corrosion Protection

Automation and Control Design Standards Volume 8: Flow Measurement

Automation and Control Design Standards Volume 9: Level Measurement

Automation and Control Design Standards Volume 21 – Load Cells

M30.3 GENERAL

M30.3.1 General Design Parameters

The following requirements shall be met:-

- (a) The equipment shall be designed to facilitate efficient manufacture, inspection, transport, installation, maintenance, cleaning and repairs.
- (b) The equipment shall be designed to ensure safe and satisfactory operation for a life expectancy of at least 10 years under the conditions prevailing at the Site.
- (c) The equipment shall be designed to prevent undue stresses being produced by expansion and contraction due to temperature change, and other local natural and manmade conditions.
- (d) The equipment shall be designed to keep maintenance costs to a minimum.
- (e) The equipment shall comply with the legal requirements in respect of safety and the prevention of environmental pollution.
- (f) The equipment shall satisfy any specific requirement contained in the relevant statutory codes and legislation.
- (g) The equipment shall be suitable for operation 365 days per year, 24 hours per day under the specified design conditions.
- (h) All equipment shall be provided to provide a fully operational plant within the scope of the Contract.
- (i) All materials from which the equipment is manufactured shall be compatible with the chemicals used and suitable for the intended duty and service conditions.
- (j) All equipment shall be suitably treated and protected from corrosion and erosion.
- (k) After approval by the Engineer, at the time of the award of the Contract, the information stated in the Data Sheets shall be fully complied with.
- (l) All electrical equipment, forming part of the specified equipment, shall be sealed against penetration by the chemicals in use, which may be airborne in dust form, and be also accessible for repair and maintenance.

M30.4 SUPPLY AND HANDLING

M30.4.1 Organic Polymers (Polyelectrolytes)

Depending upon the plant size and material availability, organic polymers will normally be supplied in one of two ways as follows, and as specified in the Scope of Works:

- (a) In 1.0 m³ returnable fabric Big Bags – for intermediate sized applications.
- (b) By bulk tanker – for large applications.

M30.4.1.1 1.0 m³ Big Bags

1.0 m³ bags will be supplied, each on wooden pallet. The delivering truck will be equipped with a crane for off loading purposes. Alternatively the bags shall be off loaded by forklift truck.

Handling of each 1.0 m³ bag on a pallet, at the Site, will be by forklift truck.

Each bag shall be loaded onto the top of the feed hopper, using a forklift bag, lifting frame designed to guide the big bag into position.

Loading into the specially designed feed hopper shall be achieved by undoing a neck cord at the base of the bag. Access to the bag neck shall be by an access door in the outlet section of the feed hopper.

The feed hopper inlet shall be designed to retain the empty bag during loading, whilst minimising any dust being emitted from the hopper.

The Contractor shall provide the forklift bag lifting frame when specified in the Scope of Works.

If required, the forklift truck shall be the subject of a separate contract.

M30.4.1.2 Bulk Tanker (Organic Polymers)

The Organic Polymer supplied from a totally enclosed bulk tanker will be discharged by the use of an air blower mounted on the tanker, through a flexible plastic hose with quick connectors to the receiving silo/s at the Site. The air entering the silo shall be vented through a specially designed filtration system.

M30.5 DRY STORAGE

M30.5.1 1.0 m³ Bags

The bags will be stored on the pallets, with the plastic wrapping intact, in an enclosed building, until required for use.

M30.5.2 Storage Silo/s for Organic Polymers

Storage silo/s shall be provided as follows:

Silos shall be supplied in one piece factory built construction, be vertical cylindrical, with a totally enclosed, shallow domed top, and a conical bottom with sides at not less than 60° to the horizontal. A weather proof, access manhole shall be provided in the top cover.

They shall be supported on three vertical tubular legs, suitably cross braced, for stability. A

caged ladder shall be provided to access the top, where handrails shall be provided around the periphery.

Each silo shall be positioned directly over the feed hopper, and connected through a large diameter pipe with an isolating knife gate valve and flexible rubber connection.

An anti-bridging activator shall be provided to ensure fluidisation of the product and a constant flow from the silo. This shall be in the form of motorised vibrators fixed to pads on the silo cone on smaller units, or of the bin activator type fixed at the bottom of the cone on larger units.

The anti-bridging mechanical vibrators shall prevent the outlet from being under pressure and bridging. It shall transfer vibration to the product, breaking the forces of cohesion, which bond the particles together. Together with a timing device, the activator shall ensure that the product does not over compact and is able to flow readily at all times.

A load cell shall be fitted under the silo legs to measure the amount of material in the silo. A transmitter shall be provided, capable of transmitting a signal from the load cells to a local, and a remote SCADA system.

Each silo shall be provided with the special hose connection and knife gate valve, an air filtration system, Humidifier sensor, De-humidifier and all other equipment required for satisfactory and safe operation and maintenance.

M30.6 CHEMICAL MAKE UP (WETTING)

M30.6.1 Polyelectrolyte Make-Up Equipment

M30.6.1.1 General

Polyelectrolytes are notoriously difficult to dissolve in water and special equipment and procedures are required.

The polyelectrolyte make-up equipment shall be capable of making up a 0.25% solution from polyelectrolyte beads or powder.

The make-up and dosing equipment shall comprise of single or multiple units of the following, as detailed in the Scope of Works:

- (a) Polyelectrolyte dry feeder, air blower, eductor and piping for transport of polyelectrolyte into the make-up tank, and jet wet unit.
- (b) Polyelectrolyte make-up and dosing tanks each complete with an ultrasonic level measurement and transmitter instrument.
- (c) A mechanical mixer for the make-up tank.
- (d) Two pumps (duty and standby) for the transfer of polyelectrolyte solution from the make-up tank to each dosing tank.
- (e) Two Variable speed polyelectrolyte dosing pumps (one duty and one standby).
- (f) In line mixers to mix the polyelectrolyte dose solution into the dilution water flow. One mixer for each mixing point.
- (g) Make-up water supply piping from the potable or filtered effluent supply to the jet wet

head and make-up tank as detailed in the Scope of Works.

- (h) Magnetic flow meter for polyelectrolyte dilution water.
- (i) Magnetic flow meters for each polyelectrolyte dosing point.

The polyelectrolyte make-up and dosing equipment shall be sized and selected to meet the following criteria:

- a) The equipment shall be sized to make up a batch of 0.25% polyelectrolyte solution for eight hours of operation of the dewatering equipment at the maximum dosing rate and the maximum solids loading of the dewatering equipment as specified in the Scope of Works.
- b) The dry feeder, transfer blower, eductor and jet wet unit shall have the capacity to transfer the polyelectrolyte to the make-up tank within 20 minutes to make up the eight hour batch.
- c) The polyelectrolyte dosing tank/s shall have a capacity at least as large as the makeup tank, but shall also be large enough to allow for at least a four hour hydration time of the 0.25% polyelectrolyte solution at all times prior to dilution and dosing.
- d) A single polyelectrolyte transfer pump shall be capable of transferring the contents of the make-up tank to the dosing tank/s within 40 minutes.
- e) Each polyelectrolyte dosing pump shall be sized to meet the dosing range specified in the Scope of Works for each dewatering unit.
- f) The inline mixers shall mix the 0.25% polyelectrolyte dosing solution into sufficient dilution water to produce a 0.1% solution prior to dosing.

M30.6.1.2 Dry Feeder

The dry feeder shall be of the rotary vane type or the helical screw type where the screw rotates in a tubular nozzle. The feeder shall have a manually adjusted variable feed rate with a predictable accuracy of plus or minus 5%. The maximum rate of feeding shall be in accordance with the requirements detailed in the Scope of Works

The feeder parts in contact with the polyelectrolyte shall be manufactured from stainless steel or other superior corrosion resistant material.

When of the screw type, an electrical heater shall be incorporated around the tubular nozzle to minimise the ingress of moisture at the discharge point. The nozzle shall discharge into the branch of the eductor.

The feeder shall be fitted with a feed hopper of sufficient capacity to hold the mass of polyelectrolyte required for one charge of the make-up tank at the maximum polyelectrolyte dose and maximum dry solids feed rate as given in the Project Specific Specification.

M30.6.1.3 Transfer Blower, Eductor and Jet Wet Unit

The blower, eductor and jet wet units shall be supplied by a specialist supplier.

The blower unit shall deliver sufficient dry air to draw the dry polyelectrolyte powder or beads into the eductor, and transport the polyelectrolyte to the jet wet unit without blow back into the dry feeder. The jet wet unit shall thoroughly wet each particle of polyelectrolyte such that all the polyelectrolyte is truly dissolved in the makeup tank after 30 minute of mixing.

An electrical heater shall be incorporated around the eductor to prevent condensation.

M30.6.1.4 Polyelectrolyte Make Up Water

Potable or effluent water shall be used for polyelectrolyte make-up as indicated in the Scope of Works.

This water supply shall be piped to both the jet wet unit and the make-up tank.

The water shall be drawn from the site potable water supply or from the filtered effluent water supply.

The piping to the jet wet unit and make-up tank shall be fitted with solenoid valves and magnetic flow meters.

The equipment supplied shall include all piping, valves, flow meters, supports and fittings to draw from the water supply and deliver to the jet wet unit and make-up tank.

M30.6.1.5 Polyelectrolyte Make Up and Dosing Tanks

The make-up and dosing tank/s shall have a capacity as detailed in the Scope of Works.

The make-up and dosing tanks shall be of the vertical cylindrical type with an open top. They shall be provided with flanged outlet nozzles for connection of the transfer pump piping, the dosing pump piping, drains and overflow pipes.

They shall be manufactured from Stainless steel or mild steel. Mild steel tanks and nozzles shall be rubber lined internally and painted externally using a two-pack polyamide cured epoxy in accordance with the corrosion protection specification.

The flat base of each tank shall sit on a 25 mm thick supporting layer of a mixture of bitumen and sand.

The make-up tank shall be fitted with a vertical or inclined shaft low speed mixer. The mixer shall incorporate two axial flow impellers at different heights along the shaft. The mixer shall operate from a geared motor mounted at the top of the tank.

The mixer shall have low shear impellers that shall not shear a 0.25% polyelectrolyte solution, but shall thoroughly mix the tank contents without the entrainment of air.

M30.7 CHEMICAL PUMPS

M30.7.1 Polyelectrolyte Transfer Pumps

Two transfer pumps shall be provided for each make up tank, 1 duty and 1 standby, complete with all piping, valves and fittings required to draw from the bottom of the make-up tank and deliver to the dosing tank/s.

The pumps shall have a capacity as specified in the Scope of Works. They shall be of the progressive cavity rotating helix pump type. The pumps shall have a rubbing speed of less than 3.0 m/s and be suitable for handling dilute polyelectrolyte solutions without shearing the polymer.

M30.7.2 Polyelectrolyte Dosing Pumps

Depending upon the Polyelectrolyte supplier's recommendations and the size of the dosing

plant, the dosing pumps shall be either the Diaphragm type, the Progressive Cavity type or the Peristaltic type.

Diaphragm type pumps will have a high accuracy and be used for small applications. Peristaltic type pumps will also have a high accuracy and be used for large applications. Progressive Cavity type pumps may be used for large applications, but will not have a high accuracy. The type of pump required will be detailed in the Scope of Works.

Two variable speed dosing pumps (one duty and one standby) for each dosing point shall be provided unless specified otherwise in the project specific specification. Each pump shall have the capacity as detailed in the Scope of Works.

All pumps shall be run at a low speed to ensure low shear conditions, suitable for pumping dilute polyelectrolyte solutions.

All piping, valves and fittings and inline mixers shall be provided to draw from the polyelectrolyte dosing / stock tank and deliver to the dosing point.

M30.7.3 Diaphragm Type Pumps

Diaphragm type dosing pumps shall be electric motor and gear driven.

The pump shall be driven through an oil filled gearbox and a spring loaded plunger with a support plate at the rear of the diaphragm. An eccentric cam system which actuates the plunger shall be manually adjustable to deliver from 0 to 100% of the design quantity of discharge.

The diaphragm chamber shall be designed such that in the event of a diaphragm rupture the pumped liquid cannot escape or enter the cam and gear mechanism of the pump and is drained away to a special chamber. The pump shall be designed in such a way that a leakage detector probe can be installed if so specified in the Project Specification or if required at a later date. The diaphragm and coating shall be completely resistant to the chemical concerned.

The diaphragm housing shall be manufactured from PVC or other suitable and resistant material. The diaphragm plunger shall be manufactured from stainless steel with the diaphragm support plate specially coated to resist any liquid, which could leak through the diaphragm in the event of a rupture.

Non-return valves shall be incorporated on the suction side and the delivery side of the pump. The valves shall be an integral part of the pump and of the double-ball type. The balls shall be manufactured from glass or ceramic, and the valve seats from PVC or other suitable and resistant material.

If automatic remote adjustment of the flow rate is specified, this shall be done using a VSD control unit for the pump motor.

M30.7.4 Peristaltic Type Pumps

Peristaltic type dosing pumps shall be electric motor and gear driven. The pump shall be driven through an oil filled gearbox and shall not run at more than 50% of its possible design speed. Variation of pumped flow shall be provided by varying the motor speed using a VSD control unit.

The pump casing shall be designed such that in the event of a tube rupture the pumped liquid cannot escape or enter the gear mechanism of the pump. The pump shall be designed in such a way that a leakage detector probe can be installed if so specified in the Project Specification or if required at a later date. An easily removable cover shall be incorporated on the casing of the pump such that the pump tube can be easily replaced. The tube and casing coating shall be

completely resistant to the chemical concerned.

If peristaltic type pumps are used, then the back pressure valve may not be required.

M30.7.5 Progressive Cavity Type Pumps

Progressive Cavity type pumps with a rotating helix shall be 'V' belt or gearbox driven and all parts shall be fully corrosion resistant to the chemical being pumped. Variation of pumped flow shall be provided by varying the motor speed using a VSD control unit.

M30.8 **POLYELECTROLYTE DOSING**

M30.8.1 Dilution Water Piping and Inline Mixers

After pumping, the dosing solution shall be diluted from 0.25% to 0.1% by the addition of dilution water drawn from the service water main. An inline mixer shall be provided to intimately mix the dilution water into the polyelectrolyte dosing solution.

All piping, valves and fittings to draw dilution water from the service water main to each dilution water mixer, including a pressure reducing valve and magnetic flow meter shall be provided.

M30.8.2 Piping and Valve Materials

Piping for the conveyance of dry polyelectrolyte, transfer of polyelectrolyte solution from the make-up tank to the dosing tank, make up water feed to the make-up tank and polyelectrolyte dilution water shall be provided with adequate support to prevent damage by pedestrian access.,

The following actuated valves shall be provided:

- Make-up water to the polyelectrolyte make-up tank. Two x 230 Volts solenoid operated isolating valves, energised to open, one for the feed water to the jet wet head, and the other for make-up water directly into the tank.
- Dilution water valves. One electro / mechanically ball valve for each dosing point, for dilution water to be injected into the pipeline from the dosing pumps to each dosing point.

The actuators shall be designed for slow valve closure.

M30.9 **SAFETY EQUIPMENT**

The following safety equipment shall be provided for hazardous chemicals and when specified in the Scope of Works.

M30.9.1 Safety Shower/eye baths

Safety shower/eye baths shall be supplied and installed at the location specified in the Scope of Works. The shower/eye bath shall be of an SABS approved type suitable for use where dangerous chemicals are in use and shall be constructed from 316 Stainless Steel or corrosion resistant, reinforced plastic. It shall be of the single column type, operated by standing upon a tilting foot stand to douse downwards and forwards, and also by pushing a lever to spray upwards to the hands and face. The sprayed liquid shall be collected in a concrete basin supplied by others, and which will incorporate a drain.

The water supply to the eye bath is to be by rigid pipe work and fittings, flexible plastic tubing shall not be acceptably.

The Contractor shall include for the supply and installation of 5.0 m of 25 N.B. Galvanised Steel feed piping and a 25 N.B. Isolating Valve of the 90 degree ball type in stainless steel.

M30.9.2 Safety Signage

A set of safety signage for each hazardous chemical specified in the Project Specification shall be supplied and fitted as follows:

- (a) Two identical signs, each indicating both the Hazchem Code (2R) and the Substance Identity No. (1773).
- (b) Two identical signs, each indicating the First Aid Requirements, in case of accidental contact with the polyelectrolyte.
- (c) Two identical signs, each indicating '(THE RELEVANT CHEMICAL) – HAZARDOUS SUBSTANCE'.
- (d) One Emergency Procedures Chart with emergency telephone numbers.
- (e) One sign, indicating 'SAFETY SHOWER' for each shower proposed.

Signs items (a) to (d) shall measure at least 450 mm x 600 mm. The Safety Shower sign shall measure at least 300 mm x 500 mm.

All signs shall be manufactured from a strong UV resistant plastic material. When fixing to a flat wall, at least four 316 Stainless Steel screws and plastic plugs shall be used. Each Shower sign shall be bolted to a Stainless Steel or GRP plate, which in turn shall be fitted to the shower upright, using Stainless Steel 'U' bolts

Signs items (a) to (c) shall be mounted such that they can be clearly seen before entering the hazardous area. The final position to be agreed by the engineer prior to mounting the signs.

Each Safety Shower sign shall be fitted to each shower upright approximately 1,5 m high.

If the dosing station is positioned remotely from the storage area, one additional set of signs will be required to be fitted in prominent positions, close to the dosing station.

Notwithstanding the above all signs shall be in accordance with the requirements of the Occupational Health and Safety Act.

M30.10 **DOSING CONTROL EQUIPMENT**

Unless otherwise specified in the Scope of Works the dosing control equipment will form part of a separate electrical / instrumentation contract. The Contractor shall ensure that the type of instrumentation is provided to satisfactorily control the equipment in accordance with the specified requirements.

M30.11 **MATERIALS OF CONSTRUCTION & FINISH**

M30.11.1 Materials of Construction (General)

Water Supply Piping Galvanised Mild Steel

	Piping (indoors)	Galvanised Steel
	Piping (outside)	Galvanised Steel
	Bolts & Nuts	304 Stainless Steel
	Concrete Anchors	304 Stainless Steel
M30.11.2	<u>Materials of Construction (Polyelectrolyte)</u>	
	Dry Material Storage Silo	Mild Steel
	Storage Silo Ladder & Hand Railing	Mild Steel
	Make Up Tank	Mild Steel/304 stainless steel
	Stock Tanks	Mild Steel/304 stainless steel
	Feed Hopper & Assoc. Parts	304 Stainless Steel
	Feeder & Assoc. Parts	304 Stainless Steel
	Jet Wet Unit.....	316 S.S. or Plastic
	Pressure Water Piping	Galvanised Mild Steel
	Liquid Polyelectrolyte Piping (Indoors)	Galvanised Mild Steel
	Liquid Polyelectrolyte Piping (Outdoors).....	Galvanised Mild Steel
M30.11.3	<u>Corrosion Protection (General)</u>	
	Water Supply Piping	Galvanised steel
	Piping (outside)	Galvanised steel
M30.11.4	<u>Corrosion Protection (Polyelectrolyte)</u>	
	Dry Material Storage Silo internal	Primer
	Storage Silo Ladder & Hand Railing	H.D. Galvanised
	Make Up Tank & Stock Tanks (Inside)	Rubber Lined
	Make Up Tank & Stock Tanks (Outside)	two-pack polyamide cured epoxy
	Feed Hopper & Assoc. Parts	Polished
	Feeder & Assoc. Parts	Polished
	Pressure Water Piping	Galvanised steel
	Liquid Polyelectrolyte Piping (Outdoors).....	Galvanised steel
M30.12	INSTALLATION AND OPERATING REQUIREMENTS	
M30.12.1	<u>General</u>	
	The equipment shall operate as described in the Scope of Works, depending upon the chemical dosed and the particular installation.	
	Unless otherwise specified, equipment shall dose the amount of chemical automatically in accordance with the associated equipment demand. Only duty and standby equipment shall be selected manually.	
M30.12.2	<u>Tools</u>	
	A wall mounted toolbox shall be provided and mounted as directed by the Engineer. It shall contain all tools required to service and maintain all the equipment provided.	
M30.13	INFORMATION REQUIRED	
M30.13.1	<u>Manufacturing Drawings</u>	
	The Contractor shall inform the Engineer prior to the manufacture of any piece of equipment of the availability of the General Arrangement drawings for inspection and approval by the Engineer to be made available at the Engineer's office. The Contract will be deemed	

incomplete until the Contractor has made available these drawings to the Engineer, and they have been checked and approved.

M30.13.2 As Built Drawings

The Contractor shall provide 'To Scale' As Built General Arrangement Drawings of all the relevant equipment. Such drawings shall be made available in a recognized electronic format such as AutoCAD.

M30.14 **TESTING/COMMISSIONING**

Two series of tests shall be conducted on the equipment, as specified hereunder.

M30.14.1 Preliminary Test

Before delivery of the equipment is accepted, each item of mechanised equipment shall be tested, at the supplier's works, throughout the operating range using the chemicals which the equipment is required to dose. Calibration curves to demonstrate compliance with the specification shall be plotted and submitted to the Engineer.

M30.14.2 Acceptance Test

After installation of the equipment and before commissioning, each item of mechanised equipment shall be tested throughout its operating range and calibration curves shall be produced. The calibration curves shall be incorporated into the operating and maintenance instructions.

M30.15 **QUALITY MANAGEMENT**

Quality management criticality categorization: Major.

M30.16 **MEASUREMENT AND PAYMENT**

M30.16.1 General

Measurement and payment will distinguish between supply/delivery and installation/commission for each item of equipment as listed and priced only in the Schedule of Quantities. Payment will not be made for part supply of any listed item.

The respective tender item rates shall be deemed to cover all costs of equipment required within the scope of this Contract.

The tendered rates or sums shall cover the cost of design, drawings, manufacture, supply, testing at the manufacturers works, delivery to site, off loading, installation, site testing, setting into operation, the supply of O & M manuals, commissioning and maintenance during the warranty period of all equipment specified and also for anything not specifically mentioned but obviously required, (e.g. all ancillaries, including all bolts, fastenings and brackets, safety guards and any work or material required for the proper installation of such equipment) to enable the equipment to be installed and/or function safely and correctly as specified. No claims whatsoever for extras will be allowed on the grounds that a necessary piece of equipment or a part thereof is not specifically mentioned.

M30.16.2 Testing

The tendered sum shall cover the cost of all plant and personnel for conducting the testing, and in the case of the workshop and preliminary testing shall include the cost of any consumables. For the acceptance testing, the consumables will be provided for the initial test only, by the Employer.

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER
PARTICULAR SPECIFICATION
E01 : ELECTRICAL MOTORS

Johannesburg Water (SOC) Ltd.
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ACTION	FUNCTION	NAME	DATE	SIGNATURE
Prepared	Senior Electrical Engineer	B Pieterse	August 2019	
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RECORD OF REVISIONS

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3	2014-06-03		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance
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1	2009-05-12		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance

PARTICULAR SPECIFICATION: VOLUME E01: ELECTRICAL MOTORS

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E01.1 SCOPE

This specification shall cover all electric motors to be designed, supplied installed and tested that shall drive any of the items of equipment to be supplied under the contract. This specification shall be read together with those specifying the mechanical driven equipment.

E01.2 INTERPRETATIONS

E01.2.1 Abbreviations

In this Specification, the following abbreviations will apply:

ANSI	:	American National Standards Institute
ASTM	:	American Society for Testing and Materials
BS	:	British Standards Institution
SANS	:	South African National Standards

E01.2.2 Standards

The latest edition, including all amendments to until the date of tender, of the following particular national and international specifications, publications and codes of practice shall be read in conjunction with this specification and shall be deemed to form part thereof:

- (a) SANS 1804-2 : Low-voltage three-phase standard motors
- (b) SANS 60529 : Degrees of protection provided by enclosures (IP code)
- (c) SANS 60034 : Rotating electrical machines
- (d) BS 1486-2 : Heavy duty lubricating nipples
- (e) SANS 60034-1 : Rotating electrical machines Part 1: Rating and performance
- (f) ISO 281 : Rolling bearings - dynamic load ratings and rating life

E01.3 GENERAL REQUIREMENTS

- (a) Electric motors shall be manufactured in South Africa and shall comply with the requirements of SANS 1804-2.
- (b) Imported motors shall be accepted only if they form an integral part of the equipment offered. Where imported motors are offered they shall be submitted to the South African Bureau of Standards to be tested in accordance with the requirements of SANS 1804-2.
- (c) The Engineer shall be provided with the appropriate certificates obtained from the South African National Standards stating that such motors do comply, prior with the installation of the motors. However, where tests reveal that motors do not comply, it shall be the responsibility of the Contractor to supply alternative motors that comply with the requirements of SANS 1804-2.
- (d) Where imported motors are not normally kept in stock in South Africa, written proof shall be provided of the availability of replacement parts as well as the delivery period of the parts after placing the orders.
- (e) All motors shall be standard catalogue models and shall be readily available.
- (f) All motors shall where possible, be from the same manufacturer and shall have the same interchangeable frames. Variations in type and size shall, where possible, be limited to prevent stocking a variety of special spares.
- (g) All motors shall be wound for direct-on-line (DOL) type of starting.

E01.4 WORKING VOLTAGE AND SUPPLY SYSTEMS

- (a) The motors shall be capable of operating within $\pm 10\%$ of the nominal supply voltage without risk of damage. All motors shall be suitable for operating continuously at the specified 3-phase voltage system under actual service conditions, including the $\pm 10\%$ voltage tolerance, without exceeding the specified temperature rise determined by the resistance on a basic full load heat run.
- (b) All motors shall be capable of operating continuously under actual service conditions at any supply frequency between 48 and 51 Hz together with any voltage between $\pm 5\%$ of the nominal supply voltage.
- (c) The slip-in speed of any motor at 80 percent of the nominal voltage at 50Hz shall not exceed a percentage agreed on by the engineer, and the motors shall be capable of operating at this voltage for a period of five minutes without deleterious heating.

E01.5 TEMPERATURE RISE

The temperature rise, as determined by resistance, of all motors, shall not exceed the following derated values:

Insulation class	E	B	F	H
Temperature rise (K)	50	60	80	100

E01.6 EFFICIENCY AND POWER FACTOR

- (a) All motors supplied will be energy-efficient as described in SANS 60034-31: Selection of energy-efficient motors
- (b) The efficiency of all motors shall be guaranteed by the contractor. Deviations from the guaranteed efficiency shall be within the limits specified in SANS 1804-2.
- (c) The guaranteed efficiency of each motor size and rating shall be as determined in accordance with SANS 60034. A basic test certificate of efficiency will be accepted for a motor of identical size and rating or a basic test of efficiency shall be conducted if no certificate is available.
- (d) The power factor of motors with a capacity of 20 kW or more shall not be less than 0,85 under all operating conditions.

E01.7 VIBRATION

- (a) Motors shall be statically and dynamically balanced.
- (b) All motors shall be checked for inadvertent vibration without load, and at full rated voltage at the manufacturer's works, and the vibration amplitude as measured shall be in accordance with SANS 60034-1.
- (c) The ratio of axial to radial vibration shall not exceed 0,5.

E01.8 NOISE LEVEL

Unless specified differently all motors shall be of 'normal sound power', in compliance with SANS 60034.

E01.9 ENCLOSURE AND FRAME

- (a) Each motor shall be ingress protected to the degree required by its application, and its enclosure shall be designed for the system of cooling associated therewith.
- (b) Notwithstanding the requirements above, the minimum degree of protection shall be IP 55 to SANS 60529, or alternatively specified. Motors shall preferably be of the totally enclosed fan-cooled (TEFC) type.
- (c) The motor cooling system must be of an aerodynamic design with minimal noise levels and superb airflow distribution over the frame with superior mechanical strength. All motor

cooling fan covers will be constructed in metal.

- (d) All motors of the vertical-spindle type and exposed to the weather, shall be provided with a robust canopy of approved design by the Engineer.

E01.10 MOTOR TYPE

Motors shall be of the squirrel-cage induction type. Slip-ring induction motors or other approved types will be considered if the contractor is of the opinion that better results could be obtained by using such motors. Full electrical and mechanical details of each alternative shall be submitted with the tender documents. Alternative motors must be accepted by the Engineer in writing.

When motors are connected to VFD's with variable torque loads operated under usual service conditions, inverter-ready general-purpose motors must be supplied (IEC 60034-1)

When motors are connected to VFD's operating at extremely low speeds and/or with a constant torque load, or when operating over base speed, definite-purpose, inverter-duty motors must be supplied (IEC 60034-1).

Larger inverter-duty motors must be equipped with a constant speed auxiliary blower to provide adequate cooling at low motor operating speeds. The contractor must submit a statement from the motor supplier on the need for an auxiliary blower when omitted.

Inverter-duty motors above the 500 frame size should have both bearings insulated, and be equipped with a shaft grounding brush with a ground strap from the motor to the drive case. For frame sizes below 500, the contractor must check with the motor manufacturer regarding requirements for motor bearing insulation.

E01.11 RATING AND STARTING REQUIREMENTS

- (a) Motors shall be adequately rated for the service for which they are intended, and due allowance shall be made for the temperature, altitude, climatic conditions and variations in the supply voltage. Motors shall not exceed 120% of the required capacity without prior approval from the Engineer.
- (b) Not only shall motors be based on the full load requirements, but also the motor capacity and starting characteristics shall be compatible with the requirements of the driven equipment.
- (c) Where motors are required to drive high inertia loads, the starting torque of the motor and the torque curve of the driven load shall be submitted to the Engineer for approval prior to manufacture. Such motors shall be capable of at least three starts per hour, with two consecutive starts from normal operating temperature, or more frequently if required by the Engineer.
- (d) Motors shall be of the continuously running duty class S1 unless otherwise specified in the detailed specification or if a more onerous duty is dictated by the drive requirement.
- (e) All squirrel-cage induction motors shall be suitable for direct on line starting at full voltage. Single-speed motors shall conform to SANS 60034-12, Design B characteristics unless approved by or dictated by the drive requirements.
- (f) Unless otherwise approved, the 15% tolerance on locked-rotor torque permitted by SANS 60034-1 will not be accepted and shall be limited to 10%.
- (g) Documentation shall include performance curves to suit the designed working conditions.
- (h) When making a selection of the motor size for driven equipment, motor power shall be over-rated by a factor of thirty percent (30%) more than the demand of the driven equipment.

E01.12 BEARINGS

- (a) All motors shall, wherever possible, be provided with pre-lubricated sealed bearings.
- (b) Re-greasable bearings shall require only one lubrication per year. Grease lubrication of ball or roller bearings, where approved, shall be by means of hexagonal button-type grease

nipples to BS 1486- 2, Nos. 21A or 21B (industrial type).

- (c) Grease-lubricated bearings shall have relief holes to ensure that the bearings have been correctly packed, which holes shall be positioned so that the excess grease can be easily removed. Cups shall be fitted to contain excess grease.
- (d) Bearings shall be protected against eddy currents and shall be capable of withstanding vibrations caused by unbalanced loads.
- (e) All bearings shall be designed for a minimum L_{10h} , basic life rating of 50 000 hours at the rated load and speed for the application in accordance with ISO 281.

E01.13 EARTHING

All motors shall be provided with a machined or spot-faced boss earth point, tapped to receive a bolt of not less than 10 mm in diameter for earthing purposes. This earth point must be located on one side of the motor, between the mounting feet.

A protective earth cable must be installed between the MCC earth bar and the motor earth point, sized in accordance with SANS1042-1.

Earth bonding must be installed between the motor frame and the motor support structure as well as the cable support structure.

E01.14 HEATERS AND DRAINAGE

Non-submersible motors that will be located outdoors or in a damp location such as in a drainage sump shall be provided with suitable means of drainage to prevent the accumulation of water due to condensation. They shall also be fitted with anti-condensation heaters suitable for a 220V AC supply if considered advisable by the manufacturer.

All motors shall be supplied with anti-condensation heaters (220V AC supply) to keep the motor temperature at 23°C when the motor is not operational to prevent moisture from condensing in the motor unless specified otherwise.

Heater terminal boxes shall be fitted on the motor frame and shall be of robust design, liberally sized and complete with suitable terminal block and mechanical cable gland or conduit entry.

E01.15 TERMINAL ARRANGEMENTS

- (a) All motor terminal boxes must be oversized to fit a cable one size bigger than the standard cable as a minimum
- (b) The terminal box must be installed with an OME supplied seal between the terminal box and the motor chassis
- (c) Motor cable termination blocks must confirm to the IEC 60034-1 standard
- (d) The line connections of each motor shall be brought out to a terminal box located in an approved position. In the case of two-speed motors, separate terminal boxes shall be provided for each speed.
- (e) Terminal boxes shall be of the totally enclosed type designed to exclude the ingress of dust and moisture and sealed from the internal circuit of the motor, and shall be manufactured from sand-cast metal. The wall thickness of the terminal boxes and the dimension of the cable inlet shall be as specified in SANS 1804-2. The terminal box shall be so designed that the cable entry may be made in any one of four positions placed at right angles to one another.
- (f) Winding termination in the motor terminal boxes shall be properly secured or fastened to avoid hot connections during operation.
- (g) Terminal boxes shall be of ample size to allow the cable to be terminated in the box. Under no circumstances shall the cable be allowed to be in contact with the inside of the box or lid.
- (h) Terminals shall be of a substantial design and shall be suited to receive cable lugs. Pinch-screw connections will not be accepted.

- (i) The terminal arrangement shall permit the motor to be disconnected from its supply cable without damaging the cable tails and shall allow the supply cable and motor windings to be tested separately.
- (j) The electrical clearance and creepage distances, with the correct cable terminations in position, shall comply with the requirements of SANS 60034.
- (k) Terminal markings shall be clear and permanent. Irrespective of the direction of rotation required on the site, the connections shall be such that, when the supply leads L1 - L2 - L3 are connected to the motor terminals U - V - W respectively, the motor shall rotate in a clockwise direction when viewed from the driving end.
- (l) Motors suited for only one-directional rotation, shall be clearly marked as such by an arrow fixed to the motor frame at the driving end.
- (m) Before the contractor orders terminal boxes for electrical equipment, he shall supply details of the proposed boxes to the engineer for approval. These precautions are necessary to ensure that the size of the connecting blocks installed is sufficient to accommodate the cables supplied and connected by another contractor, and that sufficient space exists within the box to route cables conveniently.

E01.16 MOTOR/LOAD COUPLING

- (a) Motors shall be coupled direct to the equipment to be driven by means of approved couplings and/or gearboxes unless specified differently. Refer to the relevant sections for specific specifications on transmission couplings and gearboxes. Vee-belt and chain drives will be considered only if direct coupling of the motor to the equipment is impossible or impractical.

Motors driving vee-belt or chain drives shall be fitted with heavy-duty bearings suited to the full side thrust at 120% of full load torque and short-term overloads of up to 250% of the full load torques during starting. The stiffness of the rotor shaft shall be checked to ensure that resonance and fatigue do not occur.
- (b) Where applicable, the flanges of the motors and equipment shall be identical.
- (c) The precision tolerance class shall apply to all flange-mounted motors with regard to concentricity, perpendicularity and shaft run-out.

E01.17 INFORMATION PLATES FOR MOTORS

In addition to the information required by SABS 948-1 the following shall also be marked on the nameplates:

- (a) Year of manufacture,
- (b) The order number,
- (c) Total mass of motor in kilogram,
- (d) Diagram indicating the number, type and positions of heaters and temperature detectors if applicable,
- (e) Bearing types and sizes, and
- (f) Bearing grease interval or bearing replacement interval where pre-packed bearings are used.

E01.18 ADDITIONAL SPECIFICATIONS FOR TWO-SPEED MOTORS

The following additional specifications apply to all two-speed motors:

- (a) Terminal markings shall be as per SANS 1804-2.
- (b) The starting current shall not exceed six times the full load current of the high-speed rating.

E01.19 SUBMERSIBLE MOTORS

The following additional requirements apply specifically to all submersible motors:

All submersible motors shall be suited for submersion up to a depth of 1,5 times the depth of submersion shown on the drawings for each application, or as specified in the detail specifications.

All submersible motors shall have dynamically balanced rotors supported by maintenance-free, sealed-for-life ball bearings.

All motors shall be suitably coated to ensure the satisfactory operation of the motor under the specified class of service.

All terminal boxes shall be waterproof and suited for submersion up to the depth as specified for the motors.

An adequate length of waterproof cable, purpose-made for submersion, shall be supplied with each submersible motor. The coupling of this cable to the normal power-distribution cable, which usually is of the PVC type with steel-wire armour, shall be placed at least 1 m above the maximum water level by means of a purpose-made, weatherproof, outdoor junction box. The submerged cable shall be supported to minimize any movement of the cable, which results from turbulence caused by the operation of the equipment or the flow of the water.

Thermistor protection temperature switches shall be provided for submersible motors.

Seal monitors shall be provided for submersible motors, together with the required seal monitor relays. The cost for the seal monitor relays shall be deemed included in the rates tendered for the equipment.

E01.20

ADDITIONAL REQUIREMENTS

- (a) The rotation speed of motors shall not exceed 1 500 rpm unless approved by the Engineer.
- (b) Thermistor protection shall be provided for each winding of each motor. Motors rated below 22kW shall have no thermistor and heater protection devices installed on them. Motor rated 22kW and above shall have both thermistor and heater protection devices installed on them.
- (c) Motors below 55kW shall be started by the DOL type method of starting. Motors including 55kW and above shall be started by the softer-starter type method of starting.
- (d) A separate thermistor and heater terminal box shall be fitted on the motor frame next to the power terminal box and shall be of robust design, liberally sized and complete with suitable terminal block and mechanical cable gland or conduit entry.
- (e) The minimum preferred class of insulation is Class F, derated in accordance with the relevant clause above.

E01.21

TECHNICAL DATA SHEETS

Details of all individual electric machines and equipment requiring electrical energy shall be indicated on the technical data sheet provided for in the tender Schedules (included in the technical data sheets).

E01.22

TESTING

Tests on completion (commissioning tests) shall be performed as described below in this specification.

E01.22.1

Performance Tests

- (a) One motor of every type shall be tested for temperature rise and excess torque. Type test certificates on identical motors will be acceptable in lieu of these tests. Should type test certificates not be available, the first motor of each size manufactured shall be tested. All tests shall be in accordance with SANS 60034.
- (b) The measurement of the temperature rise of the stator windings of motors for use on voltages up to 1 000 volts shall be by the increase in resistance method as is now permitted by SANS 60034.

E01.22.2 Routine Tests

- (a) Each motor shall be tested at the manufacturer's works for light-run, locked rotor, insulation resistance, high voltage, air-gap clearances and Tan Delta on each complete stator.
- (b) All tests shall be in accordance with SANS 60034.

E01.22.3 Test Certificates

- (a) Four copies of all test certificates, showing the results of all tests performed, shall be supplied at a date not later than the delivery date of the motors.
- (b) The test certificates shall contain power factor and efficiency figures for 125%, 100%, 75%, 50% and 25% of full load conditions as calculated from the test results.

E01.22.4 Witnessing of Tests

All type and routine tests on motors larger than 45 kW shall be witnessed by the Engineer.

E01.22.5 Testing of Terminal Box Assembly

- (a) Proof shall be given to show that a prototype terminal and cable box assembly of the type being supplied on medium voltage motors has been tested under internal short-circuit conditions and that the pressure relief diaphragm ruptured protecting the case of the terminal box from serious damage. In addition, that a through fault current test was made to demonstrate that the complete assembly is capable of handling the short-circuit current without damage. The fault current for these tests shall have been 45 000 ampere for a duration of 0.25 seconds.
- (b) These type tests shall have been witnessed by an independent authority.

E01.23 **DRAWINGS FOR APPROVAL**

The following drawings shall be submitted for approval:

- (a) Dimensioned outline and foundation drawings of the motors. (Shaft diameter, shaft height and motor weight to be clearly shown).
- (b) Detailed drawings of the bearing arrangement, showing all lubrication pipes, coolers and pumps.
- (c) Cross-sectional dimensioned drawings of the cable boxes.
- (d) Detailed drawings of the motor base plate showing full constructional details with dimensions.
- (e) For motors of 250 kW and larger fully dimensioned drawings of the shaft showing all tolerances.
- (f) For motors designed for voltages of 3.3 kV and above, drawings showing the end winding bracing arrangements.

E01.24 **STORAGE**

The contractor must ensure that the storage requirements as specified by the manufacturer are adhered to strictly so as avoid voiding of the warranty. Every effort must be taken to ensure the motor is protected against ingress of water, vermin or anything that may affect its future operation. The following are only given as guidelines, the contractor is expected to exercise due care in the storage and handling of electric motors.

- (a) The motor should be store upright in its normal position, free of dust, dirt, gasses and corrosive atmospheres.
- (b) Motors should be stored under roof on a concrete base, normally in a store environment. Do not remove the motor from the wooden pallet.
- (c) For bigger units, which cannot be housed in a store or relevant building, shed must be built with a proper concrete floor. Do not remove the motor from the wooden pallet.

- (d) Store the bigger units close to the final position within access with overhead crane or mobile crane.
- (e) Do not stack any objects on top of or against the motor.
- (f) Motors must be stored in places free from vibrations in order to avoid damage to the bearings.
- (g) The motors space heaters/ anti condensation heaters and similar accessories must be switched on at all times to avoid condensation and corrosion within the enclosure.
- (h) If painting has been damaged during transportation, it must be repainted to avoid rusting.
- (i) Ensure all machined surfaces and shaft extensions are covered with grease or a rust inhibiting substance.
- (j) For slip-ring motors, the brushes must be lifted to avoid condensation between contact surfaces and slip rings.
- (k) Before operation all brushes and contact surfaces have to be inspected and brush seating confirmed.
- (l) When any motor is kept for extended period, the shaft must be manually turned on monthly intervals.
- (m) For big machines with frames greater than or equal to 400mm, the shaft should be rotated monthly at any number of turns and then put at rest at 180 degrees difference from previous stationary position.
- (n) When a motor is not immediately required in operation, it should be protected against moisture, high temperature and impurities in order to avoid damage to the insulation system.
- (o) If the ambient contains high humidity, periodical insulation resistance inspection is recommended during storage.
- (p) The following guidelines show the approximate insulation resistance values that can be expected from a clean and dry motor at 40° Celsius ambient.
- (q) Minimum insulation resistance = rated voltage (kV) + 1 (Mega ohm) using 2 times the rated voltage.
- (r) These periodical measurements should be recorded and be available prior to installation.

E01.25

ERECTION AND INSTALLATION

E01.25.1

Erection

- (a) When motors are erected, care shall be taken to ensure that adequate tolerance margins are made available to ensure interchangeability with replacement motors.
- (b) A minimum of 10 mm of packers shall be provided under the motor frame or motor bedplate to allow for adjustments in height.
- (c) Before holding-down bolts are grouted in, the motor shall be lined up and the bolts shall be properly centred in the hole of the bedplate.
- (d) The bending radius of the motor supply cable should not be exceeded when installing the cable (SANS10142-1).
- (e) Motor supply cables must be supported and should not hang from the terminal box/gland.

E01.25.2

Bearing Inspection

- (a) The Engineer shall inspect motors having ball/roller bearings.
- (b) The grease shall be examined to ensure that it is not hard.
- (c) Providing that no roughness is felt when the shaft is rotated by hand and that the motor runs without undue noise or vibration, the bearings will be considered acceptable.
- (d) Should the bearings fail or exhibit the symptoms of brinelling during the guarantee period,

the Contractor, free of charge, without delay, shall change them.

E01.25.3 Alignment

- (a) After erection, the alignment of the half-couplings between the motor and the driven machine shall be measured. In the case of a pedestal, bearing motor the air gap clearance between the rotor and the stator shall also be measured. A record shall be kept of these figures and they shall be submitted to the Engineer for approval.
- (b) A horizontal sleeve bearing or limited end-float roller bearing motor shall be run uncoupled from its load to ensure that it rotates at the axial position indicated on the shaft and that the rotor is free to move to either side of this position. Particular attention shall be paid to ensure that the free running position and the rotor end-float are in agreement with the axial movement of the flexible coupling.

E01.25.4 Drying Out

- (a) The Contractor shall dry out all motors larger than 100 kW and all smaller motors which have stood in the open during rain or have been flooded or whose cold insulation resistance is below 1.5 MΩ, before they are connected to the supply. If a motor is flooded, the motor bearings shall be replaced as a matter of urgency.
- (b) The method of drying the motor shall be by placing the motor in a heating oven.

Sufficient heat shall be applied to produce a temperature of 60°C but not greater than 80°C for a Class A or 90° C for Class B insulation systems. Insulation resistance measurements and temperature readings shall be taken regularly every half hour at the start of dry-out until the motor attains an even temperature and thereafter every hour.

The characteristic dry-out curve of insulation resistance versus temperature shall be plotted and dry-out may be considered complete four hours after the resistance readings have started to rise from the steady minimum value, providing that the winding temperatures have remained steady during this period.
- (c) The Contractor shall provide all equipment and the personnel required for the drying-out operation.
- (d) In the case of motor smaller than 100kW, the onus remains on the Contractor to satisfy himself that a motor is dry before it is connected to the supply.
- (e) Any motor, which fails as a result of being commissioned in a damp condition, shall be repaired at the cost of the Contractor.

E01.25.5 Double Shaft Extensions

The unused shaft extensions of a double-ended shaft motor shall be covered with an approved rust preventative after the motor is commissioned.

E01.26 **TESTING AND COMMISSIONING**

The contractor must supply a Manufacturers Test Certificate with each motor supplied.

The contractor must do a visual inspection as well as an insulation test on each motor before installation.

The contractor must do a direction test on each motor before handing the installation over. Where equipment can be damaged when rotated in an incorrect direction, the equipment must be disconnected from the motor before the direction check is done.

All test results must recorded and submitted to the Engineer for approval. The Engineer must be informed timeously off all tests to allow witnessing.

E01.27 **MEASUREMENT AND PAYMENT**

No separate payment will be made for electric motors for equipment unless otherwise specified in the detail specifications. All direct and indirect costs associated with such motors shall be deemed included in the rates tendered for the equipment.

Where separate payment is required for electric motors and specified as such in the detail

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specifications, the following payment items shall be applicable:

<u>Item</u>	<u>Unit</u>
Supply and delivery electric motors	No

The unit of measurement shall be the number of motors supplied.

The tendered rate shall include full compensation for the design, manufacture, corrosion protection, supply, handling, transport, testing and delivery of each complete motor as specified in the detail specification to ensure satisfactory operation after installation.

Separate items will be scheduled for different sizes/types of motors required.

<u>Item</u>	<u>Unit</u>
Installation, test and commission of electric motors	No

The unit of measurement shall be the number of motors installed.

The tendered rate shall include full compensation for the installation and coupling of the motor to the required load. The tendered rate shall include full compensation for all required installation material.

Separate items will be scheduled for different sizes/types of motors required.

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

PARTICULAR SPECIFICATION
E02 : ELECTRICAL CABLE RACKS

Johannesburg Water (SOC) Ltd.
PO Box 61542
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PARTICULAR SPECIFICATION: VOLUME E02: ELECTRICAL CABLE RACKS

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E02.1 SCOPE

This specification covers the supply, delivery and installation of cable ladders for industrial installations. Only cable ladders are to be supplied. Cable trays shall not be acceptable. Cable ladders are not recommended for large cables and open ground as they expose the cable to theft.

E02.1.1 Statutory Documents and Standards

Cable ladders shall be manufactured in accordance with the requirements of the latest editions of the following standards:

- (a) SANS 10044 : Welding
- (b) SANS 10064 : Preparation of steel surfaces for coating
- (c) SANS 1274 : Coatings applied by the powder process
- (d) SANS 10162-1 : The structural use of steel Part 1: Limit-states design of hot-rolled steelwork
- (e) SANS 10162-2 : The structural use of steel Part 2: Limit-states design of cold-formed steelwork
- (f) SANS 10162-4 : The structural use of steel Part 4: The design of cold-formed stainless steel structural members
- (g) SANS 10142-1 : The wiring of premises Part 1 – Low voltage Installations

E02.1.2 Particular Specifications to be read in conjunction with this specifications

This specification shall be read in conjunction with the following specifications:-

- (a) E06 : ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE INSTALLATION

E02.2 CABLE LADDER MATERIAL

All cable ladders shall, unless otherwise specified, be heavy-duty cable ladder standard pattern.

Cable ladders used inside Elutriation Terrace pump stations or in areas within 50m or less of Ferric Chloride, Hypochlorite or Chlorine shall be manufactured from corrosion resistant GRP (Glass Reinforced Polyester) in which vinyl ester resin is used. All GRP cable ladders shall consist of a 75 mm high side rail. The minimum thickness of the material that the cable rack is to be manufactured from, shall at least be 4mm. Cross rungs shall be spaced at maximum intervals of 300 mm (centre-to-centre). All screws, bolts and nuts shall be hexagonal to ISO Metric commercial standards. All bolts, nuts, spring washers, etc. shall be 316 grade stainless steel for all applications, except for Ferric Chloride areas, where 304 grade stainless steel must be used. Racks for instrumentation and control cabling shall contain pigmentation to produce an electric orange rack. A sample of the rack material must be approved by the engineer before manufacturing commences. Sections of rack, bends, t-pieces etc. shall be joined together with the correct dowels and resins as specified by the supplier. Wherever racking is drilled or cut, the exposed areas of GRP must be sealed with the same resin to ensure that the material does not fray. Channels or other sections used for securing of cable ladders should as far as possible be made from the same GRP material. Where this is not possible, 316 grade stainless steel support systems shall be used for all applications, except for Ferric Chloride areas, where 304 grade stainless steel must be used.

Cable ladders used inside de-watering buildings shall be metal cable ladders, manufactured from corrosion resistant, powder coated, 3CR12 grade stainless steel. All cable ladders shall consist of at least 75 mm high side rail. The minimum sheet thickness of the material that the cable rack

is to be manufactured from shall at least be 2mm. Cross rungs shall be spaced at maximum intervals of 300 mm (centre-to-centre). All screws, bolts and nuts shall be hexagonal to ISO Metric commercial standards. All bolts, nuts, spring washers, etc. shall be 316 grade stainless steel. Metal racks for instrumentation and control cabling shall be powder coated electric orange. If GRP ladder racking (as described in item 6.5.2 above) is cheaper than 3CR12 grade ladder racking, the GRP racking should be used inside de-watering buildings as well.

Cable ladders used for all applications other than those mentioned above shall be heavy-duty metal cable ladders, manufactured from 3CR12 grade, powder coated, stainless steel. All metal cable ladders shall consist of at least 75 mm high side rail. The minimum sheet thickness of the material that the cable rack is to be manufactured from shall at least be 3mm. Cross rungs shall be spaced at maximum intervals of 300 mm (centre-to-centre). All screws, bolts and nuts shall be hexagonal to ISO Metric commercial standards. All bolts, nuts, spring washers, etc. shall be 316 grade stainless steel. Racks for instrumentation and control cabling shall be powder coated electric orange.

E02.3 CABLE LADDER ACCESSORIES

E02.3.1 General

Cable ladder accessories shall be considered to be horizontal bends, vertical bends, internal bends, external bends, Tee-pieces, cross-pieces, reducers (transition pieces), support struts and fasteners. The accessories shall have dimensions that correspond to the dimensions of the linear sections to which they are connected. The radii of all bends shall be 1 m minimum.

The inside dimensions of horizontal angles or connections shall be large enough to ensure that the allowable bending radius of the cables are not exceeded. Sharp angles shall be 45° metered.

E02.4 INSTALLATION

Cable ladders shall be installed within accessible civil constructed cable ducts. These ducts may form part of the scope of works or may be existing.

Cable ladders are required to be installed within the cable ducts in the motor control centre rooms, on site electrical reticulation, and on access platforms to the mechanical equipment.

Cable ladders shall be installed within accessible cable ducts and shall be supported by a strut channel section securely fixed to the wall. The corrosion protection shall be of the same system as that of the cable ladder. Only vertical installation of cable ladder will be allowed in cable ducts. All cable must be installed on cable ladders and no loose cables will be accepted.

Cable ladders shall be supported with the struts, channels, brackets, clamps, cantilever arms and nuts/bolts/washers. Unless otherwise agreed, drilling into or welding onto metal columns, trusses and other metal building structures are not allowed and suitable clamps must be used to fix the cable ladders to the building structure.

The platform mounted cable ladder reticulation shall be installed at minimum of 150 mm from the supporting concrete structure.

Crevice corrosion of the metal elements in contact with concrete surface shall be eliminated by means of a suitable layer of non-shrink grouting.

Unless otherwise agreed, all screws, bolts and nuts shall be hexagonal to ISO Metric commercial standards. All bolts, nuts, spring washers, etc. shall be stainless steel 316.

All cable ladders shall be spliced with splice sets. The corrosion protection of splices shall be of the same system as that of the cable ladder.

All cable racks not installed in closed ducts or inside buildings will be installed with flat (vertical installation) or peaked covers (horizontal installation). The corrosion protection of covers shall be of the same system as that of the cable ladder.

All cable ducting must be covered with anti-theft covers. All exposed cable on cable ladders must

be covered with anti-theft covers.

All overhead cable ladders crossing a walkway must be at least 2000mm above floor level.

Structural designs must be done for any cable bridges. Support material must be corrosion protected to the same standard as the cable ladder. The design must be approved by the Engineer.

E02.5 EARTH BONDING OF CABLE RACKING

All cable rack joints must be equipotential bonded. Both the ends of cable racking must be bonded to an equipotential bonding bar. Where cable racks enter a lighting protected structure, the bonding conductor must be connected to the rack as close as possible to the point of entrance. All bonding conductors must be equal to 6 sq. mm copper PVC insulated wire.

The bonding conductor cable will be a composite stranded cable made up of tinned copper wires and galvanised steel wires that are braided-interwoven to form the cable. The complex braided and interwoven wires of steel and copper make it very difficult to separate and is unattractive and uneconomical to copper thieves and scrap dealers. The conductor must be insulated in clear PVC.

E02.6 CORROSION PROTECTION

All cable ladders and the cable ladder accessories shall be coated as specified below.

The preparation of the metal surfaces of the cable ladders and cable ladder accessories shall be in accordance with the latest edition of SANS 10064, prior to the application of protective coating.

Corrosion protection shall conform to the coating system stated below:

E02.6.1 Powder Coating Systems

All cable ladder shall be coated in the colour B26 – orange

E02.6.1.1 Paint System 1: Powder Coating, seven (7) stage zinc phosphate treatment, pure epoxy primer, polyester finishing coat, thickness 140 µm.

Paint System	Host Material	Preparation	Primer Coat	Finishing Coat	Dry film Thickness
			(70 µm)	(70 µm)	(µm)
No 1	304 L SS	7 stage zinc phosphate pre-treatment	Epoxy	Epoxy	140

E02.6.1.2 Upon the completion of the corrosion protection specified, the Contractor shall be required to perform the following quality control testing procedures:-

- Impact testing in accordance with SABS 6: Part J,
- Cross hatch adhesion test
- Bend test

E02.6.1.3 The corrosion protection shall form part of the quality control system as approved by the Engineer and the Tenderer shall submit a certificate of compliance upon the delivery of all cable rack supplied. The tenderer will supply a sample of all cable rack to Johannesburg Water for testing purposes.

E02.6.1.4 Epoxy Powder Coat Products

Item	Product type	Powder – Lak
1	Epoxy primer	23-007
2	Pure Epoxy / Polyester finishing coat	Series 3000

E02.7 INSPECTION

After installation, a visual inspection should be conducted with the Engineer. The contractor must compile a butt list with all items not to the satisfaction of the Engineer.

E02.8 MEASUREMENT AND PAYMENT

<u>Item</u>	<u>Unit</u>

Supply and deliver cable ladder	m

The unit of measurement shall be per linear length in meter of cable ladder supplied and delivered. Separate items shall be scheduled to include for each size of cable ladder required under the Contract.

The tendered rates shall include for the manufacture, supply, delivery, handling and inspection of the complete cable ladder.

<u>Item</u>	<u>Unit</u>

Install cable ladder	m

The unit of measurement shall be per linear meter of cable ladder installed. Separate items will be scheduled in the Schedule of Quantities differentiating each size of cable ladder installed under the Contract.

The tendered rates shall include for all labour, handling, the cutting at points of change in direction, jointing, etc, for the complete installation and inspection of the cable ladders installed under the Contract.

<u>Item</u>	<u>Unit</u>

Supply and deliver horizontal bends	No

The unit of measurement shall be the number of horizontal bends supplied and delivered. Separate items shall be scheduled to include for each size of horizontal bend required under the Contract.

The tendered rates shall include for the manufacture, supply, delivery, handling and inspection of the complete horizontal bends.

<u>Item</u>	<u>Unit</u>

Install horizontal bends	No

The unit of measurement shall be the number of horizontal bends installed. Separate items will be scheduled in the Schedule of Quantities differentiating each size horizontal bend installed under the Contract.

The tendered rates shall include for all labour, handling, the cutting at points of change in direction, jointing, etc, for the complete installation and inspection of the horizontal bends installed under the Contract.

<u>Item</u>	<u>Unit</u>

Supply and deliver vertical bends	No

The unit of measurement shall be the number of vertical bends supplied and delivered. Separate items shall be scheduled to include for each size of vertical bend required under the Contract.

The tendered rates shall include for the manufacture, supply, delivery, handling and inspection of the complete vertical bends.

<u>Item</u>	<u>Unit</u>

Install vertical bends	No

The unit of measurement shall be the number of vertical bends installed. Separate items will be scheduled in the Schedule of Quantities differentiating each size of vertical bend installed under the Contract.

The tendered rates shall include for all labour, handling, the cutting at points of change in direction, jointing, etc, for the complete installation and inspection of the vertical bends installed under the Contract.

<u>Item</u>	<u>Unit</u>

Supply and deliver internal bends.....	No

The unit of measurement shall be the number of internal bends supplied and delivered. Separate items shall be scheduled to include for each size of internal bend required under the Contract.

The tendered rates shall include for the manufacture, supply, delivery, handling and inspection of the complete internal bends.

<u>Item</u>	<u>Unit</u>

Install internal bends	No

The unit of measurement shall be the number of internal bends installed. Separate items will be scheduled in the Schedule of Quantities differentiating each size of internal bend installed under the Contract.

The tendered rates shall include for all labour, handling, the cutting at points of change in direction, jointing, etc, for the complete installation and inspection of the internal bends installed under the Contract.

<u>Item</u>	<u>Unit</u>

Supply and deliver external bends.....	No

The unit of measurement shall be the number of external bends supplied and delivered. Separate

items shall be scheduled to include for each size of external bend required under the Contract.

The tendered rates shall include for the manufacture, supply, delivery, handling and inspection of the complete external bends.

<u>Item</u>	<u>Unit</u>
Install external bends	No

The unit of measurement shall be the number of external bends installed. Separate items will be scheduled in the Schedule of Quantities differentiating each size of external bend installed under the Contract.

The tendered rates shall include for all labour, handling, the cutting at points of change in direction, jointing, etc, for the complete installation and inspection of the external bends installed under the Contract.

<u>Item</u>	<u>Unit</u>
Supply and deliver Tee-pieces	No

The unit of measurement shall be the number of Tee-pieces supplied and delivered. Separate items shall be scheduled to include for each size of Tee-piece required under the Contract.

The tendered rates shall include for the manufacture, supply, delivery, handling and inspection of the complete Tee-pieces.

<u>Item</u>	<u>Unit</u>
Install Tee-pieces	No

The unit of measurement shall be the number of Tee-pieces installed. Separate items will be scheduled in the Schedule of Quantities differentiating each size of Tee-pieces installed under the Contract.

The tendered rates shall include for all labour, handling, the cutting at points of change in direction, jointing, etc, for the complete installation and inspection of the Tee-pieces installed under the Contract.

<u>Item</u>	<u>Unit</u>
Supply and deliver cross-pieces	No

The unit of measurement shall be the number of cross-pieces supplied and delivered. Separate items shall be scheduled to include for each size of cross-piece required under the Contract.

The tendered rates shall include for the manufacture, supply, delivery, handling and inspection of the complete cross-pieces.

<u>Item</u>	<u>Unit</u>
Install deliver cross-pieces	No

The unit of measurement shall be the number of cross-pieces installed. Separate items will be scheduled in the Schedule of Quantities differentiating each size of cross-pieces installed under the Contract.

The tendered rates shall include for all labour, handling, the cutting at points of change in direction, jointing, etc, for the complete installation and inspection of the cross-pieces installed under the Contract.

<u>Item</u>	<u>Unit</u>
Supply and deliver reducers (transition-pieces)	No

The unit of measurement shall be the number of transition pieces supplied and delivered. Separate items shall be scheduled to include for each size of transition-piece required under the Contract.

The tendered rates shall include for the manufacture, supply, delivery, handling and inspection of the complete transition-pieces.

<u>Item</u>	<u>Unit</u>
Install reducers (transition-pieces)	No

The unit of measurement shall be the number of transition-pieces installed. Separate items will be scheduled in the Schedule of Quantities differentiating each size of transition-pieces installed under the Contract.

The tendered rates shall include for all labour, handling, the cutting at points of change in direction, jointing, etc, for the complete installation and inspection of the transition-pieces installed under the Contract.

<u>Item</u>	<u>Unit</u>
Supply and deliver cable ladder support struts material	m

The unit of measurement shall be per linear meter of material supplied and delivered. Separate items will be scheduled in the Schedule of Quantities differentiating each size of cable ladder support struts supplied and delivered under the Contract.

The tendered rates shall include for the manufacture, supply, delivery, handling and inspection of the cable ladder support struts material.

<u>Item</u>	<u>Unit</u>
Install cable ladder support struts	m

The unit of measurement shall be per linear meter of material supplied and installed. Separate items will be scheduled in the Schedule of Quantities differentiating each cable ladder support struts installed under the Contract.

The tendered rates shall include for all labour, handling, cutting, welding, painting, drilling and mounting, etc., for the complete installation and inspection of the cable ladders support struts installed under the Contract.

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER
PARTICULAR SPECIFICATION
E03 : ELECTRICAL ISOLATOR
PUSHBUTTON STATION
(LOCAL START/STOP) EQUIPMENT

Johannesburg Water (SOC) Ltd.
PO Box 61542
Marshalltown
2107

Revision 5

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**PARTICULAR SPECIFICATION: VOLUME E03: ELECTRICAL ISOLATOR PUSHBUTTON STATION
(LOCAL START/STOP) EQUIPMENT**

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E03.1 SCOPE

This section covers the requirements for local isolator/start/stop pushbutton stations. Local isolator/start/stop pushbutton stations shall be supplied, delivered, installed and commissioned for each mechanical equipment driven by a motor.

E03.2 STANDARDS

The latest edition, including all amendments up to date of tender of the following particular national specifications, publications and codes of practice shall be read in conjunction with this specification and shall be deemed to form part thereof:

- (a) SANS 62262 : Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)
- (b) SANS 60529 : Degrees of protection provided by enclosures (IP code)
- (c) SANS 10142-1 : The wiring of premises Part 1 Low-voltage installations
- (d) SANS 60439-1 : Low-voltage Switchgear and Control gear Assemblies Part 1 Type-tested and partially type-tested assemblies
- (e) SANS 60439-2 : Low-voltage Switchgear and Control gear Assemblies Part 2 Particular requirements for busbar trunking systems (busways)
- (f) SANS 60439-3 : Low-voltage Switchgear and Control gear Assemblies Part 3 Particular requirements for low-voltage switchgear and control gear assemblies intended to be installed in places where unskilled persons have access for their use - Distribution boards
- (g) SANS 60947-1 : Low-voltage Switchgear and Control gear Part 1 General rules
- (h) SANS 60947-2 : Low-voltage Switchgear and Control gear Part 2 Circuit breakers
- (i) SANS 60947-3 : Low-voltage Switchgear and Control gear Part 3 Switches, disconnectors, switch-disconnectors and fuse-combination units
- (j) BSI-BS 3858 : Specification for Binding and identification sleeves for use on electric cables and wires
- (k) SANS 1091 : National colour standard

E03.3 GENERAL REQUIREMENTS

E03.3.1 Particular specifications to be read in conjunction with this specification

This specification shall be read in conjunction with the following specifications:-

E26: ELECTRICAL SPECIFICATION FOR COLOUR CODES

G02: PARTICULAR SPECIFICATION FOR CORROSION PROTECTION

E08: WIRING

E03.3.2 General Requirements

- (a) The enclosure will be manufactured from 3CR12 stainless steel.
- (b) The enclosure will be rated IP65 to SANS 60529 and shall be fitted with a canopy.
- (c) The enclosure shall be painted electric orange (B26).
- (d) The Isolator Pushbutton Station will be equipped with

- A green flush START pushbutton with spring return. In case of a bidirectional drive a START FORWARD and START REVERSE pushbutton will be installed;
- A red flush STOP pushbutton with spring return;
- A red mushroom head EMERGENCY STOP button with mechanical latching, turn to release. The emergency stop pushbutton will be lockable (key reset) and not a padlockable unit. This will not be a lockout point, but will be used for Process use only.
- A three-pole non-fusible disconnect switch complete with a shaft extension and a door interlocked red and yellow padlockable rotary handle mounted on the door. The current rating of the disconnect switch must match the motor rating as specified in the motor equipment schedule (rated for on-load conditions).
- All equipment must be installed in one box (power and control).

- (e) The Isolator Pushbutton Station will be clearly labelled with an identity label, engraved with 30mm high black on white characters, and shall be mounted on top of the enclosure. The name of the associated drive will be shown.
- (e) All pushbuttons shall be labelled with an identity label, engraved with 10mm high black on white characters and shall be mounted above the pushbutton.
- (f) The Isolator Pushbutton Station shall be mounted within a radius of 1000mm maximum from the associated drive. If this is not possible, the Engineer will indicate the position of the Pushbutton Station.
- (g) The station shall be pedestal mounted at least 1100mm above floor level. The pedestal design shall be approved by the Engineer.
- (h) The pedestal base plate shall be installed on 10mm of epoxy grout to prevent crack corrosion.
- (i) The pedestal material shall be Stainless steel (3CR12) and have minimum thickness of 6mm. The pedestal shall be painted electric orange (B26).
- (j) The station enclosure shall be designed to provide adequate space for the following:
 - The required pushbuttons, the disconnect switch and the respective labels.
 - A single multi-core control cable (including glanding) shall be installed from the MCC to the station, from where the required signals shall be individually wired, as per the cable schedule.
 - Power cable/s (including glanding) shall be installed from the MCC to the station, providing power to the associated motor, as per the cable schedule.

E03.4 DIMENSION FOR ISOLATOR STATION

The dimensions of the start/stop isolator pushbutton stations shall allow ample space to accommodate all the equipment, taking into account the bending radius of all cables and minimum clearances. The contractor must supply design drawings of the Isolator Pushbutton Station to Johannesburg Water or their representative for approval prior to manufacturing.

E03.5 FASTENERS

All fasteners in concrete shall be 316 stainless steel. Pedestal bases shall be sealed against the ingress of any crevice corrosion by means of a suitable non-shrink cementitious grout and approved by the Engineer.

E03.6 MEASUREMENT AND PAYMENT

<u>Item</u>	<u>Unit</u>
Supply and delivery of local start/stop isolator pushbutton stations	No

The unit of measure shall be the number of stations supplied and delivered.

The tendered rate shall include all costs related to the manufacture, supply and delivery of the local start/stop isolator pushbutton or control stations (as detailed in the schedule of quantities), including support pedestal in accordance with this specification and the additional requirements detailed in the detail specification complete with all mounting brackets.

Separate items will be scheduled in the schedule of quantities for different types and sizes, defined by the kW rating of the driven equipment, of pushbutton / control stations.

Item

Unit

Install local start/stop isolator pushbutton stations No

The unit of measure shall be the number of stations installed.

The tendered rate shall include full compensation for installing, testing and commissioning of the local start/stop isolator or control stations as specified. The rate shall further include for pedestal support securing and sealing preventing crevice corrosion.

Separate items will be scheduled in the schedule of quantities for different types of pushbutton / control stations.

Separate items will be scheduled in the schedule of quantities for different types and sizes, defined by the kW rating of the driven equipment, of pushbutton / control stations.

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER
PARTICULAR SPECIFICATION
E04 : ELECTRICAL LOW VOLTAGE
DISTRIBUTION BOARDS AND MOTOR
CONTROL CENTRES

Johannesburg Water (SOC) Ltd.
PO Box 61542
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2	2010-05-30		Review Electrical Standards
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**PARTICULAR SPECIFICATION: VOLUME E04: ELECTRICAL LOW VOLTAGE DISTRIBUTION BOARDS
AND MOTOR CONTROL CENTRES**

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E04.1 INTRODUCTION

This specification is for the supply of low voltage (400V) distribution switchboards.

E04.2 SCOPE

E04.2.1 General

The scope of work includes the furnishing of all labour, material and services for the design, supply, manufacture, testing and inspection at works, delivery to site, off-loading and rectification of defects developing during the warranty period for equipment as specified below.

E04.2.2 Work to be Included

The work includes, but shall not be limited to the items listed below.-

- (a) All work in E04.2.1 above.
- (b) Documentation, as called for in the vendor QA and document requirement list and drawings and data.
- (c) The supply of one complete set of any special tools required per switchboard that will be required for operation or maintenance purposes, including three spare sets of each type of fuse.
- (d) Recommended spares for one year's operating period and the prices of it.
- (e) Technical assistance if requested during checking for operational readiness.

E04.3 STANDARDS

In general, work and materials shall be in accordance with the latest practice and in particular in accordance with the latest revision of the following specifications, and any amendments thereto, the SANS specification taking precedence:

- (a) SANS 10142-1 : The wiring of premises Part 1: Low-voltage installations
- (b) SANS 60439-1 : Low-voltage switchgear and controlgear assemblies Part 1: Type-tested and partially type-tested assemblies
- (c) SANS 60439-2 : Low-voltage switchgear and controlgear assemblies Part 2: Particular requirements for busbar trunking systems (busways)
- (d) SANS 60439-3 : Low-voltage switchgear and controlgear assemblies Part 3: Particular requirements for low-voltage switchgear and controlgear assemblies intended to be installed in places where unskilled persons have access for their use - Distribution boards
- (e) SANS 1973-1 : Low-voltage switchgear and controlgear Assemblies Part 1: Type-tested ASSEMBLIES with stated deviations and a rated short-circuit withstand strength above 10 kA
- (f) SANS 60947-1 : Low-voltage Switchgear and Control gear Part 1: General rules
- (g) SANS 60947-2 : Low-voltage Switchgear and Control gear Part 2: Circuit-breakers
- (h) SANS 60947-3 : Low-voltage Switchgear and Control gear Part 3 Switches, disconnectors, switch-disconnectors and fuse-combination units
- (i) SANS 60947-4.1 : Low-voltage Switchgear and Control gear Part 4-1: Contactors and motor-starters - Electromechanical contactors and motor-starters
- (j) SANS 60947-4.2 : Low-voltage Switchgear and Control gear Part 4-2: Contactors and motor-starters - AC semiconductor motor controllers and starters
- (k) SANS 60947-4-3 : Low-voltage Switchgear and Control gear Part 4-3: Contactors and motor-starters - AC semiconductor controllers and contactors

for non-motor loads

- (l) SANS 60947-5-1 : Low-voltage Switchgear and Control gear Part 5-1: Control circuit devices and switching elements - Electromechanical control circuit devices
- (m) SANS 62262 : Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)
- (n) SANS 60529 : Degrees of protection provided by enclosures (IP code)
- (o) IEC 60228 : Conductors of insulated cables
- (p) BSS 3858 : Binding and identification sleeves for use on electric cables and wires
- (q) SANS 1507-1 : Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) Part 1: General
- (r) SANS 1507-2 : Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) Part 2: Wiring cables
- (s) SANS 1574-1 : Electric Cables – Flexible Cords and Flexible Cables Part 1: General
- (t) SANS 1574-3 : Electric Cables – Flexible Cords and Flexible Cables Part 3: PVC-insulated cables for industrial use
- (u) SANS 1619 : Small power distribution units (ready-boards) for single-phase 230 V service connections
- (v) SANS 61643-11 : Low-voltage surge protective devices Part 11: Surge protective devices connected to low-voltage power systems - Requirements and test methods
- (w) SANS 61643-12 : Low-voltage surge protective devices Part 12: Surge protective devices connected to low-voltage power distribution systems - Selection and application principles
- (x) SANS 61238-1 : Compression and mechanical connectors for power cables for rated voltages up to 30 kV ($U_m = 36$ kV) Part 1: Test methods and requirements
- (y) SANS 60730-2-7 : Automatic electrical controls for household and similar use Part 2-7: Particular requirements for timers and time switches
- (z) SANS 62053-61 : Electricity metering equipment (a.c.) - Particular requirements Part 61: Power consumption and voltage requirements
- (aa) BSS 1322 : Aminoplastic Moulding Materials
- (bb) SANS 60076-1 : Power transformers, Part 1: General
- (cc) SANS 1091 : National colour standard
- (dd) SANS 61869-1 : Instrument transformers Part 1: General requirements
- (ee) SANS 61869-2 : Instrument transformers Part 2: Additional requirements for current transformers
- (ff) SANS 61869-3 : Instrument transformers Part 3: Additional requirements for inductive voltage transformers
- (gg) IEC 60051/BS 89 : Direct acting indicating analogue electrical measuring instruments and their accessories. Specification for special requirements for ammeters and voltmeters
- (hh) BS EN 60255 : Measuring relays and protection equipment. Common requirements
- (ii) SANS 156 : Moulded-case circuit-breakers
- (jj) SANS 1195 : Busbars
- (kk) BS159 : High-voltage busbars and busbar connections

E04.3.1 Particular specifications to read in conjunction with this specification

This specification shall be read in conjunction with the following specifications:-

E26: ELECTRICAL COLOUR CODING OF EQUIPMENT

G02: PARTICULAR SPECIFICATION FOR CORROSION PROTECTION

E06: ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE INSTALLATION

E08: WIRING

E04.3.2 Mandatory Requirements

All equipment and services shall comply with the mandatory requirements of:

- (a) Occupational Health and Safety Act 85 of 1993 (as amended).

E04.4 **SYSTEM DETAIL**

Busbar voltage 400V $\pm$ 10% as per system voltage on the site

Frequency 50 Hz

Phase rotation R-Y-B-R

Phases 3Ph+N, with Protective Earth (PE)

Earthing system TN-S

E04.5 **GENERAL REQUIREMENTS**

This section will be applicable to the following equipment:

- (a) Motor Control Centres (MCC).
- (b) Main Distribution Boards (MDB).
- (c) Auxiliary Distribution Boards (ADB).

The following is described in separate sections:

- (a) Flush Mounted Distribution Boards.
- (b) Surface Mounted Distribution Boards
- (c) LV Kiosks (Switch Cubicles)

E04.5.1 Manufacturing and Construction Details

E04.5.1.1 General

- (a) Electrical panels will be floor standing unless specified differently.
- (b) All floor-standing switchboards will be positioned above a cable trench with bottom entry cables.
- (c) Electrical switchboards positioned inside Electrical Distribution/MCC rooms shall be manufactured with 2mm thick mild steel.
- (d) Electrical switchboards positioned outside Electrical Distribution/MCC rooms shall be manufactured from 2mm thick stainless steel (3CR12) as a minimum. Heaters will be installed in the switchboards to prevent condensation.
- (e) In special applications, the Electrical switchboards will be manufactured to the Engineers specification.

City of Johannesburg
Johannesburg Water (SOC) Ltd

- (f) All switchboards shall be of ample size to accommodate all the specified switchgear and provide space for future switchgear. For every 4 (or part of 4) circuit breakers of a kind on a switchboard, space for an additional circuit breaker of similar size shall be allowed unless future space requirements are clearly specified.
- (g) All specified external dimensions for switchboards shall be strictly adhered to.
- (h) The Contractor or Manufacturer shall obtain the opinion of the Engineer before manufacturing any switchboard.
- (i) The Contractor shall ascertain the exact position of switchboards and shall arrange timeously for the installation of cable sleeves, openings in the structure, flush draw trays behind switchboards and supports over cable trenches.
- (j) In general, flush and surface mounted switchboards shall be mounted 2000mm above finished floor level - measured to the top of the switchboard. The upper ends of switchboards may not be higher than 2100mm above finished floor level.
- (k) Unless otherwise agreed or stated in this Specification, all screws, bolts and nuts shall be hexagonal to ISO metric commercial standards and shall be rustproof. Loose 'bolts and nuts' shall not be used on steelwork. Blind threaded fastening system bushings or equivalent shall be used for thread sizes M5 and above. Studs projecting from the exterior surfaces of the board shall have chrome or cadmium plated dome nuts. Self-tapping screws shall not be utilised for any purpose on any equipment.
- (l) The short-circuit current levels as indicated on drawings shall be deemed the maximum fault current occurring at the panel under symmetrical short circuit conditions on the line side of the final limiting device in a circuit. The duration of the maximum short circuit currents shall be deemed a minimum of one second. Evidence (in the form of certificates from testing authorities recognised by Johannesburg Water) of the ability of the 400V switchboards offered to withstand satisfactorily the prospective fault conditions shall be furnished with the tender.
- (m) Switchboards shall be designed to confine internal arcing faults and to direct arcs and gases arising from these away from the operator.
- (n) The general structure of the panel shall be designed and fabricated to ensure that no excessive vibration caused by the operation of any component is transmitted to any other components, thereby causing spurious tripping of any device.
- (o) Measures shall be taken to prevent electrolytic corrosion where dissimilar metals are in contact with each other.
- (p) Bolts shall be of the correct size for the holes provided and shall be fitted with matching sizes of washers and lock washers. Where removable covers are provided with bolt fastening, the nuts shall be either welded in position or securely fixed by means of a mechanical fixing device. Self-tapping screws, captive head nuts or cage nuts are not acceptable.

E04.5.1.2 Panel Subdivision

- (a) The Electrical panel will be constructed as one or more fully interchangeable modular, rigid, free standing columns, bolted together to form an extensible, composite, vermin proof unit of uniform appearance.
- (b) Panels shall be designed to permit the addition of identical columns.
- (c) Columns widths will be 600, 700, 800, 900 or 1000 mm for design flexibility. Columns will be 600 or 800mm deep. Increase in depth of certain sections of panels for high current ratings shall be subject to the Engineer's approval.
- (d) The overall height of the column may not be more than 2300mm.
- (e) Each column shall be divided horizontally into buckets.
- (f) Panels will be split into transportable section with lengths not exceeding 3000mm for ease of transportation.
- (g) A channel iron frame (minimum 100mm x 50mm) shall be provided under each panel

section of transportable length, which shall be so constructed that it can be used for lifting the transportable section without distortion taking place.

- (h) All panel section of transportable length shall be fitted with lifting lugs and shall have sufficient strength to withstand all stresses occurring during transportation, installation and operation without distortion or damage.

E04.5.1.3 Internal Form of Separation

- (a) The minimum internal Forms of Separation for any Electrical switchboards shall be Form 3b, as described below:
 - i. Separation of busbars from all functional units;
 - ii. Separation of all functional units from one another;
 - iii. Separation of terminals for external conductors from the functional units, but not from those of other functional units;
 - iv. The power cable connections are disposed in the same compartment;
 - v. Maintenance services require extra care, as placed in the same compartment the connections of other units might be powered;

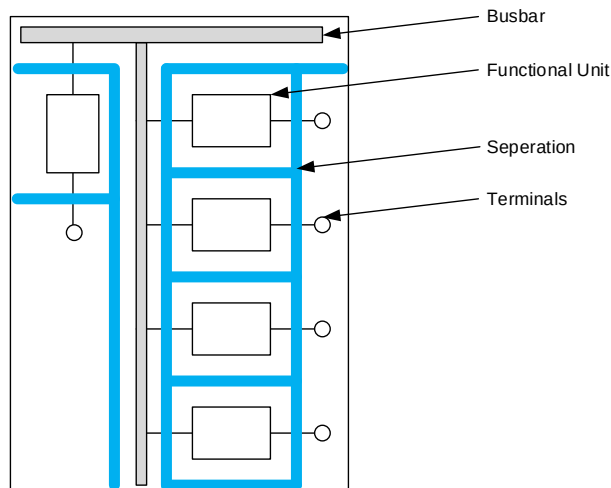


Figure 1: Form 3B

E04.5.1.4 Buckets

- (a) Buckets will be equipped and wired as per the drawings issued by the Engineer.
- (b) The buckets will be sized to accommodate all components with ease.
- (c) Buckets will be fixed pattern with components permanently mounted to the chassis plate of the bucket.
- (d) All bucket design and construction shall be based on natural cooling by convection or radiation. Attention shall be given to ventilation to prevent the accumulation of heat in buckets where power electronic drives (soft starters and VSD's) or other heat generating equipment (i.e. control transformers) are contained. Extraction ventilation fans should be installed in these cases to remove heat from the cubicle. The filtered extraction fan should be placed as high as possible in the compartment door with a filtered air inlet opening as low as possible in the compartment door. The fan and opening must be sized to ensure all generated heat is extracted from the bucket. Natural convection cooling will not be accepted.
- (e) Spare buckets shall be equipped generally as detailed on the drawings issued by the

Engineer, and shall include all circuit breakers, busbars, wiring, instruments, etc., with the exception that, in the case of withdrawable circuit breakers, only the breaker cradle shall be furnished.

E04.5.1.5 Doors

- (a) Buckets shall have doors suitably constructed to ensure rigidity and shall be a neat fit in the framework and around the circuit breaker escutcheon plate.
- (b) Doors shall be fitted with robust steel or brass hinges with at least two 6mm square recessed quick close/open latches. Hinges shall be provided at 500mm intervals per door with a minimum of two hinges per door. Each door shall be fitted with an equal number of hinges and latches. At least one of these latches shall be lockable with a padlock.
- (c) Doors and covers shall be provided with a high-density neoprene gasket to form a firm seal. The neoprene seal shall be a nominal 5mm thick compressed to 3mm on closing of the door. The entire switchboard shall be effectively dust and splash proof to IP 54.
- (d) All hinged doors shall be fitted with a robust mechanism to latch and hold the door in the wide-open position, to minimise inadvertent contact with live parts during maintenance operations.
- (e) All hinged doors shall open to a minimum of 135° from the closed position, to facilitate easy access for maintenance.
- (f) Doors should be the same width as the MCC column. A single door shall not exceed the width of 800mm. Where the column width exceeds 800mm, two doors must be installed.
- (g) The Bucket door shall be interlocked with the circuit breakers to prevent opening of the door when the circuit breaker is in the "ON" position. A non-apparent door interlock defeat shall be provided for the opening of the door with the circuit breaker in the "ON" position for testing and maintenance. In addition, there shall be provision for attaching a padlock to the operating handle in the "OFF" position that prevent the circuit breaker from being operated. Should more than one padlock be fitted, a safety lockout hasp must be used.
- (h) All access doors are to be effectively and permanently earthed to the main panel enclosure, by means of a suitable braided copper earth strap, not less than 6mm², crimped with properly sized lugs and bolted at each end to the door and enclosure.
- (i) All equipment mounted on bucket door will be flush mounted.

E04.5.1.6 Busbar Compartments

- (a) The Busbar compartment shall contain the three phases and the neutral busbars, duly marked L1, L2, L3 and N or identifiable by colour coding Red, White, Blue and Black.
- (b) The protective earth busbar shall be located in a separate compartment, and shall be duly marked PE.
- (c) Provision shall be made for expansion or contraction of the busbars and the housing due to loadings, temperature changes and short circuit conditions. The busbars shall allow for expansion on both the left and right-hand side.
- (d) The busbar compartment shall have bolted covers on the front of the panel for access to the busbars, insulators and joints. Removable covers shall be provided with captive screws.
- (e) All busbars and droppers shall be securely supported by heavy, high di-electric, non-hygroscopic material with bracing to withstand stresses due to short circuits of one second duration and at least equal to the interrupting rating of the circuit breaker protecting the busbars.
- (f) Busbar standoff insulators and support will be injection moulded (Polyamide 66 fibreglass reinforced (30%) (Halogen free)). Threaded inserts will be galvanized steel.
- (g) The Busbar shall be supported by insulators made of flameproof and leakage-proof

material. Busbars, insulators and supports shall be braced to withstand the mechanical and thermal effects of fault currents.

- (h) Busbar insulators shall be mounted in such a way that they can be easily removed and replaced.
- (i) In addition to any support/bracing required by the electrical conditions, the busbars shall also have sufficient support to prevent stresses being transmitted to the circuit breakers or any components by cable terminations. Particular attention must be paid to the termination arrangements of any multiple incoming three-core cables to ensure adequate glanding space.
- (j) The following minimum air clearances shall be observed for busbars and other current carrying or live parts:
 - i. Phase – Earth : 30mm
 - ii. Phase – Phase : 45mm

Where these clearances cannot be attained, suitable insulating barriers shall be employed. In addition, all busbar work (including connections to, from and between equipment) shall have applied solid insulation suitable for the rated voltages. GPO-3 (Glass Polymer laminate) insulation shall be used wherever possible. GPO-3 is constructed with fiberglass-reinforced thermoset polyesters. It must feature a combination of beneficial electrical and mechanical properties. These attributes include Dielectric strength, flame resistance, arc and track resistance, high-flex strength and high-impact strength. They maintain stability, will not melt under heat and have excellent overall electrical properties.

- (k) The busbar compartment shall be constructed to ensure that fire or other faults cannot spread between the various sections. All insulation used on electrical conductors/connections and wiring shall be flame retardant types, constructed of low toxicity materials.
- (l) The busbar compartment must have suitable sealing arrangement at each end as well as between the busbar compartment and buckets.

E04.5.1.7 Cable termination points

- (a) Suitable termination points shall be provided to enable any multiple three-core cables to be terminated without cross-overs of different phases and with minimum lengths of cable "tails".
- (b) All cable termination points and associated connections shall be suitably braced to withstand the available fault currents without damage. If necessary cable support clamps shall be provided for the individual cable tails after the cable gland.

E04.5.1.8 Cable Gland Plates

- (a) Sectionalised removable gland plates shall be fitted and shall be fixed by means of captive nuts or screws and so located that ample space is available for the satisfactory entry and termination of cables
- (b) Cable entry shall be at the bottom of the board.
- (c) All gland plates are to be connected to the main panel earth bar via suitably sized copper conductors and unused sections shall be left blank.
- (d) Gland plates for three-core cable of cross-sectional area 70mm² and above shall be minimum 5mm thickness.
- (e) Mild steel gland plates shall be galvanised.
- (f) Where single core cables are used, gland plates are to be of non-magnetic material or slit to mitigate effect of eddy currents.
- (g) The cable gland compartments shall have removable covers attached with standard 6mm

square recessed quick close/open latches.

E04.5.1.9 Labelling and markings

- (a) The panel shall be provided with an identity label, engraved with 30mm high black on white characters and shall be mounted on top of the switchgear.
- (b) Each buckets shall be labelled on the left top door corner with the reference letter(s) of that compartment, using durable designation label with 30mm high black letters on a white background. The labels shall have two designation letters, the first referring the column, numbered from A, left to right and the second referring to the bucket, numbered from 1 top to bottom.
- (c) All buckets shall be clearly labelled with suitable inscriptions indicating their function. All labels shall have black characters at least 6mm high on white background.
- (d) Incomers shall be labelled "Incomer from" as indicated on the drawings issued by the Engineer, using engraved black characters at least 6mm high on white background.
- (e) Standby bus coupler (where applicable) shall be labelled "Standby Bus Coupler", using engraved black characters at least 6mm high on white background.
- (f) All removable covers protecting live equipment shall be fitted with warning labels as well as ID tags to ensure the covers are replaced in the original position after removal. Warning labels shall be engraved white characters 6mm high on a red background.
- (g) All electrical components/equipment shall be labelled (with designations corresponding to those of the Engineer's schematic diagrams) to facilitate recognition.
- (h) The labels for equipment mounted on doors shall be identified with white trifoliate labels having black lettering engraved on them, with a maximum height of 3mm letters.
- (i) The equipment labels shall be secured by means of high quality double-sided tape.
- (j) The labels for all equipment, installed behind panels, shall be fixed to the chassis close to the equipment.
- (k) If this equipment is positioned too close to each other to accommodate descriptive engraved labels, the equipment may be identified by a code or number label, which shall be fixed close to the equipment. The code or number shall be identified on a legend board, which shall be installed on the switchboard behind a protective cover.
- (l) The types of labels for equipment behind the doors or covers shall be subject to the Engineer's approval.
- (m) Danger labels shall be white lettering 6mm high engraved on a red background.
- (n) All labels and label brackets shall be affixed by machine screws. Adhesive labels are not acceptable.
- (o) Over and above labelling requirements of this specification, the labelling requirements of SANS 10142-1 must be met.

E04.5.1.10 Insulation Materials

- (a) Any insulation, filling putty, etc., used shall be selected such that it can withstand without harmful effect (mechanically or electrically), all temperatures encountered within the MCC.

E04.5.2 Electrical Details

E04.5.2.1 Busbars and Connections

- (a) Busbars and connections shall generally comply with SANS 1195 for air clearances. Notwithstanding the contents of the above-mentioned specifications, all solid copper work shall be made of hard drawn high conductivity copper of constant cross-section throughout

their lengths with a maximum design current density of 1,66A/mm².

- (b) The Phase and Neutral busbars shall be manufactured with flat copper bars with a standard rectangular conductor profile, of the same cross-section over the whole width of the panel.
- (c) Busbar droppers shall be manufactured with flat copper bars with a standard rectangular conductor profile, of the same cross-section over the whole length of the dropper. The use of flexible conductors as droppers from the main busbars to circuit breakers shall not be permitted.
- (d) All busbar joints shall be silver plated or tinplated. High pressure bolted lap joints shall be used and all bolts shall be of the high tensile type.
- (e) All fixed busbar joints (separation links) between adjacent sections shall be maintenance-free.

E04.5.2.2 Earth Bar

- (a) A protective earth bar shall extend the whole length of each Electrical panel and shall be duly marked PE. The earth bar shall at least, be bolted to the switchgear housing at each column.
- (b) Stranded clear insulated aluminium earth wire (equal to 70mm² copper wire) with crimp type terminals shall be provided at both ends of the protective earth bar for connection to the substation earth bar/earthing system.

E04.5.2.3 Control Wiring

- (a) Each Electrical panel shall be equipped and completely wired at the factory and, only after satisfactory testing, be split, if necessary, for transportation.
- (b) Control and instrumentation wiring shall be silicone insulated throughout and of flexible, stranded, annealed, untinned copper construction. All wiring shall comply with the table below. Conductors shall comply with SANS 1411, Part 1, Table 4, Class 5.

CT Wiring	- 2.5mm ² phase coloured, common return black insulated, earth green/yellow
General Control Wiring	- (AC) 1.0mm ² grey
	- (DC) 2.5mm ² (positive – red, negative – black)
Control Neutral	- (AC) 1.0mm ² (same size as phase wiring) – black
LED's and PLC Inputs	- (AC) 0.75mm ² grey
	- (DC) 0.75mm ² (positive – red, negative – black)

- (c) Notwithstanding the above-mentioned requirements, the vendor shall ensure wire size used is amply rated for the applicable current, under ambient conditions.
- (d) All control/instrument panel wiring shall terminate by means of suitably sized compression crimp lugs on screw-type terminals. Terminals of the pressure pad type are not accepted. The minimum voltage rating of the control wiring shall be 600/1000V grade to SANS 1507 and SANS 1411 Parts 1 and 3.
- (e) Wiring shall be run in plastic trunking. Only where a space problem exists will loomed wiring be acceptable.

Note: Stick-on harness holders are not acceptable.

- (f) Conductors passing through holes in compartments shall be protected by means of neoprene grommets. Bevelling of sheet steel will not be accepted as a substitute.
- (g) Conductors shall be general-purpose 600/1000V grade PVC-insulated copper wire to SANS 1507 and SANS 1574. Aluminium conductors are not acceptable.
- (h) Single or solid conductor wire shall not be used.
- (i) Joints or splices in any wiring are not acceptable.
- (j) Panel and equipment terminals, labels, etc., shall be accessible after the wiring has been completed.
- (k) Connections to equipment on swing doors shall be arranged to give a twisting motion and not a bending motion to the conductor.
- (l) Single pole and double pole moulded-case circuit breakers shall be wired in a way that the supply to the switchboard is equally balanced.
- (m) Stripping of insulation shall not result in damage to the conductors. The stripping tools used shall be of the type, which permits the length of strip to be pre-set. Control wiring shall be terminated with pre-insulated, crimped or compression type lugs. Crimping tools shall be of the type, which will not release the termination during normal operation until the conductor crimp has been correctly formed. Any damaged wiring will be rejected.
- (n) Lugs shall be of the hooked blade type when used in conjunction with screw clamp spring loaded insertion type terminals, ring tongue type when used with stud or direct screw mounted connections and wire pin when used with pinch screw type connections such as indicating lamp fittings.
- (o) Not more than two conductors shall be connected to any side of a terminal.
- (p) Each terminal strip shall be provided with not less than 10% spare terminals, with a minimum of two, unless otherwise approved.

E04.5.2.4 Power Wiring and Cable Terminations

- (a) Power wiring on the "live" side of the circuit breakers (from the busbar dropper to the circuit breaker terminals) shall be as short as possible, sized to carry the maximum current continuously of the frame size of the respective circuit breaker and shall be a flexible copper conductor. The flexible connection shall be provided on all such connections and shall be designed to prevent the transmission of any forces that may arise between the busbar droppers and the circuit breaker. In terms of SANS 60439, this connection is deemed a fault free zone and the design and use of the flexibles shall in no manner compromise this zone.
- (b) Power wiring on the "load" side of the circuit breaker terminals to cable termination terminal shall be as short as possible, sized to carry the maximum current continuously of the frame size of the respective breaker and shall be a flexible conductor. The flexible connection shall be provided on all such connections and shall be designed to prevent the transmission of any forces that may arise between the circuit breaker and the cable termination terminal. In terms of SANS 60439, this connection is deemed a fault free zone and the design and use of the flexibles shall in no manner compromise this zone.
- (c) Terminals that are on the live side of fuses and isolating switches shall be completely shrouded to prevent accidental contact.
- (d) Power circuit wiring and connections in a switchboard shall be rated to the full frame size rating of the associated equipment, i.e. fused switch, contactor, circuit breaker, etc., and not to the circuit or fuse rating.
- (e) Power wires shall bear the colour along their entire length of the phase to which they are connected.
- (f) Neutral connections shall have the same rating as the phase connections unless otherwise

approved.

- (g) Power wiring terminations shall use an appropriate crimped accessory (the pressed tubular type of accessories). Stamped, folded, split-barrel type accessories are not acceptable.
- (h) Terminations for power wiring and cabling shall be provided with pressure type clamping connections or bolted connections capable of accepting crimped or compression type lugs on conductors.
- (i) In addition, hexagonal die type hydraulic crimping shall be used for all wiring greater than 16mm² in size.
- (j) Cables shall be made off directly onto circuit breakers, switches, contractors, thermal-overloads, etc. Terminals or solid copper terminating conductors shall be provided where necessary. Provision shall be made for bracing and fixing of the cable leads to prevent vibration.
- (k) A predrilled solid copper bar shall be provided for terminating all external power cables above 70mm, or where three or more cables in parallel are specified. The arrangement shall be suitable for accepting cable lugs of conductors up to 630mm².

E04.5.2.5 Wire Numbering

- (a) Each end of every wire shall be marked with a wire number by means of plastic cable ferrules (black lettering on a white or yellow base).
- (b) All wires shall be identified on both ends with a wire marker. The wire marker shall consist of a transparent flexible tube that slides over the wire with a wire identification label (black letters on a rigid white PVC tag) which slides into a label pocket on the tube. The tube must be correctly sized for the wire diameter.
- (c) Split or open type marking ferrules shall not be used.
- (d) Cable/wire marking ferrules shall correlate to the appropriate schematic or wiring diagrams.
- (e) For all control wires without lug terminations, the numbered ferrule must not fall off when disconnecting the wire and in this regard, the use of one strand of wire to retain the ferrule is acceptable.
- (f) All cables shall be identified on both ends with a cable marker. The cable marker shall consist of printed stainless steel band fixed to the cable with stainless steel strapping.

E04.5.2.6 Terminals and Connections

- (a) All terminals will be of the screw-type. Terminals of the pressure pad type are not accepted. Minimum rating for terminal blocks shall be 40A. Terminal strips/blocks shall be marked with designations corresponding with the suppliers/buyers drawings. Generally, terminal numbers shall be the same as the relevant wire number. No more than two wires may be connected to any one side of a terminal. Ten percent (10%) additional spare terminals shall be furnished.
- (b) Terminals are to be provided for all door-mounted components, diodes, etc.
- (c) Power connections on any equipment shall not use "Philips/Star" type screw/socket heads. Hexagon socket head cap screws (Allen type socket heads) are preferred.
- (d) Where a large number of control terminals are mounted in close proximity, the terminals shall be in vertical rows with a minimum of 125mm below rows. Spare terminals shall be mounted at the bottom of the row unless the cabling drawing shows otherwise.
- (e) Terminals shall be provided for all cores of external control cable as indicated on the drawings whether internally connected or not.

E04.5.2.7 Air Circuit Breakers (ACBs)

- (a) ACBs shall be of the withdrawable type with self-aligning disconnecting devices with the disconnecting fingers preferably mounted on the breaker for ease of maintenance. The draw out mechanism shall hold the circuit breaker rigidly in the fully connected, test and fully disconnected positions.
- (b) Safety shutters shall be provided to shield the fixed part automatically when the draw out parts removed preventing access to the conductors (main and auxiliary circuits). These shutters shall be clearly labelled indicating busbar and cable sections and in addition "live" section shall be labelled "400V – LIVE". ACBs shall be equipped with inter-phase barriers.
- (c) Each Incoming ACB from a transformer and each Bus Section ACB shall be equipped with a protection unit incorporating:
 - i. Overload protection (IDMT)
 - ii. Thermal overload protection
 - iii. Instantaneous short-circuit protection

All protection devices will be delivered with protection settings adjusted to the minimum level. The protection unit shall be fitted with a transparent cover that can be sealed in the closed position to prevent tampering with the settings.

- (d) The Contractor shall take particular care to ensure that the ACB protection is correctly co-ordinated with the upstream and downstream protective devices.
- (e) Current and time delay set points on ACBs shall be accessible from the front of the ACB without removing the ACB from its cradle and shall only be adjustable when the cubicle door is open.
- (f) Interlocks shall be provided to ensure the following:
 - i. That the main circuit breaker cannot be removed from or to the fully connected position unless the ACB is open;
 - ii. That the compartment doors cannot be opened should any accessible portion of the ACB frame be energised;
 - iii. That the ACB cannot be closed unless in the fully connected, test or fully disconnected positions.
- (g) Mechanical restrictions shall be provided to inhibit mismatch of ACBs of different ratings.
- (h) Provision shall be made for the padlocking of any ACB in any one of the fully connected, test or fully open positions. In addition, all ACBs shall have padlocking facility to prevent the close push button being operated when padlocked.
- (i) ACBs employed as incomers and bus-section switches shall incorporate captive key interlocks to prevent paralleling of incoming supplies. Locks with captive keys must be built into the ACB's to prevent both Incomers and the Bus-coupler circuit breakers in the "ON" position at the same time. Padlocks will not be accepted for this application.
- (j) The ACBs supplied shall be three pole, magnetic operated. The mechanism shall be of the stored energy type having hand charged spring with mechanical and electrical releases for closing.

E04.5.2.8 Moulded Case Circuit Breakers (MCCBs)

- (a) MCCBs shall be of the manually operated type with thermal and instantaneous magnetic protection. Trip functions shall be resettable via the MCCB switching handle.
- (b) Each MCCB shall be fitted with a vari-depth operating handle.
- (c) Flash barriers shall be furnished to increase creepage distance between phases and shall be furnished on all circuit breaker cradles between the phases on both sides of the MCCB.
- (d) The thermal trip elements of each MCCB shall be calibrated for the maximum ambient

temperature at 40°C.

- (e) Current ratings of MCCBs shall be detailed in the Single Line Diagram drawings.
- (f) MCCBs shall be selected according to rating and the fault level as specified by the Engineer.
- (g) The name of the MCCB manufacturer shall be furnished by the tenderer at tender stage.
- (h) Each MCCB shall be provided with suitable insulation between the terminals of the MCCB and the back plate/chassis onto which the MCCB is mounted, such that any loose nut, screw, etc., which may fall between the MCCB terminals and back plate cannot cause a short circuit.
- (i) Where interlocking is called for between the MCCBs this shall be effected using captive keys in the breaker or a mechanical interlock.
- (j) All outgoing circuits shall be equipped with individual core balance earth leakage units arranged to shunt trip each respective outgoing circuit.
- (k) Outgoing circuits rated 125A and above shall have IDMT 375 mA earth leakage units EPC type Elsec T. Outgoing circuits rated 100A and below shall have instantaneous 250 mA earth leakage units - EPC type Elsec – X. All earth leakages must be of the manual reset type.
- (l) All circuit breakers, except bus couplers, shall be connected with the switched side to the load, i.e. with reference to power flow incoming to "LINE" and outgoing to "LOAD".
- (m) The incoming terminals/shutters of all 400V circuit breakers shall be effectively shrouded and marked "400V LIVE" with white characters on a red ground.

E04.5.2.9 Miniature circuit breakers (MCBs)

- (a) Miniature circuit breakers (MCBs) shall be confined to auxiliary circuits such as control and indication in which the prospective short-circuit current will not exceed 5kA (3ph at 440Vac), or 7.5kA (1p at 24Vdc). They shall be of the thermal and magnetic trip free type. Where the prospective short-circuit current exceeds the above values, cascaded circuit breakers should be used. All cascaded circuits must be marked with the wording "Warning: This is a cascaded system. Never replace any circuit breaker in the system with another circuit breaker that is not identical in manufacturer, type and rating."
- (b) Auxiliary contacts on MCBs
 - i. Provide the position (open/closed/tripped) remote indication functions of the associated MCB.
 - ii. Clip on (no tool required) to the left-hand side of the MCB. The type that connects to the MCB operating lever is preferred.
 - iii. Shall be of good quality and will not interfere with the operation or tripping of the MCB.

E04.5.2.10 Surge Arrestors

- (a) All Electrical switchboards shall have a surge arrestor fitted to each phase on the incoming circuit breaker. The surge arrestors shall be fitted to the LIVE side of the circuit breaker.

E04.5.2.11 Instruments and Meters

- (a) Incoming CBs shall be equipped with the following as a minimum requirement:
 - i. A single 96mm x 96mm 5A secondary, combined maximum demand and instantaneous ammeter. The maximum demand portion shall have a thermal movement with 15-minute time lag and drag pointer having a reset facility. It shall have a built-in saturation transformer for increased overload capacity to 90 times

rated current for one second;

- ii. A 96mm x 96mm voltmeter connected to measure phase-to-phase voltage and phase to neutral voltage via a multi-position selector switch and a set of fuses suitably rated for voltage and short circuit current;

E04.5.2.12 Current Transformers

- (a) All current transformers shall conform to SANS 61869-2. For protection purposes, class 10P CT's are to be used and for indicating purposes class 1 CT's are to be used and for metering purposes class 0.5 CT's are to be used. In general, current transformer mechanical and thermal ratings shall be co-ordinated with the short circuit ratings of the equipment.

E04.5.2.13 Fuses

- (a) Fuse protection shall be used in cases where capacitive loads are switched i.e. Power factor correction or static capacitors panels.
- (b) Fuses shall not be used for purposes other than voltmeter or kWh meter protection, unless specifically authorised. All short circuit protection shall be provided by means of circuit breakers and fast blow fuses for protecting the incoming side of the devices. In cases where the fault current level is excessively high, HRC fuses in conjunction with CB's should be considered to reduce the fault level and afford better protection for electrical personnel.

E04.5.2.14 Limit Switches

- (a) Limit switches shall be metal encapsulated precision switches with robust and compact explosion-proof structures.
- (b) Cables shall be equipped with a strain-relief device and safely cast into the enclosure. Switches shall have bottom, side or lateral cable outlets as per the requirement of the application. The integrated basic switch shall have a single-pole changeover contact with a high switching accuracy and a precise repeatability of the switching point.
- (c) It shall have high vibration resistance and long mechanical life. It shall have a high protection class that would allow the switch to be used in all processes of Johannesburg Water wastewater treatment plants.

E04.5.3 Mounting of Equipment

E04.5.3.1 Clearance and Access

- (a) A minimum clearance of 50mm shall be maintained between items of equipment and the side of the compartment.
- (b) Where extra equipment is specified after the design has been finalised, this clearance requirement may be altered subject to the Engineer's approval.
- (c) No piece of equipment shall be mounted in any position where it is not visible and accessible to a viewer looking into the compartment through the door opening.

E04.5.3.2 Mounting of Circuit Breakers

- (a) All moulded case circuit breakers shall be flush mounted with only toggles protruding.
- (b) Miniature circuit breakers may be installed in clip-in trays mounted on the frame.
- (c) Special provision shall be made for large main switches.
- (d) Circuit breakers shall be installed so that the toggles are in the up position when "ON" and down when "OFF".

E04.5.3.3 Mounting of Contactors

- (a) Contactors shall only protrude through the panel in special cases. Plastic covers or other coverings will not be required.

E04.5.3.4 Instrumentation

- (a) All metering instruments shall be mounted flush in the front panel unless otherwise specified.
- (b) In certain instances it may be required that instruments be mounted flush in the door. In these instances, the back of metres shall be covered by removable covers of isolating material fixed to the door to protect the terminals of instruments and to prevent accidental contact.
- (c) Equipment mounted normally on the surface, e.g. time switches and relays shall be mounted behind the front panel. In these cases, hinged access panels shall be provided in the front panel.

E04.5.3.5 Fuse-Links and Carriers

- (a) Fuses shall be of the high rupturing capacity type and shall be mounted on insulated draw-out carriers, which shall hold the fuses positively and remain firmly fixed after withdrawal. In all cases, the top terminal shall be the live terminal. This applies also for MCB's.
- (b) DC circuits shall have fuses in the positive and negative leads.
- (c) Fuses shall be so positioned that they are readily accessible to a person standing on the floor.
- (d) Fuses for instrumentation shall be mounted on the outside of the compartment door adjacent to or below the instrument.
- (e) Fuses shall be provided with labels giving their rating and duty.
- (f) Solid link holders shall be coloured white.
- (g) One spare fuse of each type and size used in each board shall be fitted on clip holders on the inside of the front panel.

E04.5.3.6 Control Equipment

- (a) All equipment performing control functions, e.g. control relays, transducers, and time relays not requiring adjustment, shall be mounted behind the front panel.

E04.5.3.7 Current Transformers

- (a) Current transformers shall be accessible and easily removable.
- (b) Secondary windings of current transformers shall be earthed at one point only. Each group of current transformers, i.e. protection, metering, etc., shall be earthed directly to the protective conductor (earth bar).
- (c) Current transformers shall be naturally air-cooled, and shall be able to withstand the maximum fault current for the duration of time taken by the functional unit to clear, with protective devices set at the maximum time delay settings.

E04.6 MOTOR CONTROL CENTRE

A Motor Control Centre (MCC) is an assembly of one or more enclosed sections having a common

power bus and principally containing motor control units that serves to govern in some predetermined manner the performance of an electric motor. Motor control centres are in modern practice a factory assembly of several motor starters. A motor control centre can include variable frequency drives, programmable controllers, metering apparatus etc. Motor Control Centre is used for controlling of various motors of a particular plant.

E04.6.1 MCC Buckets

- (a) The following types of motor starters will be used:
 - i. Direct-on-line (DOL) type motor starting;
 - ii. Star/Delta (S/D) type motor starting;
 - iii. Forward/Reverse type motor starting;
 - iv. Soft starting (SS) type motor starting;
 - v. Variable Speed Drive (VSD) type motor starting.
- (b) The main contactors on Star/Delta and Forward/Reverse type starters will be mechanically interlocked. The type of motor starting required shall be project specific and shall be indicated in the MCC schedule/s to be issued by the Engineer.
- (c) All the protection devices, i.e. overloads, circuit breakers, motor thermistors, motor heaters, gearbox oil flow switches etc. on mechanical equipment shall be hard wired onto the individual motor starter circuits.
- (d) Only one motor will be controlled from any MCC bucket.

E04.6.2 Busbars

- (a) Main busbars in MCCs shall be rated for 2000 amps as a minimum.
- (b) Busbar droppers in MCCs shall be rated for the maximum possible current (determined by the breaker frame size) in that section with a minimum rating of 1000 amps.

E04.6.3 Earth bar

- (a) The earth bar shall be rectangular, with a minimum cross sectional area of 400mm² (10mm x 40mm).

E04.6.4 Power wiring

- (a) The minimum MCC power wiring size shall be 25mm².

E04.6.5 Circuit Breakers

- (a) Air circuit breaker (ACBs) will be used for Incomer circuit breakers on MCCs.
- (b) Bus coupler circuit breakers on MCCs will use an air circuit breaker (ACBs).
- (c) Moulded Case circuit breakers (MCCBs) will be used for outgoing feeders on MCCs up to a maximum rating of 800 amps.

E04.6.6 Instruments and Meters

- (a) Incoming CBs shall be equipped with an power meter capable of providing multiple parameters of the connection including kWh, kVARh, kW, kVAR, PF, MD, etc. and provide a pulsed output and Ethernet connectivity.
- (b) Each bucket shall be equipped with a suitably sized 5A current transformer (CT) operated

96mm x 96mm 90° movement suppressed maximum demand ammeter having an overload rating of 40 times the rated current for one second. The CT primary current rating will match (equal) the outgoing feeder circuit breaker current rating. The CT secondary current rating will be 5A.

E04.7 MAIN DISTRIBUTION BOARD

A Main Distribution Board is a panel from where electrical energy is taken out to distribute power to various consumer points. It has a single incoming power sources from a distribution transformer and includes feeder circuit breakers and protection devices to the consumers.

E04.7.1 Busbars

- (a) Main busbars in MDBs shall be rated for 2000 amps as a minimum.
- (b) Busbar droppers in MDBs shall be rated for the maximum possible current (determined by the breaker frame size) in that section with a minimum rating of 1000 amps.

E04.7.2 Earth bar

- (a) The earth bar shall be rectangular, with a minimum cross sectional area of 400mm² (10mm x 40mm).

E04.7.3 Power wiring

- (a) The minimum MDB power wiring size shall be 25mm².

E04.7.4 Circuit Breakers

- (a) Air circuit breakers (ACBs) shall be used as Incomer circuit breakers on MDBs.
- (b) Moulded Case circuit breakers (MCCBs) will be used for outgoing feeders on MDBs up to a maximum rating of 800 amps.

E04.7.5 Instruments and Meters

- (a) Incoming CBs shall be equipped with an power meter capable of providing multiple parameters of the connection including kWh, kVA_{rh}, kW, kVA_r, PF, MD, etc. and provide a pulsed output and Ethernet connectivity.
- (b) Feeder CBs shall be equipped with an power meter capable of providing multiple parameters of the connection including kWh, kVA_{rh}, kW, kVA_r, PF, MD, etc. and provide a pulsed output and Ethernet connectivity.

E04.8 AUXILIARY DISTRIBUTION BOARD

An Auxiliary Distribution Board is a panel from where electrical energy is taken out to distribute power to various consumer points. It has a single incoming power sources from a Main Distribution Board and includes feeder circuit breakers and protection devices to the consumers.

E04.8.1 Busbars

- (a) Main busbars in ADBs shall be rated for 1000 amps as a minimum unless otherwise specified/approved by the engineer.
- (b) Busbar droppers in ADBs shall be rated for the maximum possible current (determined by

the breaker frame size) in that section with a minimum rating of 600 amps unless otherwise specified/approved by the engineer.

E04.8.2 Earth bar

- (a) The earth bar shall be rectangular, with a minimum cross sectional area of 250mm² (10mm x 25mm) unless otherwise specified/approved by the engineer.

E04.8.3 Power wiring

- (a) The minimum ADB power wiring size shall be 16mm² unless otherwise specified/approved by the engineer.

E04.8.4 Circuit Breakers

- (a) Air circuit breakers (ACBs) shall be used as Incomer circuit breakers on ADBs unless otherwise specified/approved by the engineer.
- (b) Moulded Case circuit breakers (MCCBs) will be used for outgoing feeders on ADBs up to a maximum rating of 800 amps.

E04.8.5 Instruments and Meters

- (a) Incoming CBs shall be equipped with an power meter capable of providing multiple parameters of the connection including kWh, kVArh, kW, kVA, PF, MD, etc. and provide a pulsed output and Ethernet connectivity.
- (b) Feeder CBs shall be equipped with a suitably sized 5A current transformer operated 96mm x 96mm 90° movement suppressed maximum demand ammeter having an overload rating of 40 times the rated current for one second. The CT primary current rating will match (equal) the outgoing feeder circuit breaker current rating. The CT secondary current rating will be 5A.

E04.9 FLUSH MOUNTED DISTRIBUTION BOARD

E04.9.1 Internal for of Separation

- (a) The internal for of separation will be specified by the Engineer.

E04.9.2 Bonding Tray

- (a) Bonding trays for flush mounted switchboards shall be of rigidly constructed 1,6mm thick galvanised steel, braced and reinforced.
- (b) Formed gussets shall be provided at the corners. All the tray joints shall be properly welded or securely bolted with a brass or cadmium plated steel earth connecting stud and nut.

E04.9.3 Expanded Metal

- (a) Where switchboards are to be built into 116mm thick walls, expanded metal shall be spot welded to the rear of the bonding trays.
- (b) The expanded metal shall protrude at least 150mm on each side to prevent plaster from cracking.

E04.9.4 Knock-Outs

- (a) Ample knockouts shall be provided in the top and bottom ends of each switchboard tray to allow for the installation of conduits for the specified and future circuits.
- (b) Knockouts shall be allowed for any size of specified conduit.
- (c) Provision shall however be made for termination of at least 2 x 25mm diameter conduits at top and 2 x 25mm diameter conduits at the bottom of each tray.

E04.9.5 Architrave Frame

- (a) The architrave frame shall be of 2,0mm thick sheet steel with bevelled edges.
- (b) The architrave frame shall accommodate the chassis, panels and doors.
- (c) The architrave shall overlap the bonding tray by at least 25mm on each side.
- (d) The architrave frame shall be fixed to the tray in such a fashion to allow for depth adjustment and irregularities of the wall.

E04.9.6 Extension Frames

- (a) Semi-flush mounted switchboards shall be equipped with extension frames.
- (b) Generally, the frame depths shall be 50mm but may be altered to suit each application.

E04.9.7 Chassis

- (a) The chassis for mounting of switchgear and equipment shall be of rigid construction and shall be fixed securely to the architrave frame or bonding tray by means of bolts screwed into tapped holes or bolts and nuts. Self-tapping screws are not acceptable.
- (b) The chassis position shall be adjustable in the horizontal plane.

E04.9.8 Panel (Faceplate)

- (a) A suitably stiffened panel manufactured of 2,0mm thick sheet steel shall be installed in the architrave frame for flush mounting of switchgear.
- (b) The panels shall have machined punched slots for housing the specified and future switchgear, instruments, fuse holders, isolating switches, indicator lamps, etc. In exceptional cases, contractors will be allowed to protrude through the panel.
- (c) Blanking plates shall be provided in positions where future switchgear will be installed.
- (d) The distance between the inside of the closed doors and the panels shall be not less than 40mm.
- (e) No equipment may be mounted on the panel (faceplate) unless it is permanently hinged to the switchboard frame.

E04.9.9 Fixing of Panels

- (a) The panel for each switchboard shall be secured to the architrave frame by means of captive fasteners. Alternatively, the panel may be secured to the architrave frame by means of two pins at the bottom and a latch or lock at the top of the panel. Self-tapping screws or dome nuts will not be allowed.
- (b) Where it is required that equipment be mounted on the panel, the panel shall be securely hinged to the switchboard frame.

E04.9.10 Panel Handles

- (a) Two chromium plated handles shall be provided on each front cover.
- (b) The handles shall be mounted at the top and bottom of each panel.

E04.9.11 Hinged Panels

- (a) Where hinged panels are specified, the hinges shall be fixed to the architrave frame and the panel shall be secured by means of studs and hexagonal chromium plated nuts or by means of a suitable lock or latch, which can be operated with a screwdriver.
- (b) The panel shall be removable when it is in the open position.

E04.10 SURFACE MOUNTED DISTRIBUTION BOARD

This section refers to surface mounted sub-switchboards and not to floor standing main switchboards in substations or sub-main switchboards.

E04.10.1 Internal for of Separation

- (a) The internal for of separation will be specified by the Engineer.

E04.10.2 Switchboard Tray

- (a) Surface mounted switchboards shall be equipped with a 1,6mm sheet steel reinforced tray.
- (b) Securing lugs shall be provided to fix the tray to walls or any other structure.
- (c) A solid brass or cadmium plated steel earth connection stud and nut shall be provided.

E04.10.3 Construction

- (a) All joints shall be welded or securely bolted.
- (b) The tray shall be square and neatly finished without protrusions.
- (c) The front tray sides shall be rounded with an edge of at least 20mm to accommodate flush doors.
- (d) The requirements for chassis, panels and doors shall be as specified for flush mounted switchboards.
- (e) The doors shall be hinged and shall fit flush in the frame in the closed position.
- (f) Knockouts shall not be provided unless specifically called for.

E04.11 LV KIOSKS (SWITCH CUBICLES)

LV kiosks shall be of sufficient size to accommodate all the specified equipment.

E04.11.1 Framework

LV kiosks shall be manufactured of mild steel sheet metal with a minimum thickness of 2mm or cold rolled 3CR12 sheet metal with a minimum thickness of 1,6mm. Fibre re-inforced or other corrosion proof material (e.g. glass fibre) may also be used if adequately reinforced.

E04.11.2 Ventilation

Two ventilation slots or grilles, approximately 150 x 125mm and covered on the inside with copper mesh, shall be provided on opposite sides of the cubicle.

E04.11.3 Doors

Doors shall be provided in the front and back panels and shall swivel through 180°. Rigid padlocks and base plates for security latches shall be provided on the doors. Openings for security latches shall be blanked with chromed brass discs.

E04.11.4 Warning Sign

Warning and danger signs shall be mounted on each door in compliance with the requirements.

E04.11.5 Base

The kiosk shall be mounted on a well-finished concrete base, with minimum height of 150mm above ground level in the case of mild steel and any of the other specified acceptable materials. The kiosk can be made for direct mounting into the ground in which case it shall be equipped with a base, forming part of the structure, for this purpose. The switch cubicle shall protrude at least 10mm past the edges of the base to prevent water collecting on the base.

E04.12 **STANDBY SUPPLIES**

- (a) Where standby power from a diesel-generator set or other source is available and has to be connected to some of the equipment on a panel, the panel shall be divided into electrically separate sections with sheet metal division plates to isolate power and mains power sections. The section doors must be appropriately colour coded to provide visual distinguishing.
- (b) A means shall be provided to isolate both the standby and mains power supplies simultaneously. For this purpose, either a 6-pole rotary switch or mechanically and electrically interlocked circuit breakers or contactors may be used. Electrical interlocking alone is not sufficient. Rotary switches may only be used on panels where the fault level does not exceed 10kA.
- (c) A separate 3-pole circuit breaker shall be provided as main switch for both the standby power section and the mains power section in addition to the isolator of (b) above.

Where a 6-pole rotary switch is used as isolator for the incoming supplies, this switch may be located in the standby section of the switchboard in which case the rotary switch can also serve as the isolator for the standby section. This arrangement is acceptable where the equipment on the mains power section of the switchboard can be turned off whenever it is necessary to work on the standby section of the switchboards.
- (d) The main switches to the standby and mains power sections shall be interlocked with the doors providing access to those sections to ensure that the door can only be opened when the switches are in the OFF position.

E04.13 **ELECTRICAL SUBSTATION FIRE PROTECTION SYSTEM**

It is the duty of the Contractor to appoint a trained and competent fire engineering company to design, supply, install, commission, and test and certify a fire protection system for each electrical substation building forming part of the contract.

Each fire protection system will consist out of a fire detection and an extinguishing system as described below. Both systems will be of the highest quality and latest technology, supplied by a reputable manufacturer. The contractor will submit written proof that local support is available to maintain the system and to supply spare parts as required.

E04.13.1 Fire Detection System

The fire detection system must:

- (a) Utilise a sub-micron combustion particle detector that detects a fire at its initial stage, before the presence of smoke. This allows preventative action can be taken before any catastrophic event occurs.
- (b) Utilise detectors suitable for dusty plant environments and must be impervious to false alarms caused by dust particles in substation buildings with sheet metal roofs where no ceilings are present.
- (c) Cover the substation building, all electrical cabinets and all cable trenches.
- (d) Only when there is a second alarm from a second detector the system will trigger the gas.
- (e) Double Knock system (Trigger an alarm on the first detector activation and trigger the operation of a fire extinguishing system on a second detector activation).
- (f) Alert a control and alarm signalling system in case of a fire or a system fault.
- (g) Be designed and installed to conform to SANS/ISO 10139 and SANS 369 Parts 1 and 2.

E04.13.2 Fire Extinguishing System

The fire extinguishing system must:

- (a) Utilise an automatic system to flood the substation building with a concentration of a gaseous extinguishing agent to extinguishing a fire burning in Class A, B, and C hazards by lowering the oxygen content below the level that supports combustion as quickly as possible.
- (b) Utilise a non-toxic, human friendly extinguishing agent. The use of an extinguishing agent that does not support human life must be approved in writing by the Engineer. In this case, other safety measures such as a lockout system should be integrated to ensure safe entrance into the protected substation.
- (c) Utilise an efficient extinguishing agent that is electrically non-conductive and that will not adversely affect the protected electrical equipment. No powder or other residue should remain after actuation of the system.
- (d) Audible and visual warnings must alert personnel to vacate the protected substation area before discharging the agent.
- (e) Utilise a colourless, odourless environment friendly extinguishing agent that is sustainable against impending global warming regulations.
- (f) Utilise an extinguishing agent that has a low refill cost.
- (g) Should be fully approved by the local authority to an internationally accepted engineering standard.

E04.13.3 Other measures

- (a) All points where cable or other services enter the substation building must be properly sealed with a fire rated medium of at least one-hour or as per local standards and regulations.
- (b) All ventilation and air conditioning devices must be tripped in the event of first detection of a fire.
- (c) All ventilation openings and doors in the substation building should be sealed in the event of first detection of a fire.
- (d) A room integrity test needs to be carried out to validate the hold-time for the extinguishing agent as per the room's natural leakage.

- (e) All detection, alarm and extinguishing circuits are to be monitored for system faults.
- (f) The substation fire protection system should operate a local audible and visual alarm system and report to a central 24-hour manned operations or security room.
- (g) A local handheld fire extinguisher should also be installed within the substation as per local regulations. The type and number should conform to local standards and regulations.

E04.13.4 System Maintenance

- (a) The contractor will include a fire protection system maintenance contract for a period of one year after commissioning. A trained and competent fire engineering company must do the maintenance.
- (b) Thereafter a trained and competent fire engineering company should be contracted to inspect the system on a three-month basis. It should check that the system is operational in terms of its design and take corrective action in the event of a fault.
- (c) The Client should visually check the system once a month for any faults reported on the control panel and anything that might appear out of the ordinary. The Client should immediately report to a competent fire engineering contracting company of any concerns or faults to ensure immediate rectification.
- (d) A mandatory annual room integrity test should be carried out as per SANS 1520 Part 1.
- (e) Should any physical alterations be made to a substation, a review on the fire protection system must be done to see if its performance has been compromised and appropriate actions should be made to ensure the integrity of the system.

E04.14 **QA REQUIREMENTS**

The vendor / contractor will be responsible for the following.

TABLE OF CONTENTS			
SECTION	DESCRIPTION	REQUIRED (YES OR NO)	WHEN REQUIRED
DRAWINGS & DESIGN (2 SETS OF EACH)	DESIGN CALCULATIONS		
	GA DRAWINGS	YES	ORDER + 3 WEEKS
	DETAIL DRAWINGS	YES	CONSTRUCTION
	AS BUILT DRAWINGS	YES	COMPLETION
	BROCHURES	YES	CONSTRUCTION
	SKETCHES		
	SCHEMATIC DIAGRAMS	YES	ORDER + 3 WEEKS
	RISK ASSESSMENT BY VENDOR	YES	CONSTRUCTION
	DATA SHEETS	YES	TENDER
	DESIGN CRITERIA	YES	CONSTRUCTION
QUALITY CONTROL DOCUMENTS (2 SETS OF	QUALITY CONTROL PLAN	YES	ORDER + 3 WEEKS
	MANUFACTURING PROGRAM	YES	ORDER + 3 WEEKS

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EACH)			
MATERIAL		YES	MANUFACTURE
CERTIFICATES			
CERTIFICATES OF INSPECTION TESTING AND ACCEPTANCE	PRESSURE TEST CERTIFICATE	YES	DATA BOOK
	ELECTRICAL HAZARD CERTIFICATE		
	ELECTRICAL TEST CERTIFICATES	YES	DATA BOOK
	INSTRUMENT CALIBRATION CERTS.		
	VENDORS CERTIFICATE OF CONFORMANCE	YES	COMMISSIONING
	NON-CONFORMITY / CONCESSION REPORTS	YES	COMMISSIONING
MANUALS	OPERATING / MAINTENANCE MANUAL	YES	COMPLETION
	DATA BOOK	YES	DELIVERY – 1 WEEK
	DRAWINGS	YES	COMPLETION
	WARRANTY/GUARANTEES CERTIFICATES	YES	COMPLETION

E04.15

DRAWINGS AND DATA

- (a) The vendor / contractor will supply shop drawings to the Engineer prior to manufacturing.
- (b) No switchboard manufacturing may start if the drawings are not approved by the Engineer in writing. Should the vendor / contractor start manufacturing without approved shop drawings, any changes required by the Engineer will be for the vendor / contractor's account.
- (c) The following will be included in the shop drawings as a minimum:
 - i. General arrangement drawings
 - ii. Schematic diagrams
 - iii. Equipment lists, including the make, catalogue number and capacity of all equipment such as isolators, circuit breakers, fuses, contractors, etc.
 - iv. All labelling information on a separate sheet.
- (d) The approval of the shop drawings shall not relieve the Contractor of his responsibility to the Client to supply the switchboards according to the requirements of this specification or to the requirements of the Detailed Technical Specification.
- (e) The vendor / contractor will supply three hard copies and one soft copy of the equipment data book including all items as specified in the Vendor QA and document requirement list.
- (f) Data books will be supplied to Johannesburg Water within 7 days from delivery of equipment. Johannesburg Water will review the data books within 14 days from issue and notify the Vendor of its acceptance or rejection of it.
- (g) All drawings and documentation shall be in accordance with Johannesburg Water specifications bound in book format.
- (h) A complete set of "As Built" drawings of all switchboards shall be submitted to the Engineer immediately after completion of the installation. The following information shall be presented:
 - i. Items (i) and (iv) of the previous paragraph.

- ii. Terminal strip numbers, numbers and colours of conductors connected to the terminal strips and numbers and colours of the conductors utilised for the internal wiring.
 - iii. A separate schedule of all equipment.
- (i) Where "As Built" drawings are modified during the execution of the contract, the Contractor shall at his own expense modify or replace such drawings. Accurate drawings of the equipment shall be forwarded to the Engineer.

E04.16

PAINTING AND PROTECTIVE COATING

E04.16.1

Powder Coating Systems

- (a) Paint system 1: Powder Coating, seven Stage zinc, Phosphate pre-treatment, pure epoxy primer, Polyester finishing coat, and thickness 140 µm.

Paint System	Host Material	Preparation	Primer (70µm)	Finishing Coat (70µm)	Thickness µm
No 1	Mild Steel	7 stage phosphate pre-treatment	Epoxy	Epoxy	140

- (b) On completion of the paint job, the powder manufacturer must carry out the following tests on the test panels:
- i. SABS 6J impact test
 - ii. Cross hatch adhesion test
 - iii. Bend test
- (c) The powder manufacturer must issue a Certificate of Compliance for each paint job, which should be included in the contract documentation.
- (d) The preferred corrosion protection systems are applied onto cold rolled mild steel plate with a thickness of 2.0mm.

E04.16.2

Epoxy Powder Coat Products

Item	Product Type	Powder - Lak
1	Epoxy Primer	23-007
2	Pure Epoxy / Polyester Finishing Coat.	Series 3000

E04.16.3

General

- (a) All chassis plates shall be painted white.
- (b) All mild steel gland plates shall be galvanised for improved cable earthing.
- (c) All panel doors on equipment supplied from a normal supply must be painted Electric Orange (B26).
- (d) All panel doors on equipment supplied from an emergency supply must be painted Signal Red (A11).
- (e) All panel doors on equipment supplied from an UPS supply must be painted Dark Violet (F06).
- (f) Specific external colours will be provided by Johannesburg Water.
- (g) Before the installation is handed over, the Contractor shall ensure that all paint surfaces are clean and undamaged.

E04.17 PERFORMANCE AND GUARANTEE

- (a) The performance of the items supplied in terms of this specification, as defined by the order, shall be warranted by the Vendor and, if specified, be tested in accordance therewith.
- (b) The vendor shall not be specifically required to conduct a performance test on site.
- (c) A minimum warranty period of 12 months is required.

E04.18 INSPECTION AND TESTING

E04.18.1 Factory Acceptance Test

- (a) The Johannesburg Water Representative shall have access, at all reasonable times, to those parts of the manufacturing facilities engaged in the manufacturing of items in terms of this specification. He is authorised to witness any stage of manufacture, tests and inspect documentation.
- (b) The Johannesburg Water Representative is authorised to reject any items not manufactured to the requirements of the specification.
- (c) All equipment shall be inspected at the vendor's works prior to delivery, to ensure compliance with the specification.
- (d) No unit shall be considered complete until acceptance by Johannesburg Water.
- (e) The minimum testing / pre delivery checklist shall be as follows:
 - i. The Johannesburg Water representative must carry out a clause-by-clause check of each switchboard, prior to delivery.
 - ii. This switchboard checklist is intended to assist this process but does not relieve him/her of the responsibility described above.

DETAILED INSPECTION ROUTINE

Order No. : _____

Supplier/Vendor : _____

Project : _____

Motor Control Centre Designation : _____

Inspected by : _____

Date : _____

	Comments
Overall Appearance	
☐	
☐ Paint work : Compliance with Annexure A5	
☐ Paint thickness	
☐ Door fittings good	
☐ Dust sealing effective (neoprene seals)	
☐ Board fully assembled	
☐ Overall height less than specified height	
☐ Channel iron base frame (less than 3000m)	
☐ Lifting lugs provided	
☐ Equipment supplied in accordance with specification (contractors, overloads, circuit breakers, relays, etc.)	

	Comments
Busbars	
☐ Correct cross-section	
☐ Correct phasing with incomer/feeders	
☐ Rigidly supported/braced	
☐ Properly insulated	
☐ Joints tightened	
☐ Transport section joints supplied (Fishplates, nuts and bolts, control wiring and terminals, etc.)	
☐ Droppers from main bars to circuit breakers adequately rated, braced, insulated	
☐ Nothing unnecessary mounted on bus bars	
☐ Main earth bar, min 70mm ²	
☐ Control busbars generally as above, separate from power busbars	
☐ Air clearances adequate throughout	
Single Line Diagram Check	
☐ As per approved single line diagram	
Outgoing Circuit	
☐ Correct size/rating for MCCB's	
☐ Correct size/rating for ACB's	
☐ Correct earth leakage relays	
☐ Correct current transformer and associated ammeters	
☐ Correct overload relays	
☐ Correct setting on overload relays	
☐ Reasonable provision for cable termination power and control mounting of equipment	
☐ Correct conductor sizing, power and control, and correct colouring	
☐ Correct indicator lights and colours	
☐ Air clearances correct throughout	
Incoming Circuits	
☐ Correct size/rating of ACB's	
☐ Correct metering and proper mounting	
☐ Connection of power factor meter	
☐ Fuses on volt meter, where applicable	
☐ Reasonable provision for termination of incoming cable/gland plate	
☐ Air clearances correct throughout	
Incomer status signal to PLC	
Interlocks	
Pressure and Injection Tests	
☐ Primary injection test for correct operation of all protection and overload relays	
Operational Test	
☐ Mechanical operation of all circuit breakers, preferably with doors closed	
☐ Shunt trip of all circuit breakers	
☐ Operation of overload relay	
☐ Correct operation of all interlocks	
☐ Correct operation of indicator lights	

	Comments
☐ Correct operation of earth fault/overload alarm system, including general alarm panel	
Correct signals to PLC terminals	
Correct interlocks	
Door interlocks	
General Checks	
☐ Marking of control wires and power conductors	
☐ Main Motor Control Centre label	
☐ Cubicle labels fitted – designation and cubicle number	
☐ Component labels fitted	
☐ Warning labels on all removable covers giving access to live 400V conductors	
☐ Labels for indicator lights, pushbuttons, etc.	
☐ Terminal strip labels	
☐ Incoming side of circuit breakers label	
☐ Incoming circuit label – “FROM _____”	
☐ No ‘Philips’ (star) screws	
☐ No self-tapping screws	
☐ Grommets fitted on all open holes	
☐ Correct paint specification	
☐ All documentation submitted	
☐ Arc venting arrangements satisfactory	
☐ Door latches fitted	

- (f) Specific testing and inspection requirements relating to switchgear boards are as follows:
- i. Prior to shipment, the switchgear boards shall be completely assembled, wired, adjusted and tested by the supplier in the presence of the engineer and the client representative.
 - ii. Testing shall include primary injection tests of all current transformers, pressure tests to prove quality of insulation, functional tests of all mechanical and electrical components and electrical circuitry and any other tests required to ensure compliance with this specification.
 - iii. The supplier shall give one week’s notice of readiness for final tests to the Johannesburg Water representative. The vendor shall ensure that the equipment is ready for final testing before requesting the presence of the Johannesburg Water representative at such a test. Repeat inspections necessitated by the lack of readiness of the equipment may be charged to the vendor at the discretion of the Johannesburg Water representative.

E04.18.2 Site Acceptance Test and Commissioning

- (a) A Site Acceptance Test (SAT) must be conducted at the place of installation prior to switching the DB on. The test shall include (as a minimum) the following:
- i. A visual inspection to ensure all the design specifications are adhered to;
 - ii. Insulation resistance test;
 - iii. Function testing of all components.
 - iv. All switchboards must be thermal imaged a minimum of 1 week after being put on service. The image must be taken in normal operating conditions. The image must be analysed for hot spots and must be part of the Operations and Maintenance

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Manuals presented at the end of the project.

E04.19

MEASUREMENT AND PAYMENT

Item	Unit

Supply and deliver Switchboards or Motor Control Centres	No

The unit of measurement shall be the number of MCC's or boards supplied and delivered.

The tendered rate shall include full compensation for the manufacture, supply, testing and delivery of the boards as specified in the detailed specification.

Item	Unit

Install Switchboards or Motor Control Centres	No

The unit of measurement shall be the number of MCC's or boards installed.

The tendered rates shall include full compensation for the installation of the specified boards, including all required installation material to install the MCC or board in the required position including a heavy-duty strut, mounted 400mm below the gland plate. All incoming and outgoing cables shall be attached to this strut by means of K-clamps or approved equivalent clamps.

Item	Unit

Commission Switchboards or Motor Control Centres	No

The unit of measurement shall be the number of MCC's or boards.

The tendered rates shall include full compensation for the site testing and commissioning of the specified boards including the keeping of all commissioning records in triplicate, including all material, test equipment and labour required for the testing and commissioning.

Item	Unit

Supply and install extra circuits on Switchboards and Motor Control Centres	No

The unit of measurement shall be the number of circuits supplied and installed.

The tendered rate shall include full compensation for the manufacture, supply, testing and installing of extra circuits in switchboards or motor control centres (spare space being available on the board).

Item	Unit

Supply and deliver level control equipment	No

The unit of measure shall be the number of level control systems supplied and delivered.

The tendered rate shall include full compensation for the supply, manufacturing, testing and delivery of all the material required for the level control system, including all float level switches, will the required length of cable attached to them, mounting brackets, terminal box and mounting equipment together will all material to facilitate a complete level control system.

Separate items will be measured for systems with different numbers of level switches.

Item	Unit

Install level control equipment.....	No

The unit of measure shall be the number of level control systems installed.

The tendered rate shall include full compensation for installing, testing and commissioning of the level control system including the required brackets, junction boxes, cables etc. for a complete working system.

Item	Unit

Modify existing motor starter panels	No

The unit of measure shall be the number of motor starters to be modified.

The tendered rate shall include full compensation for the supply and delivery of all material and labour required to modify the motor starter panel as detailed in the detail specification.

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Item	Unit
Supply and install PLC/Scada alarm and status signals	No
The unit of measure shall be the number of MCC's for which a siren and alarm light has been installed.	
The tendered rate shall include for the full compensation for the supply, delivery, installation and commissioning of the specified siren and alarm light including all required installation material including cables required to render a fully operational system.	

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER
PARTICULAR SPECIFICATION
E05 : ELECTRICAL LOW VOLTAGE POWER
AND CONTROL CABLES

Johannesburg Water (SOC) Ltd.
PO Box 61542
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Revision 5

August 2019

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PARTICULAR SPECIFICATION: VOLUME E05: ELECTRICAL LOW VOLTAGE POWER AND CONTROL CABLES

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E05.1 SCOPE

This specification covers the requirements with regards to the manufacture, supply, delivery, installation, testing and commissioning of power and control cables rated up to 600/1000V. The term cable shall indicate electrical conductors or carriers manufactured for supplying power for the control and supervision of multipurpose loads.

E05.1.1 Statutory Documents and Standards

Cables shall be strictly manufactured in accordance with the requirements of the latest editions of the following standards:

- (a) SANS 1507 : Electrical cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V)
- (b) SANS 1411 : Materials of insulated electric cables and flexible cords
- (c) SANS 1339 Electric cables - Cross-linked polyethylene (XLPE) insulated cables for rated voltages 3,8/6,6 kV to 19/33 kV
- (d) SANS 1520 : Flexible electrical cables for use in mines
- (e) SANS 10198 The selection, handling and installation of electric power cables of rating not exceeding 33 kV
- (f) SANS 10142-1 : The Wiring of Premises Part 1 – Low Voltage Installations
- (g) IEC 60245 : Rubber insulated cables
- (h) IEC 60287 : Electric cables - Calculation of the current rating
- (i) IEC 60811 : Electric and optical fibre cables - Test methods for non-metallic materials
- (j) DIN VDE 0250-816 : Cables – Wires and flexible cords for power installation – Heat-resistant silicone rubber insulated flexible cable

The Occupational Health and Safety Act (Act No. 85 of 1993)

E05.1.2 Definitions and Terminology

In general, the following definitions and terminology shall apply:

Armouring	A layer or layers of galvanized steel wires applied to the cable to provide mechanical protection or earth continuity, or both.
Bedding	A layer of extruded compound applied to the cable beneath the armouring.
Cable	A length of core or more cores assembled, that may or may not be provided with an overall mechanical covering.
Core	A single insulated conductor without protective covering.
Direction of lay	The lateral direction of inclination to the axis (either left or right) of the receding helix formed by wire or core in a cable or flexible cord.
PVC	Polyvinyl chloride
Sheath	A solid extruded protective covering applied as the exterior of a cable or a flexible cord.

E05.1.3 Particular Specifications to read in Conjunction with this Specification

This specification shall be read in conjunction with the following specifications:-

E06: ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE INSTALLATION

E05.2 GENERAL SCOPE

E05.2.1 Design and Supply

(a) Conductor sizes

The minimum conductor size for control cables shall be 2.5mm².

The minimum conductor size for power cables on plant equipment (excluding small power and lighting) shall be 16mm².

(b) Conductor material

In the case of plants with a high risk of cable theft, cables with aluminium conductors must be used where the nominal core diameter exceeding 25mm². This must be agreed upon in writing by the Engineer.

E05.3 CONSTRUCTION

The cable shall be constructed as follows:

E05.3.1 Conductor Material

The copper conductors shall be of plain annealed or hard draw wire in accordance with the requirements of the latest edition of SANS 1411.

The aluminium conductors shall be of plain hard drawn aluminium wire in accordance with the requirements of the latest edition of SANS 1411.

E05.3.2 Insulation

The insulation material shall comprise of PVC in accordance with the requirements of the latest edition of SANS 1411.

E05.3.3 Core Colour Identification

The cable cores colour shall be in accordance with the requirements of the latest edition of SANS 1507-3.

E05.3.4 Bedding

The bedding shall consist of a continuous PVC extruded sheath.

E05.3.5 Armour

The armouring shall consist of one layer of round galvanised steel wire in accordance with the requirements of the latest edition of SANS 1411.

E05.3.6 Sheath

The outer sheathing shall be an impermeable, halogen free, reduced smoke emission, flame retardant PVC in accordance with the latest edition of SANS 1411.

E05.4 CABLE MARKINGS

The cables shall be legibly marked in accordance with the requirements of the latest edition of SANS 1507, and shall include the following:

- (a) Conductor size in square millimetres
- (b) Number of cores
- (c) Conductor material (copper)
- (d) The specification number (SANS 1507) to which the cable has been manufactured.
- (e) The year of manufacture.
- (f) Nominal voltage.

E05.5 STORAGE

Cables shall be packed on reeled drums. The moisture content of wooden cable drums shall not exceed 20%.

Each end of the cable shall before being secured to the reeled drum, be sealed by an acceptable

method approved by the Engineer. The outer end shall be secured to the reel drum and the inner end shall be protected in a manner against mechanical damage.

The cable reeled drums shall be capable of taking a round spindle and be lagged with strong, closely fitted battens, at the inner and outer circumference to prevent damage to the cables. The spindle bearing plates shall be steel. The dimensions of the drum shall not exceed 1 100 mm width, 2 000 mm diameter and the spindle bearing plate shall not be less than 9 mm thick. Each drum shall be clearly marked on both sides in accordance with the latest edition of SANS 1507.

The ends of the PVC sheathed cable shall be sealed to avoid penetration of moisture. Each cable drum shall be numbered.

E05.6 CABLE SIZING AND DE-RATING

The cables shall be sized and de-rated in accordance with the requirements of the latest edition of SANS 10142-1.

E05.7 TESTING OF CABLES

E05.7.1 Testing and Commissioning

The contractor shall supply factory test certificates for each drum of cable supplied under the Contract.

After the installation is complete, the contractor and the Engineer shall inspect the installation. The Engineer must be notified in advance of the inspection dates. The contractor will keep a snag list, reflecting all items not acceptable to the Engineer. The contractor will correct the snag items as required to the Engineers approval, updating the snag list as the items are completed and signed off by the Engineer.

On completion of his work, the Contractor will issue an Electrical Certificate of Compliance (CoC). All tests deemed necessary to issue the CoC should be included. The Contractor shall make all arrangements, pay all fees and provide all equipment for these tests. The Contractor shall notify the Engineer timeously so that he may witness the tests.

Each installed cable shall be tested in accordance with:

- (a) The Occupational Health and Safety Act (OHSA) 1994;
- (b) SANS 1507 (Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V));

SANS 1507	Duration (min)	Commissioning test voltage between conductors			Commissioning test voltage between conductors / earth		
Test Wave		(V)			(V)		
		300/ 500	600/ 1000	1900/ 3300	300/ 500	600/ 1000	1900/ 3300
AC (rms)	15	1000	2000	6000	1000	2000	3500
DC	15	1500	3000	9000	1500	3000	5000

This test will be conducted to the Engineers judgement. The constructor must obtain written approval from the Engineer before conducting any tests.

- (a) The requirements of the Local and Supply Authorities.

E05.8 QUALITY ASSURANCE

All the cables supplied under the Scope of Works of this project shall be designed and manufactured under a quality control system, typically to ISO 9000 series. The contractor must supply current compliance certificates on the manufacturers ISO classification.

E05.9 MEASUREMENT AND PAYMENT

Measurement and payment will distinguish between supply/delivery and installation/commissioning of the cabling lengths required.

Item

Unit

Supply and delivery of low-voltage cable..... metre

The unit of measurement shall be the length of low-voltage cable supplied. It is the responsibility of the Contractor to verify the lengths of cables required on site. The Contractor shall only supply the required length of cables required. The final quantity of installed cable lengths shall determine the final quantity to be paid of the supplied cable lengths.

The tendered rate shall include for the design, manufacture, supply and delivery of the specified cable to the site.

Separate items shall be scheduled under this payment item for each size and type of cable.

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER
PARTICULAR SPECIFICATION
E06 : ELECTRICAL MEDIUM AND LOW
VOLTAGE CABLE INSTALLATION

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**PARTICULAR SPECIFICATION: VOLUME E06: ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE
INSTALLATION**

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E06.1 SCOPE

This section covers the installation of cables for the distribution of electrical power to be installed in soil trenches, electrical cable ducts, buildings and structures for system voltages up to 11 kV at 50 Hz.

E06.1.1 Statutory Documents and Standards

The installation will be conducted in accordance with the requirements of the following standards. Where any document or standard is referenced, it shall be deemed the latest version of that document.

(a) SANS 10198	:	The selection, handling and installation of electric power cables of rating not exceeding 33 kV
(b) SANS 1507	:	Electrical cables with extruded solid dielectric insulation for fixed installations
(c) SANS 10142-1	:	The wiring of premises Part 1 – Low Voltage installations
(d) SANS 1213	:	Mechanical Cable Glands
(e) DIN EN 50655-2 VDE 0278-655-2	:	Fingerprinting for heat shrinkable components for low and medium voltage applications up to 20,8/36 (42) kV

E06.1.2 Particular Specifications to be read in conjunction with this specifications

This specification shall be read in conjunction with the following specifications:-

(a) E02	:	ELECTRICAL CABLE RACKS
(b) E03	:	ISOLATOR PUSHBUTTON STATIONS
(c) E04	:	MOTOR CONTROL CENTRES
(d) E05	:	ELECTRICAL LOW VOLTAGE POWER AND CONTROL CABLES
(e) E07	:	ELECTRICAL INDUSTRIAL WELDING PLUGS, COUPLERS AND SOCKET OUTLETS
(f) E08	:	WIRING
(g) E12	:	ELECTRICAL MEDIUM VOLTAGE CABLES

E06.2 GENERAL

E06.2.1 Cable theft prevention

Consideration must be given at design stage for the risk posed by cable theft. The routing of cables on site must be so that there is minimum risk of cable theft. This can be effected by avoiding use of bare earth copper cables, burying cables where possible, covering with secured covers, using a concrete paving over a cable route and any other approaches that will reduce probability of cable theft. As each site has different exposure to the risk of cable thefts, the user plant personnel must be involved in a risk assessment exercise to determine measures that may be applied on a site-by-site basis.

Cable runs outside of buildings must be buried. Where cables need to cross, rise onto structures, enter buildings or link structures, cable ladders may be used. In such cases, cable racks must be covered to prevent access. The cover may be bolted, welded in such a way that it is secure and may not be easily removed by simple tools.

E06.2.2 Competence of Personnel

Contractor supervisors overseeing work on or the installation of MV equipment and cables on site

will be authorised under the Operating Regulations for High Voltage Systems (ORHVS). A valid authorisation certificate will be submitted with each tender. All contractor personnel working on medium voltage equipment shall work under the direct supervision of the authorised supervisor.

Cables, cable joints, cable terminations and cable accessories shall be installed in accordance with the manufacturer's installation instructions by competent personnel. The Contractor shall only employ personnel fully conversant with the cable manufacturer's recommendations to lay, joint and terminate cables.

E06.3 CABLE INSTALLATION ON CABLE RACKS AND STRUCTURES

E06.3.1 Installation of Cables

Cables may be installed in one of the following ways:

- (a) On horizontal or vertical cable ladders;
- (b) Against horizontal or vertical metal supports or brackets;
- (c) Fixed to structures.

E06.3.2 Installation of Cable Ladders

Cable ladders shall be installed:

- (a) Within Motor Control Centre stations,
- (b) On access platforms to the mechanical equipment;
- (c) In accessible cable duct.

Cable ladders shall be supported with struts, channels, brackets, clamps, cantilever arms etc. The corrosion protection of the support elements shall be of the same system as that of the cable ladder. Nuts/bolts/washers shall be used as fasteners. Unless otherwise agreed, all screws, bolts and nuts shall be hexagonal to ISO Metric commercial standards. All bolts, nuts, spring washers, etc. shall be stainless steel 316.

On access platforms, the cable ladder will be installed at minimum of 150 mm from the supporting concrete structure. Crevice corrosion of the metal elements in contact with concrete surface shall be eliminated by means of a suitable layer of non-shrink grouting.

In accessible cable duct, cable ladder shall be supported by a 50mm high strut section securely fixed to the wall. The corrosion protection of the strut shall be of the same system as that of the cable ladder

To minimise cable theft, long cable runs on cable ladders should be avoided. For high risk areas where cable racking is used or, such cable racks must be covered with solid covers of the same material and complying with the same paint specification as the racking itself. Such covers must be bolted onto the rack in such a way that either special tools or a disk grinder would be required to remove these covers. If any additional methods to prevent cable theft are required, such requirements will be made clear to the contractor at the time of tender. This will also apply to all areas where cables are exposed or where cables are visible to by passers.

Before any cables are laid, the Engineer or his representative will inspect all cable racks.

E06.3.3 Installation of Cable Supports

Cable supports must be 3CR12-grade stainless steel, 304-grade stainless steel or 316-grade stainless steel and electric orange powder coated as for the cable racks. The size of angle iron supports must be such that no part of a cable projects beyond the support.

E06.3.4 Grouping and Spacing of Cables

Wherever possible cable racks must be mounted in the vertical plane to avoid accumulation of dirt and debris. Only single layers of cable will be allowed on a rack, to reduce de-rating and for ease of replacement and/or repairs. No more than two cables may be run on a single angle profile (3CR12) support.

Cables with a cross-sectional area of more than 16 mm² shall, be spaced two outside cable

diameters apart, for which no grouping correction factor need be applied.

Where parallel cable runs are installed at different levels (e.g. on parallel cable trays), and where the spacing of the layers is not specified, a minimum spacing of 300 mm shall be maintained.

Medium voltage cables shall be separated from other cables and services throughout the installation, and shall be installed in separate floor trenches, pipes or metal channels as far as possible. Where this is not feasible, a minimum spacing of 500 mm shall be maintained.

Cables for telephone, communication and alarm systems and all other low voltage systems (less than 50 V), shall be separated from power cables. In building ducts, a physical barrier shall be provided between power cables and cables for other services. Where armoured cables are used for such other services, they shall be at least 500mm away from power cables or shall be installed on separate cable trays. In the case where unarmoured cables are used for these other services, they shall be installed in separate metal channels or conduits.

E06.3.5 Fixing of Cables on Cable Racks and Supports

UV stabilised PVC straps may be used for cables up to 4core x 25mm². For cables of larger diameter than this (i.e. 30mm diameter and larger), stainless steel strapping must be used. All cables must be individually strapped.

E06.3.6 Spacing of Cable Supports

The most generally known method of supporting cables is the restrained installation where the distance between supports is small enough to prevent any noticeable sag in the cable.

The maximum spacing between cleats (clamps) to which cables are fixed in horizontal and vertical cable routes shall be determined from Table 1 below. Additional cleats shall be installed at each bend or offset in the cable run. The maximum distance between supports or cleats for multi-core control cables shall be 20 times the outside diameter of the cable with a maximum spacing of 500 mm for unarmoured cables and 30 times the outside diameter of the cable with a maximum spacing of 1 m for armoured cables. A minimum of 20 mm ventilation clearance shall be maintained between cables and the wall to which they are cleated. Spacing of supports for cables for high voltage lighting shall be in accordance with Table 8 of SANS 10142.

Table 1: Maximum Spacing of Supports (Cleats) (mm)

FOR RESTRAINED CABLE				
Cross-sectional area of Cable conductors (mm ²)	Wire Armoured Cables		Other than Wire Armoured Cables and Unarmoured Cables	
	Horizontal Cable Routes	Vertical Cable Routes	Horizontal Cable Routes	Vertical Cable Routes
1,5	500	750	300	400
2,5	500	750	300	400
4,0	600	750	300	400
6,0	600	750	300	400
10,0	750	900	400	500
16,0	750	1 000	400	500
25,0	900	1 000	400	500
35,0	900	1 000	400	500
Above 35,0	900	1 000	400	500

E06.4 CABLE INSTALLATION IN CABLE TRENCHES

E06.4.1 General

The Contractor shall preserve the site as far as possible. Only the minimum of trees, shrubs,

rocks, etc. shall be removed and cleared for the cable route.

The cable trench will be arranged as shown in figure 2 below:

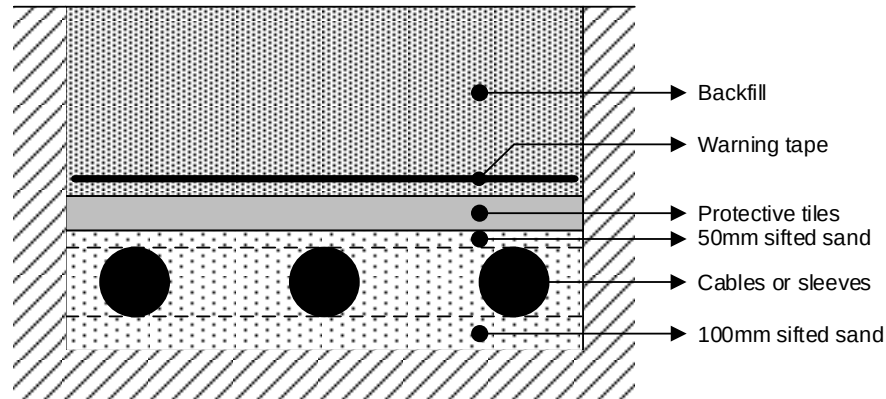


Figure 2: Cable trench arrangement

E06.4.2 Trench Routes

The cable trench shall be excavated along the route indicated on the relevant drawing. The routing should preferably traverse through the lowest theft risk areas as much as is possible.

The trench shall be as straight as possible and shall comply with all requirements. The Engineer shall determine the length of the trench to be excavated, which shall not exceed 300 m, before the cable is installed and the trench backfilled.

If any obstacle or interference should be encountered, which may require alterations to the trench or routes, such alterations shall receive prior written approval from the Engineer.

E06.4.3 Excavation of Cable Trenches

The exact positioning of trenches shall be approved on site by the Engineer and excavations shall not commence until approval has been received.

The trench shall be excavated to a depth indicated on the drawings for the different cables. Where depths are not indicated on the drawings, the following shall apply:

Cable trenches shall be excavated deep enough so that the top layer of the cables is buried a minimum of 600 mm below final ground levels for LV cables and 1000mm for MV cables.

The Contractor shall excavate by hand where he cannot excavate by means of machines due to limited access and the proximity of other services.

The bottom of the trench shall be level and shall follow the contours of the final ground level. Where the excavation is in excess of the required depth, the excavation shall be backfilled and compacted with suitable material to the required depth.

The Contractor shall remove all sharp projections, which could damage the cable where the trench is excavated through rocky formations, and shall remove all loose rocks, material, etc. from the bottom of the trench.

The Contractor shall trim the trenches and clean up the bottom of the trenches after he has completed the required excavation.

E06.4.4 Excavation of Jointing Chambers

Jointing pits shall be excavated to a depth of 1,2 m and shall be rectangular in shape and large enough for the cable jointers to work comfortably and in an efficient manner. Where more than one joint is to be made in the same position the joint pit shall be large and long enough to allow staggered joints to be made. The minimum size of a joint pit shall be as follows:

- (a) One joint : 2,5 m long x 1,25 m wide

(b) Two joints : 3,0 m long x 1,5 m wide

E06.4.5 Excavated Material

No excavated material shall be left closer than 300 mm from the side of the excavation. The excavated material shall take up as small an area as possible with the safety of the workers and Works taken into consideration. The excavated material suitable for bedding material shall be placed separately on one side of the trench so that it is available when required.

Where surplus material or material unsuitable for backfilling has to be disposed of, the Contractor shall load and transport the material in the area provided to him, where it will be dumped.

E06.4.6 Inspection of Excavations

All cable excavations will be inspected by the Engineer prior to cable laying and backfilling commences.

The Contractor shall give the Engineer 24 hours' notice to do the inspections. No inspections shall be undertaken on Saturdays, Sundays and public holidays.

E06.4.7 Measurement of Excavations

Full detail of the cable trench dimensions and classification of the type of excavation shall be recorded by the contractor. The report will be presented to the Engineer as the final quantities for such excavations. The Contractor shall be responsible to keep all records as proof of progress and as basis for claims for payment. Inspections and measurements shall be completed before the installation of any bedding or backfilling.

The Contractor shall give the Engineer 24 hours' notice to be present when excavation are measured. No measurements shall be undertaken on Saturdays, Sundays and public holidays.

E06.4.8 Maintenance of Excavations

The Contractor shall maintain the excavation in a good condition, free of water, mud, loose ground, rocks, stones, gravel and other strange material until the cables are installed and the excavation is backfilled and compacted.

E06.4.9 Bedding Sand

A 100mm layer of sifted bedding sand free from sharp objects and rocks shall be laid and levelled at the bottom of each trench after the trench has been approved by the engineer, and prior to cable laying.

If the soil for the sand bed and sand cover has to be sifted, a sieve with holes 6 mm or smaller shall be used. Where this material is not available, the contractor shall import suitable material for such purposes. Where bedding has already been laid, the Engineer may instruct the Contractor to demonstrate that the minimum thickness of bedding has been provided for before authorising cable laying to proceed.

E06.4.10 Cable Laying

After approval of the trench, the cable shall be laid with the minimum of delay so that the trench can be backfilled. The Contractor shall, however, not backfill the trench until each length of cable has been inspected and approved by the engineer.

Only one cable shall be laid at a time and the Contractor shall take precautions that installed cables are not damaged. Cables should be laid with sufficient slack to relieve stresses.

The method to be used for laying cables shall be approved by the Engineer prior to the commencement of the laying of the cables.

Cable rollers shall be used when cables are drawn into trenches. The cable rollers shall be placed so that the cable does not touch the bottom or the sides of the trench. The rollers shall be of an approved construction without any sharp metal parts, which could damage the cables.

If the Contractor intends using a winch to draw the cable into the trench, a cable stocking shall be used or the draw wires shall be soldered to the cable so that the tension is exerted on all the cores, lead sheath and/or steel wire armouring at the same time.

The maximum tension on a cable during laying operations shall not exceed the value specified

by the manufacturer.

Should the Engineer not be satisfied with the manner or method employed to lay the cable he shall have the authority to instruct the Contractor to lay the cable by hand or in accordance with approved standards.

Medium-voltage cables shall overlap by at least 1m, but not more than 1,5m at joints.

Sufficient lengths of cable shall be left at the beginning and end of the cable routes to allow for the termination of the cables. Where necessary the Engineer shall decide on what length of cable is to be left. The Contractor shall take the necessary precautions to protect the cable ends until they are terminated. The cable ends shall be sealed by means of lead or heat-shrink sealing caps to ensure that the cable is waterproof.

Where cables are drawn through sleeves, care shall be taken that they are not kinked or excessively bent. No bend in a cable shall have a radius less than the minimum-bending radius specified by the cable manufacturer.

The Contractor shall keep accurate records of each length of cable laid. The following information shall be recorded:-

- (d) Cable drum number
- (e) Size of cable
- (f) Laid from where to where
- (g) Length of cable
- (h) Date laid

E06.4.11 Inspection of Cables

The Contractor shall be solely responsible for inspecting all cables before backfilling to ensure that the correct type and number of cables have been installed. All cable installation will be inspected by the Engineer prior to backfilling commences.

The Contractor shall give the Engineer 24 hours' notice to do the inspections. No inspections shall be undertaken on Saturdays, Sundays and public holidays.

E06.4.12 Measurement of Cables

Full detail of the cable length shall be recorded by the Contractor. The report will be presented to the Engineer as the final quantities for such installation. The Contractor shall be responsible to keep all records as proof of progress and as basis for claims for payment. Inspections and measurements shall be completed before the any backfilling commences.

The Contractor shall give the Engineer 24 hours' notice to be present when cables are measured. No measurements shall be undertaken on Saturdays, Sundays and public holidays.

E06.4.13 Sifted Sand topping

A 50mm layer of sifted bedding sand free from sharp objects and rocks shall be laid and levelled on top of the installed cables, prior to laying of the protective concrete tiles. If the soil for the sand bed and sand cover has to be sifted, a sieve with holes 6mm or smaller shall be used. Where this material is not available, the contractor shall import suitable material for such purposes.

E06.4.14 Concrete Protective Slabs

Protective concrete tiles will be installed above the sifted sand topping. Protective concrete tiles in trenches are there to provide protection against hand digging and warning of cables below. These tiles therefore can be paving blocks, precast wall slabs, etc. Requirements are that the tiles are not less than 38mm thick and will not break under their own weight (i.e. when the longest span of the tile or slab is supported on its ends) or when laid in the trenches by commonly accepted means. The tiles must also not break when the soil is compacted. The tiles must cover the entire width and length of the trench. Before purchasing any protective tiles, the contractor must submit details of the proposed tiles to the engineer for approval.

E06.4.15 Cable Warning Tape

Cable warning tape shall be installed on all cable routes (LV and MV) at 300 mm above the

protective concrete slabs. Where a cable route exceeds 600 mm in width, multiple warning tapes shall be run in such a way that the space between adjacent warning tapes does not exceed 185 mm.

The plastic cable warning tape shall consist of a strip of polyethylene of thickness 0,04mm and of nominal width 230 mm. The tape will be completely impregnated with a pigment such that the colour of the tape is yellow, colour No B49 of SANS 1091. A black-triangle and an electric flash symbol and the words "Danger, Gevaar, Ingozi" will be printed on the tape at intervals not exceeding 1m along its length.

E06.4.16

Backfill

When the protective tiles are installed, the trench shall be backfilled with soil containing not more than 40% rock or shale which shall be able to pass through a 100 mm sieve and which is approved by the Engineer.

Where more than 40%, but less than 70% rock occurs, the Contractor shall replace the rock with imported soil. However, should more than 70% rock occur then all the backfilling material shall be imported.

- (a) The Contractor may import further stone-free material to the site or sieve the excavated material for sand bedding and cover but payment shall only be compensated for the actual quantity of imported material required as determined by the engineer. The quantity of imported material required shall be calculated from the nominal trench width.
- (b) The excavated material shall be backfilled in layers of 150 mm and shall be well compacted and consolidated to 90% MOD AASHTO. Where necessary the Engineer may require that a mechanical vibrator be used for compacting the trench.
- (c) The Contractor shall maintain the completed sections of the cable trench in a proper safe condition for the duration of the contract. The Contractor shall refill and compact the trench where subsidence occurs.
- (d) After completion of the work, the route of the cable shall be neatly finished off and cleared. All stones bigger than 25 mm as well as all loose organic material and rubble shall be removed.

E06.4.17

Identification and Marking of Cable Routes

Cable route markers, in the form of concrete pre-cast posts, which stand 1.0m above ground level, secured in the ground, must be installed every 50m on straight runs and at every change in direction of the trench. Movable route markers will not be acceptable. The post must be equipped with a stainless steel plate engraved with "ELECTRICAL CABLES", the cable voltage and the direction indicated in which the cables run. If there are C&I cables in the same trench, there must be a separate label engraved with "C&I CABLES", and the direction indicated in which the cables run. If there are data communication cables in the same trench, there must be a separate label engraved with "DATA CABLES" and the direction indicated in which the cables run. These labels must be cast into the concrete post so that they cannot be pried off.

At the bottom of the post, a 450 x 450 x 100mm concrete base must be cast to ensure that the route marker can only be removed if it is deliberately dug out of the ground. Steel reinforcing mesh of MRM reference 156, in accordance with SANS 1024 is required in the concrete and the concrete compressive strength of the base must not be less than 15 MPa. (Note: Reinforcing mesh to MRM 156 consists of 3.55mm diameter wire used to create 100 x 100 mm squares).

These route markers must be installed right next to the trench and not over the cables, so that the trench can be re-opened without affecting the route marker. The labels on the route marker must be on the trench side of the route marker.

Cable route markers must be protected in areas of high vehicle traffic.

Figure 1 below provides the required detail of these cable route markers.

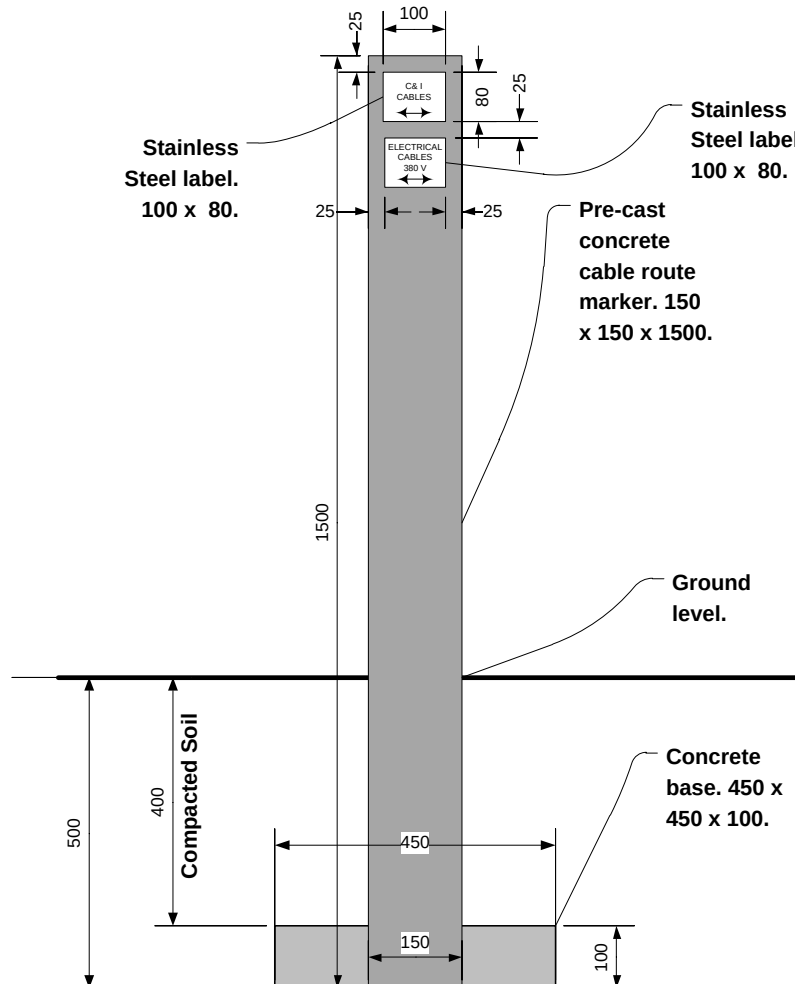


Figure 1: Cable Route Markers

E06.4.18

Road Crossings

The cable sleeves shall be installed 1,5m below ground level to avoid damage when the roads are constructed.

Unless otherwise specified, two additional sleeves shall be installed for future use at each road crossing.

Sleeves used for crossings shall be straight and undamaged. Bends shall not be allowed in road crossings. Sleeves shall be extended for a distance of 1,0m outside the roadway.

After the installation of the sleeves, the sleeves shall be meticulously backfilled so that no air pockets are left. The trench shall thereafter be backfilled in layers of 150 mm and compacted with mechanical vibrators to 95% modified AASHTO density.

The Contractor shall lay and join the cable sleeves and compact the trench to the satisfaction of the engineer. After installation, the sleeves shall be cleaned and a galvanised steel draw wire installed in the sleeve prior to the sleeve ends being sealed by means of plastic plugs.

E06.4.19

Crossing of Services

Where a cable crosses over other services, the cable shall not be installed at a depth less than

800 mm below ground level and if this is not possible, the cable shall be installed underneath the other service and shall be protected in the prescribed manner by means of concrete slabs. The depth of the cable shall be maintained for one metre on either side of the crossing.

If it is not possible to cross over or underneath a service in the prescribed manner, the matter shall be referred to the Engineer for a decision.

The following minimum clearances shall be maintained between electrical cables and other services:-

	Vertical	Horizontal
Water pipes	0,3	1,0
Sewer pipes	0,3	1,0
Storm water pipes	0,3	1,0

E06.5 CABLE INSTALLATION IN CABLE DUCTS

E06.5.1 General

This paragraph covers the installation of cables in build-up trenches, service ducts, etc. inside buildings. The trenches, ducts, etc. will be constructed and installed by others.

The use of this method of cable routing should be avoided where possible as it exposes the cables to high risk of theft. Open channels shall not be used for cable routing on any site.

E06.5.2 Installation

Cables shall be installed in one of the following ways:

- (a) On vertical cable trays or.
- (b) On metal supports fixed to the side of the trench with suitable clamps.

Cables shall be clamped in position.

Cables shall not be bunched and laid on the floor of purpose built trenches.

E06.5.3 Covers

The covering of concrete trenches shall as a rule fall outside the scope of the electrical installation. However, the Contractor shall be responsible for the cutting or drilling and smoothing of holes for cables through chequer plates, concrete or other coverings as required.

Cables shall enter and exit the trench through sleeves protruding 300 mm beyond the covering. The sleeves shall be permanently secured in position and the open space between the cable and sleeves shall be sealed with a non-hardening, watertight compound.

E06.5.4 Filled Trenches

Where specified herein, floor trenches shall be filled with sand.

If a sand filling is specified, the cables shall be fixed to non-corroding supports.

Sand-filled trenches other than in substations shall be covered in one of the following ways:-

- (a) Reinforced concrete covers;
- (b) 100mm of 20MPa concrete;
- (c) Removable chequer plates. However, this will not be acceptable in open spaces.

Reinforced concrete covers shall be used where vehicular traffic may be encountered over trenches. Unless otherwise specified herein, allowance for a mass of 2 tons shall be made.

E06.6 CABLE JOINTS

E06.6.1 General

Joints in cable runs will not be allowed unless authorized by the Engineer.

Jointing shall be carried out strictly in accordance with the manufacturer's instructions. Only personnel competent in the installation of the specific joint will carry out the work.

During outdoor jointing operations, the joint bays shall be adequately covered by tents of waterproof material suitably supported. When necessary, a trench shall be excavated around the bay to prevent the ingress of moisture. The sides of the excavation shall be draped with small tarpaulin or plastic sheeting to prevent loose earth from falling in during jointing operations.

The crossing of cores in joints shall not be permitted under any circumstances. The electrical continuity of all the conductors, screens and armouring shall not be impaired by the joints and the earth continuity shall be accomplished within the joints, i.e. no external earth continuity conductor that will be subject to corrosion, is acceptable.

Joints shall be waterproof and airtight and shall be free of voids and air pockets. The joint shall not impair the anti-electrolysis characteristics of the cable. In the case of joints in cables with an outer PVC anti-electrolysis sheath, the joints shall be subject to the same electrical insulation test as the outer sheath of the cable.

The Contractor shall notify the Engineer timeously of the day on which jointing is to be carried out in order that an inspection may be arranged if so required. Any cable joint not inspected by the Engineer because of insufficient notice being given, shall be opened for inspection and redone at the discretion of the Engineer at the cost of the Contractor.

E06.6.2 Medium Voltage Cable Joints

Medium voltage cable joints shall be of the heat shrink type.

The joints shall make minimal, if any, use of insulating or stress relieving tapes. The use of electrical stress control and insulating tubing that is heat-shrunk on to the joint is preferred above other methods.

The materials shall comply with VDE 0278 and the supplier shall be called upon to confirm this aspect before acceptance of the materials or installation.

The heat-shrinkable and other materials used for joints shall be of a high quality and shall retain their electrical and mechanical properties without deterioration.

Joint kits shall be of a reputable brand.

E06.6.3 Low Voltage Cable Joints

Low voltage cable joints shall be of the epoxy-resin type.

The resin filled joint kit shall comprise a self-sealing plastic mould of high mechanical strength having sufficient connector space. The exact amount of cold hardening resin shall be provided in a two-compartment plastic bag. The resin shall have absolute minimum shrinkage. The mould and resin shall be waterproof and non-hygroscopic and shall be resistant to ultraviolet radiation.

Joint kits shall be of a reputable brand.

E06.7 CABLE TERMINATION

E06.7.1 General

Connection of cables to switchgear shall always be effected in such a way that the various phases, seen from the front of the switchgear will be in the following positions where practically possible:-

- (a) Conductor no 1 : left (red)
- (b) Conductor no 2 : centre (white)
- (c) Conductor no 3 : right (blue)

Exposed armouring is not acceptable. Glands will be properly fitted with shrouds to cover any bare armouring.

All cable ends shall be supplied with the necessary earth connection.

A strut or other approved means of support shall be provided to remove mechanical stress from the glands.

Cable cores shall be marked with heat-shrunk sleeves where necessary to identify the phases. Refer to SANS 10142.

The current-carrying capacity and breakdown voltage of the cable end shall be the same as for the complete cable.

Cables shall be terminated in accordance with the recommendations laid down by the manufacturers of the cables and glands installed.

E06.7.2

Cable Glands

All cable glands for indoor and outdoor use shall be Ex rated as per SABS 1213 and have corrosion proof guard. It shall have a minimum IP rating of 68. The cable glands shall be suitable for use in hazardous areas classified for zone 1, 2, 21 and 22.

Cable glands shall be of the adjustable type gland suitable for indoor use and shall be suitable for use with PVC PVC SWA PVC cables complying with the latest edition of SANS 1507. All glands shall be installed with non-deteriorating neoprene shrouds.

Outdoor use cable glands shall be similar to the indoor use cable glands with an additional feature of a nipple gasket and an inner seal kit, rendering the gland suitable for type "EXe" equipment (increased safety equipment).

In high corrosive areas, such as chlorination, chemical dosing and inlet works areas, the cable gland shall

- (a) offer a minimum degree of ingress protection of IP 66 according to SANS 60529;
- (b) be suitable for type " EXe " equipment;
- (c) be corrosion proof;
- (d) Have a positive seal internal to the cable gland that seals over the cable outer sheath. For these applications, no shrouds are required.

For all gland installations on armoured cable, the outer sheath of the cable shall be cut back in accordance with the gland manufacturers' recommendations, so that a minimum of armouring is exposed between the gland and the outer sheath after gland installation. The shroud shall seal on the outer sheath of the cable.

E06.7.3

Cable Lugs

Suitable cable lugs shall be used and shall preferably be solidly sweated to cable conductor ends. Lugs may be crimped using mechanical, hydraulic or pneumatic tools specifically designed for this purpose, on condition that evidence is submitted that the system used complies with the performance requirements of BS 4579, Part 1, "Compression joints in copper".

Lugs crimped to cable with a cross-sectional area of more than 16mm² shall entail the use of either pneumatic or hydraulic crimping tools. Under no circumstances may a lug be crimped by means of a hammer and/or punch.

Lugs crimped to aluminium shall be subjected to thorough inspection with relation to the material and quality of crimping by the Engineer. Bi-metallic aluminium-copper lugs shall be used according to the manufacturer's specifications, where solid aluminium conductors are terminated onto copper busbars.

Fixing bolts shall be manufactured of cadmium plated high tensile steel and shall match the lug hole size. Contact surfaces between the lug and the busbar shall be thoroughly cleaned and smoothed.

When cutting away insulation from cable conductors to fit into lugs, care shall be taken that no strands are left exposed. Under no circumstances may any of the conductor strands be cut away to fit into lugs. Care must be taken when cutting the insulation not to damage the conductors.

Cables that are connected to clamp type terminals where the clamping screws are not in direct contact with the conductors need not be lugged, but the correct size terminals shall be used.

Ferrules shall be used where cable conductors are connected directly to equipment with screws against the conductor strands.

E06.7.4

Medium Voltage Cable Terminations

Heat shrinkable termination kits shall be used for all high voltage (above 1 kV) terminations and shall be applied strictly in accordance with the manufacturer's recommendations.

The complete termination kit shall be packed in a container that is marked for the type of cable insulation and construction as well as the voltage range for which the materials are suitable. An illustrated set of instructions for the installation of the materials shall accompany every termination kit.

The terminations shall make minimal, if any, use of insulating or stress relieving tapes. The use of electrical stress control and insulating tubing that is heat-shrunk on to the terminations is preferred above other methods.

The termination kits shall include suitable boots for the covering of the terminal studs on the equipment. The cable ends shall be terminated strictly in accordance with the termination manufacturer's specification. The cable ends shall withstand the same test voltage as the cable.

The materials shall comply with VDE 0278 and the supplier shall be called upon to confirm this aspect before acceptance of the materials or installation.

The heat-shrinkable and other materials used for the terminations shall be of a high quality and shall retain their electrical and mechanical properties without deterioration.

Terminations shall be made of a material that gives lasting protection against ultra-violet radiation.

The cores of all cables terminated outdoors and the cores of 3,3 kV and higher voltage cables terminated indoors, shall be completely covered with a shrunk-on protective layer against surface tracking, ultra-violet radiation and weathering.

Outdoor terminations shall be designed to prevent flashover under wet or contaminated conditions and to ensure additional mechanical strength. This shall be achieved with shrunk- on insulating spacers and rain sheds.

E06.7.5

Cable Identification

Cables shall be identified at all terminations (both ends). The identification of MV cables installed in cable ladders, ducts or to structures shall be to SANS 10142-1.

Both ends of the cable shall be marked with the cable number in accordance with the cable schedule. The cable tag shall comprise of a punched stainless steel strap that shall be tied onto the cable by means of a thin stainless steel tape

The use of PVC tape with punched characters or punched metallic bands or tabs is not acceptable.

The identification number of cables shall be shown on the "as built" drawings of the installation.

E06.8

TESTING OF THE INSTALLATION

The contractor shall supply factory test certificates for each drum of cable supplied under the Contract.

After the installation is complete, the contractor and the Engineer shall inspect the installation. The Engineer must be notified in advance of the inspection dates. The contractor will keep a snag list, reflecting all items not acceptable to the Engineer. The contractor will correct the snag items as required to the Engineers approval, updating the snag list as the items are completed and accepted/signed off by the Engineer.

On completion of his work, the Contractor will issue an Electrical Certificate of Compliance (CoC). All tests deemed necessary to issue the CoC should be included. The Contractor shall make all arrangements, pay all fees and provide all equipment for these tests. The Contractor shall notify the Engineer timeously so that he may witness the tests.

Each installed cable shall be tested in accordance with:

- (a) The Occupational Health and Safety Act (OHSA) 1994;
- (b) SANS 97 (Electric cables - Impregnated paper-insulated metal-sheathed cables for rated voltages 3,3/3,3 kV to 19/33 kV)

SANS 97	Duration (min)	Commissioning test voltage between conductors			Commissioning test voltage between conductors / sheath		
Test Wave		(V)			(V)		
		3300/ 3300	3800/ 6600	6350/ 11000	3300/ 3300	3800/ 6600	6350/ 11000
AC (r.m.s)		15	7000	13000	22000	7000	8000
DC	15	9000	19000	31000	9000	11000	19000

- (c) SANS 1339 (Electric cables - Cross-linked polyethylene (XLPE) insulated cables for rated voltages 3,8/6,6 kV to 19/33 kV)

SANS 1339	Duration (min)	Commissioning test voltage between conductors			
Test Wave		(V)			
		6600	11000	22000	33000
VLF (0.1 Hz)	60	11000	19000	38000	57000
Power frequency	60	8000	13000	25000	38000
DC	10	6000	10000	20000	30000

DC voltage testing is likely to cause irreversible damage to XLPE-insulated cable systems. The voltage and duration should be limited to the appropriate values given in the table above. The contractor shall use a DC test set to apply the test voltage. After completion of the DC test, the contractor shall soft-discharge the cable, using either the DC test set or a discharge stick where after the cable will be fully discharged by solidly earthing it for at least 8 h but preferably for 24 h. DC testing shall only be carried out with written permission from the Engineer,

- (d) SANS 1507 (Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V));

SANS 1507	Duration (min)	Commissioning test voltage between conductors			Commissioning test voltage between conductors / earth		
Test Wave		(V)			(V)		
		300/ 500	600/ 1000	1900/ 3300	300/ 500	600/ 1000	1900/ 3300
AC (rms)	15	1000	2000	6000	1000	2000	3500
DC	15	1500	3000	9000	1500	3000	5000

E06.9

COMPLETION

The Engineer reserves the right to inspect the installation at any stage during the course of construction. However, such inspections will not deem the portions inspected as being complete or accepted and the Contractor shall remain responsible to complete the installation fully in accordance with this specification.

The Contractor shall carry out a final "as built" survey of the cable routes and present to the Engineer "as built" route plans of the complete installation.

The following information shall be reflected on the plans or submitted as separate schedules with the plans:

- (a) Overall length of each cable;
- (b) Locations of all joints (if any) in relation to permanent reference points. Dimensions shall be shown and the method of triangulation i.e. two dimensions shall be used to each joint;
- (c) The location of all cable markers in relation to permanent reference points;
- (d) Identification numbers of all cables.

The Works will be deemed incomplete until all tests have been conducted and certified successfully and all "as built" drawings and schedules have been handed to the Engineer.

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER
PARTICULAR SPECIFICATION
E07 : ELECTRICAL INDUSTRIAL WELDING
PLUGS, COUPLERS AND SOCKET OUTLETS

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E07.1 SCOPE

This specification covers the procurement, supply, delivery, installation testing and commissioning of the required industrial welding plugs, couplers and socket outlets for industrial purposes.

E07.2 STANDARDS

E07.2.1 National Standards

The latest edition, including all amendments up to date of tender of the following particular national specifications, publications and codes of practice shall be read in conjunction with this specification and shall be deemed to form part thereof:

- (a) SANS 1222 : Enclosures for electrical equipment classified by IP code
- (b) SANS 1239 : Plugs, socket-outlets and couplers for industrial purposes
- (c) SANS 6309 : Plugs, socket-outlets and couplers for industrial purposes
- (d) SANS 1091 : National colour standard
- (e) SANS164-2 Plug and socket-outlet systems for household and similar purposes for use in South Africa Part 2: Two-pole and earth and 2 pin (Class II), 16 A 250 V a.c. system.
- (f) SANS 10142-1 : The Wiring of Premises Part 1 – Low Voltage Installations

E07.2.2 Particular specifications to be read in conjunction with this specification

- (a) E26 : ELECTRICAL SPECIFICATION FOR COLOUR CODES
- (b) G02 : PARTICULAR SPECIFICATION FOR CORROSION PROTECTION
- (c) E06 : ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE INSTALLATION
- (d) E08 : WIRING

E07.3 GENERAL REQUIREMENTS

Switched 400V 3-phase, 3-wire and earth 63A industrial welding socket outlet plus a switched 230V, single phase, 3-wire 16A industrial socket outlet shall be supplied. A 4-core cable shall be used with an earth included in the supply cable.

E07.3.1 Single phase 16A household and similar purpose socket outlet

Applied to general household, commercial and light industrial installations up to 250Vac 16 A.

- (a) Compliance: SANS 164-2/SANS10142-1
- (b) Wall mounted socket;
- (c) Be of the two-pole earthing contact type;
- (d) Incoming power supply via a 2-pole earth leakage protection unit located in the upstream distribution board;

E07.3.2 Single phase 16A industrial socket outlet

- (e) Wall mounted socket;

- (f) Pin and sleeve configuration;
- (g) 2 pole, 3-wire with 2P+E 230V ac, 16A;
- (h) Incoming power supply via a 2-pole earth leakage protection unit located in the upstream distribution board;
- (i) Ingress protection IP67 (SANS 1222);
- (j) Switched locally on the socket outlet;
- (k) Mechanical interlock to prevent plugs from being engaged or disengaged under load;
- (l) Lockable by a padlock (40mm) at the switch-off position.

E07.3.3

Three phase 63A industrial welding socket outlet (5-pin)

- (a) Compliance: SANS 60309-1
- (b) 415Vac 3phase, neutral and protective earth (5 pin), 63A current rating
- (c) Housing: Powder coated die-cast aluminium
- (d) Colour: Electric orange RAL B26
- (e) Wall mounted socket with top cable entry with removable flange;
- (f) Pin and sleeve configuration;
- (g) 3-phase earth leakage protection unit mounted in the feeder cubicle in the MCC/DB;
- (h) Rated ingress protection IP55 (SANS 1222);
- (i) Switched locally on the socket outlet, lockable by a padlock (40mm) at the switch-off position;
- (j) Mechanical interlock: The isolator cannot be "Switched ON" without the plug inserted and the plug cannot be removed while the isolator is in "ON" position
- (k) Matching metal clad plug top, 415Vac 3-phase 5 pin, 63A, IP55 to be supplied with the socket outlet.

Where pilot wire connections are required, they shall disconnect before the main phase connectors disconnect.

The equipment enclosures shall be IP55 to SANS 1222. Socket outlets that are exposed to the atmosphere or installed in damp areas, shall be minimum rated at IP 56 or as otherwise specified by the engineer. All sockets shall be constructed of corrosive resistant materials.

Both types of sockets shall be mounted on a 304 stainless steel heavy duty pedestal. The socket outlet mounting height shall be 1200 mm above finished ground level.

A purpose made metal junction box of IP65 rating to SANS 1222 fitted with a canopy shall be provided and mounted on the stand above the socket outlet in such a way that the junction box does not interfere with the use of the socket outlet. The supply cable to the welding socket shall be terminated in the junction box. Where the cross sectional area of the cores of the supply cable to the welding socket outlet exceeds 16 mm², the cable core size from the junction box terminals to the socket outlet shall be 16mm², 4-core. The 16A single-phase socket shall have its own dedicated supply.

The junction box including the canopy and the welding socket stand shall be powder coated /painted B26 – Light Orange (1673-Y48R) to SANS 1091.

E07.4

TESTING AND COMMISSIONING

During testing and commissioning, the contractor shall:

- (a) Perform a visual inspection to ensure that the installation complies to the requirements specified herein as well as in detailed specifications;
- (b) The rating of all equipment is as specified;

(c) Test all earth leakage protection units supplied to confirm the tripping current.

E07.5

MEASUREMENT AND PAYMENT

Measurement and payment will distinguish between supply / delivery and installation / commissioning of industrial welding plugs, sockets, connectors etc.

Item

Unit

Supply and deliver of welding plugs and switched socket outlets complete with plugs No

The unit of measurement shall be the number of plugs and switched socket outlets including stands and junction boxes supplied and delivered.

Separate items shall be scheduled in the schedule of quantities for different types of switched socket outlets.

The tendered rate shall include all costs related to the supply and delivery of the specified switched socket outlet and plugs and shall include for the stands and junction boxes required.

Item

Unit

Install and commission welding plugs and switched socket outlets No

The unit of measurement shall be the number of plugs and switched socket outlets including stands and junction boxes installed and commissioned.

Separate items shall be scheduled in the schedule of quantities for different types of switched socket outlets and whether the plug must be installed on a cable or whether the plug must be handed over to the employer.

The tendered rate shall include full compensation for the installation of the switched socket outlet and plugs as detailed in the detail specification including all required material and labour to render a complete and working installation, including all labour and material required for installing the plug on the cable as detailed or for handing over the plug (free issue) to the employer and obtaining a receipt therefore.

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PARTICULAR SPECIFICATION
E08 : ELECTRICAL WIRING

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PARTICULAR SPECIFICATION: VOLUME E08: ELECTRICAL WIRING

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E08.1 SCOPE

This specification covers the wiring requirements of electrical installations.

E08.2 STANDARDS

The latest edition, including all amendments to until the date of tender, of the following particular national and international specifications, publications and codes of practice shall be read in conjunction with this specification and shall be deemed to form part thereof:

- (a) SANS 10142-1 : The wiring of premises Part 1: Low-voltage installations
- (b) SANS 1411-2 : Materials of insulated electric cables and flexible cords: Part 2 – Polyvinyl Chloride (PVC)
- (c) SANS 1507 : Electric Cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V)

E08.3 GENERAL REQUIREMENTS

PVC insulated conductors for general wiring shall consist of high conductivity annealed copper wire strands with polyvinyl chloride insulation. The insulation shall be compounded and stabilised to comply with SANS 1411-2 as amended.

Conductors shall be finished in the required colours and shall be manufactured in accordance with SANS 1507 as amended.

Any special requirement regarding the type and size of wiring to be installed in a specific installation shall be specified.

E08.4 DRAWING OF CONDUCTORS

Wiring shall only be carried out after the wireway installation is completed, but before painting has commenced. No conductors shall be installed before the wireways have been cleaned of all debris and moisture. Wireways shall contain no sharp edges.

When conductors are drawn through conduit, care shall be taken that they are not kinked or twisted.

E08.5 WIRING METHOD

All wiring shall be carried out according to the loop-in system. When earth continuity conductors are looped between terminals of equipment, the looped conductor ends shall be twisted together and ferruled to ensure that earth continuity is maintained when the conductors are removed from a terminal.

When connecting more than one conductor in a terminal, the strands shall be securely twisted together. Under no circumstances shall strands be cut off.

E08.6 SIZE OF CONDUCTORS

The following minimum conductor sizes shall be used:

Bell circuits	=	1.5 mm ²
Clock circuits	=	1.5 mm ²
Lighting circuits	=	1.5 mm ²
Plug circuits	=	2.5 mm ²
All the above	=	2.5 mm ² earth conductor
Motor circuits	=	As specified

E08.7 DIFFERENT PHASES

With the exception of three-phase outlets, circuits connected to different phases shall not be present at light, switches or socket-outlet boxes.

E08.8 TESTING AND COMMISSIONING

The contractor shall supply factory test certificates for each drum of cable supplied under the Contract.

After the installation is complete, the contractor and the Engineer shall inspect the installation. The Engineer must be notified in advance of the inspection dates. The contractor will keep a snag list, reflecting all items not acceptable to the Engineer. The contractor will correct the snag items as required to the Engineers approval, updating the snag list as the items are completed and signed off by the Engineer.

On completion of his work, the Contractor will issue an Electrical Certificate of Compliance (CoC). All tests deemed necessary to issue the CoC should be included. The Contractor shall make all arrangements, pay all fees and provide all equipment for these tests. The Contractor shall notify the Engineer timeously so that he may witness the tests.

Each installed cable shall be tested in accordance with:

- (a) The Occupational Health and Safety Act (OHSA) 1994;
- (b) The requirements of the Local and Supply Authorities.

E08.9 MAINTENANCE INSTRUCTIONS AND GUARANTEES

E08.10 MEASUREMENT AND PAYMENT

<u>Item</u>	<u>Unit</u>
Supply and deliver LV conductors	m

The unit of measurement shall be the linear length of conductor supplied and delivered.

The tendered rate shall include full compensation for the supply and delivery to site of the specified conductors. Conductors will be measured linearly along the full length installed in the wireway and sufficient provision will be made in the quantities for conductor slack at outlet boxes and distribution board trays. No extra will be allowed for jointing, overlapping and wastage at connections.

Separate items shall be scheduled for each conductor size.

<u>Item</u>	<u>Unit</u>
Install LV conductors in conduit	m

The unit of measurement shall be the linear length of conductors installed in conduit.

The tendered rate shall include full compensation for the handling, inspection, pulling in conduit the specified number and sizes of conductors, cutting and testing of the conductors. Sufficient provision will be made for conductor slack at outlet boxes and distribution board trays to make the necessary connections to equipment.

Separate items shall be scheduled for each size of conductor.

<u>Item</u>	<u>Unit</u>
Install LV conductors in trunking	m

The unit of measurement shall be the linear length of conductors installed in trunking.

The tendered rate shall include full compensation for the handling, inspection, installing in trunking the specified number and sizes of conductors, the grouping of these conductors into circuits using plastic cable ties, cutting and testing of the conductors.

Separate items shall be scheduled for each size of trunking and for each size of conductor.

This rate shall furthermore include for the supply of all cable ties, clamps and other materials

necessary to ensure that the wiring conforms to the specification.

<u>Item</u>	<u>Unit</u>

Install LV conductors in power skirting.....	m

The unit of measurement shall be the linear length of conductor installed in power skirting.

The tendered rate shall include full compensation for the handling, inspection, installing in power skirting the specified number and sizes of conductors, the grouping of these conductors into circuits using plastic cable ties, cutting and testing of the conductors. Sufficient provision will be made for conductor slack at power outlets.

Separate items shall be scheduled for each type of power skirting and for each size of conductor.

This rate shall furthermore include for the supply of all cable ties, PVC sleeving for earth conductors and other materials necessary to ensure that the wiring conforms to the specification.

<u>Item</u>	<u>Unit</u>

Install LV conductors in floor ducting	m

The unit of measurement shall be the linear length of conductors installed in floor ducting.

The tendered rate shall include full compensation for the handling, inspection, installing in floor ducting the specified number and sizes of conductors, the grouping of these conductors into circuits using plastic cable ties, cutting and testing of the conductors. Sufficient provision will be made for conductor slack at power outlets. Where cables are exposed to the sun they shall be strapped, using stainless steel strapping.

Separate items shall be scheduled for each type of floor ducting and for each size of conductor.

This rate shall furthermore include for the supply of all cable ties, PVC sleeving for earth conductors and other materials necessary to ensure that the wiring conforms to specification.

<u>Item</u>	<u>Unit</u>

Supply conductor terminals.....	No

The unit of measurement shall be the number of conductor terminals supplied.

The tendered rate shall include full compensation for the supply and delivery to site of the specified terminals complete with mounting rail and all hardware required to fasten the terminals and mounting rail. Separate items shall be scheduled for each size of terminal.

<u>Item</u>	<u>Unit</u>

Install conductor terminals	No

The unit of measurement shall be the number of conductor terminals installed.

The tendered rate shall include full compensation for the handling, inspection and installation of the specified terminals and mounting rail. Separate items shall be scheduled for each size of terminal.

<u>Item</u>	<u>Unit</u>

Supply PVC insulated multicore cables	m

The unit of measurement shall be the linear length of cable installed.

The tendered rate shall include full compensation for the supply and delivery of the cables. Separate items shall be scheduled for the different types and sizes of cables.

<u>Item</u>	<u>Unit</u>

Install PVC insulated multi core cables.....	m

The unit of measurement shall be the linear length of cable installed.

The tendered rate shall include full compensation for the supply and delivery of the cables. Separate items shall be scheduled for the different types and sizes of cables.

<u>Item</u>	<u>Unit</u>

City of Johannesburg
Johannesburg Water (SOC) Ltd

Supply and install the terminations for PVC multicore cables No

The unit of measurement shall be the number of terminations installed.

The tendered rate shall include full compensation for the supply and installing of the terminations as specified.

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER
PARTICULAR SPECIFICATION
E09 : ELECTRICAL BUILDING
INSTALLATION

Johannesburg Water (SOC) Ltd.
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PARTICULAR SPECIFICATION: VOLUME E09: ELECTRICAL BUILDING INSTALLATION

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E09.1 GENERAL

The Particular Specification shall be read in conjunction with the Detailed Technical Specification.

Where the Detailed Technical Specification is in contradiction with this Particular Specification, the former shall apply to this contract.

E09.2 STATUTORY DOCUMENTS AND STANDARDS

E09.2.1 Standards

The installation shall be erected and carried out in compliance with:

- (a) SANS 10142-1 : The wiring of premises Part 1: Low-voltage installations
- (b) SANS 60529 : Degrees of protection provided by enclosures (IP Code)
- (c) SANS 10400-FR : National Building Regulations and Building Standards Act (Act 103 of 1977), as amended
- (d) SANS 60529 : Degrees of protection provided by enclosures (IP Code)

E09.2.2 Regulations, Acts and Bylaws

The installation shall be erected and carried out in compliance with the latest edition of the following:

- (a) Occupational Health and Safety Act (Act 85 of 1993) and Regulations;
- (b) Construction Regulation;
- (c) Applicable By-Laws and Regulations as implemented by the Local Authority;
- (d) Fire Regulations as implemented by the Local Authority.

E09.2.3 Particular Specifications to be read in conjunction with this specification

This specification shall also be read in conjunction with the following specifications:-

- (a) E02 : ELECTRICAL CABLE RACKS
- (b) E06 : ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE INSTALLATION
- (c) E08 : WIRING

In addition, the Contractor shall issue all notices and pay all the required fees in respect of the installation to the local authorities, and shall exempt the Employer from all losses, costs or expenditures that may arise because of the Contractor's negligence to comply with the requirements of the regulations enumerated in paragraph 9.2.

It is assumed that the Contractor is conversant with the above-mentioned requirements. Should any requirements, by-law or regulation, which contradict the requirements of this document, apply or become applicable during erection of the installation, such requirement, by-law or regulation shall overrule this document and the Contractor shall immediately inform the Engineer of such a contradiction. Under no circumstances shall the Contractor carry out any variations to the installation in terms of such contradictions without obtaining the written permission to do so from the Engineer.

E09.3 ARRANGEMENTS WITH THE SUPPLY AUTHORITY

It shall be the responsibility of the Contractor to issue all notices and pay all monies that are due for the electrical builders / temporary supply connection, except where otherwise specified. If, according to the contract, these monies are reclaimable from the Employer, then these claims by the Contractor shall be substantiated with official receipts.

It shall be the responsibility of the Contractor to make the necessary arrangements at his own cost with the local supply authority and to supply the labour, equipment and means to inspect, test, commission and to hand over the installation.

The Contractor shall supply and install all signage, notices and warning signs that are required by the appropriate laws, regulations and/or by this document.

E09.4 FIXING AND SUPPORTING OF EQUIPMENT AND MATERIALS

- (a) It is the responsibility of the Contractor to position and securely fix conduits, wiring ducts, cables and cable channels, switchboards, fittings and all other equipment or accessories as required for the installation. The Contractor shall provide and fix all supports, clamps, brackets, hangers and other fixing materials.
- (b) All supporting steelwork shall be wire-brushed and given one coat of rust resisting primer, followed by one coat of high quality enamel paint before any other equipment is fixed.
- (c) Supports, brackets, hangers, etc. may only be welded to steel structural members where prior permission has been obtained. Drilling of holes into or welding onto steel structural members is only allowed where prior permission has been obtained.
- (d) All methods of suspension or supports shall be submitted to the Engineer for approval and for reference to the Structural Engineers where necessary, prior to manufacture or installation.
- (e) Supporting of any rotating equipment shall incorporate anti-vibration mountings of the type and selection specified in the applicable clauses referring to equipment bases herein.
- (f) Supports shall preferably be strut channel, shall be of mild steel sections, purpose fabricated for their application. Under no circumstances whatsoever will sheet metal straps be accepted as a supporting method. All supports shall cradle the item to be supported; supports shall not be riveted or welded to the equipment. Rod hangers shall not exceed 3000mm in length and be of minimum diameter 12mm. For longer suspensions use mild steel angles. Angle profile supports shall be of 38 x 5mm minimum section.
- (g) Where holes in equipment exist, bolts and fixing screws as specified shall be used. Where sizes are not specified, the largest bolt or screw that will fit into the hole shall be used.
- (h) Anchor bolts shall be used for fixing supports to brick or concrete walls, it not being permissible to utilise gunpowder shot-driven bolts for this purpose unless prior permission has been obtained.
- (i) Where the fixing holes in brick or concrete walls are smaller than 10mm diameter and where the mass of the equipment is less than 15kg, wall plugs may be used to fix conduits, cables and other equipment. Aluminium, fibre or plastic plugs only may be used. Wooden plugs are not acceptable. Plugs installed in seams between bricks are not acceptable. A masonry drill of the correct size shall be used to drill holes for plugs. Round headed screws shall be used throughout.
- (j) Where the fixing holes are 10mm and larger or where the mass of the equipment is 15kg or more, equipment shall be fixed by means of expanding anchor bolts or by means of bolts cast into the concrete.
- (k) Galvanised screws, bolts and nuts shall be used to fix galvanised equipment.
- (l) No shot-fired or explosion driven tools will be allowed.

E09.5 ELECTRICAL CONDUIT INSTALLATION

E09.5.1 General

Where conduits are to be installed in concrete, this shall be done while the building work is still in progress. Surface mounted conduit shall only be installed after the concrete has cured sufficiently.

E09.5.2 Other Services

Conduits may not be installed closer than 150mm to pipes containing gas, steam, hot water or other materials which may damage the conduits. Conduits may not touch pipes or other service installations in order to prevent electrolytic corrosion. Where doubtful situations of this nature occur or where there are installation incompatibilities, the matter shall be reported to the Engineer immediately.

E09.5.3 Galvanised Conduit

Galvanised conduit and accessories shall be used under all circumstances:

Conduit and accessories shall be hot-dipped galvanised to SANS 32: Internal and/or external protective coatings for steel tubes - Specification for hot dip galvanised coatings applied in automatic plants and SANS 121: Hot dip galvanised coatings on fabricated iron and steel articles - Specifications and test methods.

E09.5.4 Debris

Care shall be taken to prevent any debris or moisture from entering the conduit during and after installation of the conduits. All conduit ends shall be sealed by means of a solid plug, which shall be screwed to the conduit end. All conduits shall be cleaned to remove all oil, moisture or other debris that may be present, before conductors are installed.

E09.5.5 Defects

Each length of conduit shall be inspected for defects and all burrs shall be removed. All conduits that are split, dented or otherwise damaged or any conduits with sharp internal edges shall be removed from site. The Contractor shall ensure that conduits are not blocked.

E09.5.6 Conduit Ends

Conduit ends shall be cut at right angles to ensure that ends butt squarely at joints. Threads shall not be visible at joints and connections except at running joints for steel conduits.

E09.5.7 Joints

All conduit ends shall be reamed and all joints tightly screwed. Only approved couplings shall be used. Running joints with long threads shall be kept to a minimum and locknuts shall be provided to ensure a strong mechanical and a continuous electrical joint for steel conduits.

E09.5.8 Finish

All joints shall be painted with cold galvanizing paint to prevent them from rusting in damp areas, and in cases where the installation is exposed to the weather for any length of time. Where the galvanising finish was damaged, the area shall first be cleaned and a coat of cold galvanizing paint applied subsequently. Additional coats of paint shall only be applied after the undercoat has been completed.

E09.5.9 Continuity

Mechanical and electrical continuity shall be maintained throughout the conduit installation. The use of conduits as earth continuity conductors are not allowed.

E09.5.10 Inspection Type Accessories

Inspection type couplings, elbows and tees shall not be used except with the written consent of the Engineer. All outlet boxes and draw boxes shall however be of the inspection type.

E09.5.11 Position of Outlets

All accessories such as socket outlets, switches, lights, etc., shall be accurately positioned. It is the responsibility of the Contractor to ensure that all accessories are installed level and

square at the correct height from the floor, ceiling or roof level as specified. It shall be the responsibility of the Contractor to determine the correct final floor, ceiling and roof levels in conjunction with the Main Contractor. Draw boxes shall not be installed in positions where they will be inaccessible after completion of the installation. Draw boxes shall be installed in inconspicuous positions to the approval of the Engineer. All installed draw boxes shall be pointed out to the Engineer. The positions of all draw boxes shall be indicated on the 'as-built' drawings.

E09.5.12 Draw Wires

Galvanised steel draw wires shall be installed in all unwired conduits, e.g. conduits for future extensions, telephone installations and other services.

E09.5.13 Bends

A maximum of two 90° bends or the equivalent displacement will be allowed between outlets and/or draw boxes. Draw boxes shall be installed at maximum intervals of 12m in straight conduit runs. All bends shall be made without heating the conduit or without reducing the diameter of the conduit. The inside diameter of a bend shall not be less than three times the outside diameter of the conduit.

E09.5.14 Wall Sockets

Where more than one socket outlet is connected to the same circuit, the conduit shall be looped from one outlet box to the following on the same circuit. Where a metal channel is used, the conduit may be installed from the channel directly to the outlet box on condition that the conductors can be looped from one outlet to the next without the jointing of wires.

E09.5.15 Luminaires

Conduit end may not be used to solely support luminaires. Where luminaires are specified which are fixed directly to the pendant box, the pendant box shall be fixed independently of the conduit installation except where the pendant box is cast into concrete.

E09.5.16 Withdrawal of Conductors

To ensure that all electrical conductors shall be easily withdrawable from conduits, the Engineer reserves the right to have the conductors on any circuit removed at his discretion and replaced at the cost of the Contractor. If the conductors are damaged during removal, the damaged conductors shall be replaced and the cost of the replacement shall be borne by the Contractor.

E09.5.17 Temperature Differences

Should the conduit installation be subject to temperature gradients at the same time, an expansion joint shall be installed in a suitable position to accommodate expansion and contraction. The conduit at the higher temperature shall be insulated from the rest of the installation with a suitable material. The above conditions for example apply where conduits leave cold rooms.

E09.5.18 Flush Mounted Outlet Boxes

The edges of flush mounted outlet boxes shall not be deeper than 10mm from the final surface. Where this is not the case, an extension box which ends flush with the surface, shall be screwed to the outlet box. This method shall be used in partitions and clad surfaces.

E09.5.19 Excess Holes

All excess holes in draw boxes, distribution boxes, switchboards, cable ducts or trunking, power skirting, etc., shall be securely blanked off to render the installation vermin proof.

E09.5.20 PVC Conduit

The use of PVC conduit shall not be allowed, only if stated in the Detailed Technical Specification portion of the document.

E09.5.21 Terminations

E09.5.21.1 Switchboards, Power Skirting, Etc.

A female bush and two lock nuts shall be installed where conduits terminate in pressed steel switchboards and distribution boxes, cable ducts, power skirting, etc. The conduit end shall only project far enough through the hole to accommodate the bush and lock nut.

E09.5.21.2 Draw Boxes

A female bush and lock nut must be used to terminate conduits at draw boxes and outlet boxes without spouts.

E09.5.22 Open Roof Spaces

E09.5.22.1 Sequence of Work

Conduits and wiring in open roof spaces above ceilings other than concrete slabs must be installed before the ceilings and walls are painted and before removable ceiling tiles are installed. In roof spaces where access is limited after installation of the ceiling. It is the responsibility of the Contractor to ensure close liaison with the Main Contractor in connection with the work.

E09.5.22.2 Fixing

All conduits in open roof spaces shall be installed parallel and at right angles to the roof members and shall be fixed to the structures at intervals not exceeding 1 metre. Approved saddles shall be used throughout. Clout nails, clamps or wood screws shall be used to secure the saddles to wooden roof members. Saddles which comply with the requirements of this specification shall be used to secure conduits against concrete slabs. Written permission shall be obtained to secure conduits to steel beams in which case saddles shall be fixed by means of bolts, nuts and lock washers or purpose made saddles shall be used.

E09.5.22.3 Cross-Overs

Crossovers in conduit routes shall be minimised. Where crossovers are unavoidable offset one conduit only to cross the other conduit. Where several conduits enter the same draw box, they shall as far as possible be installed parallel to each other.

E09.5.22.4 Draw Boxes

Install draw boxes with metal cover plates where required and as far as possible near gangplanks. The use of socket and switch boxes instead of draw boxes in open roof spaces is unacceptable.

E09.5.22.5 Positions of Accessories

Install conduits in open roof spaces, which is accessible after completion of the building to allow wiring or inspection from a position above the conduits. Install conduits in ceiling voids with less than 900mm clear space between the ceiling and the roof, to permit wiring and inspection from a position below the conduits. Loop conduits between outlet boxes.

E09.5.22.6 Incandescent Luminaires

Where luminaires are secured directly to draw boxes in false ceilings or where ceiling roses or special connections are used, flush mounted, rear entry round draw boxes that are independently fixed to roof beams, shall be provided.

E09.5.22.7 Conduit Ends

All conduit ends for lighting outlets in ceilings shall be securely supported.

E09.5.22.8 Fluorescent Luminaires

Draw boxes for fluorescent luminaires shall be installed as specified in the previous paragraph but luminaires shall be installed as specified in paragraph 9.5.22.6.

E09.5.23 Installation in Concrete and Screeds

The Contractor must position all conduits and accessories casted in concrete in good time to prevent building delays.

In order not to delay building operations, the Contractor shall ensure that all conduits and accessories that casted in concrete are positioned in good time. The Contractor or his representative must attend when the concrete casting.

E09.5.23.1 Draw Boxes

Draw boxes, expansion joints and round ceiling boxes shall be installed where required and shall be neatly finished to match the finished slab and wall surfaces. Ceiling draw boxes shall be of the deep type. In hollow tile slabs, rear-entry draw boxes shall be used. In columns where flush mounted draw boxes are installed, the conduits shall be offset from the surface of the column immediately after leaving the draw box.

E09.5.23.2 Cover Plates

Where possible draw boxes and/or inspection boxes shall be grouped together under a common approved cover plate. The cover plate shall be secured by means of screws.

E09.5.23.3 Fixing to the Shuttering

All conduits, draw boxes etc., shall be securely fixed to the shuttering to prevent displacement when concrete is cast. Wire will not be accepted for securing boxes to the shuttering where off-shutter finishes are required. All draw boxes and outlet boxes shall be plugged with wet paper before they are secured to the shuttering.

E09.5.23.4 Concrete Floor Slabs

Conduits will not be allowed in concrete floor slabs of boiler rooms (or boiler houses), laundries, dewatering buildings, pump stations or other damp areas. Equipment in damp areas shall only be supplied from above by means of multi-core PVC-insulated cables which shall either be installed in galvanised steel ducting or on galvanised cable trays. All socket outlets and three phase outlets in damp areas shall be supplied from above.

E09.5.23.5 Screeds

The installation of conduits in floor screeds shall be kept to a minimum. Where conduits are installed in screeds, the top of the conduit shall be at least 20mm below the surface of the screed. Where the screed is laid directly on the ground, galvanised conduits shall be used. This ruling will always be applicable to the lowest floor of a building. A minimum distance of twice the outside diameter of the conduit shall be left free between adjoining conduits. Conduits shall be secured to the concrete slab at intervals not exceeding 2,0m.

E09.5.23.6 Inspection

All draw boxes, conduits, etc., which are installed in concrete shall be cleaned with compressed air and provided with draw wires two days after removal of the shuttering. Errors that occur during the installation of the conduits, or any lost draw boxes, or blocked conduits, shall be immediately reported to the Engineer in order that an alternative route can be planned and approved by the Engineer before the additional concrete is cast. Any additional cost shall be to the Contractor's account.

E09.5.24 Surface Installation

Except where installed in ceiling spaces, the installation of conduit on the surface of walls and concrete slabs will only be allowed when authorised, in writing, by the Engineer. Where surface conduits are specified, saddles shall be of the hospital (spacer) type.

E09.5.24.1 Building Lines

All conduits shall be installed horizontally or vertically as determined by the route and the Contractor shall take all measures to ensure a neat installation. Where conduits are to be installed directly alongside door frames, beams, etc., that are not true, conduits shall be installed parallel to the frames, beams, etc. When in doubt, the Contractor shall consult the Engineer before installation is commenced.

E09.5.24.2 Saddles

Conduits shall be firmly secured by means of saddles spaced at maximum intervals of 2000mm with at least two saddles per run. Saddles shall be submitted to the Engineer for

approval prior to commencement of installation. Where saddles are used to secure vertical lengths of conduit connected to surface mounted switch boxes or socket outlet boxes, the saddles shall be spaced so that the intervals between the box and the first saddle, between any two successive saddles and between the last saddle and the ceiling or roof are equidistant. Conduits shall be secured within 250mm before and after each 90° bend.

E09.5.24.3

Joints

Joints will not be allowed in conduit lengths not exceeding 3500mm when these conduits are installed on the surface of a wall. Threads shall not be visible at joints of completed installations, except where running joints are used. Running joints will be allowed only when absolutely necessary. All running joints shall be provided with lock nuts and shall be painted with red lead immediately after installation.

E09.5.24.4

Accessories

Inspection bends or tee pieces shall not be used. Non-inspection type bends may be used in the case of 40mm or 50mm diameter conduits. All draw boxes supporting luminaires or other equipment shall be fixed independently of the conduit installation.

E09.5.25

Flexible Conduits

In installations where the equipment has to be moved frequently to enable adjustment during normal operation, for the connection of motors or any other vibrating equipment, for the connection to thermostats and sensors on equipment, for stove connections and where otherwise required by the Engineer, flexible conduit shall be used for the final connection to the equipment.

The lengths of flexible conduit shall be as short as possible to comply with the requirements of the particular connection but shall not exceed 600mm, except when specified or approved by the Engineer.

Flexible conduit shall preferably be connected to the remainder of the installation by means of a draw box. The flexible conduit may be connected directly to the end of a conduit if an existing draw box is available within 2000mm of the junction and if the flexible conduit can easily be rewired.

Flexible conduit shall consist of metal-reinforced plastic conduit or PVC covered metal conduit with an internal diameter of at least 15mm, unless approved to the contrary. In false ceiling voids, flexible conduit of galvanised steel construction may be used. Connectors for coupling to the flexible conduit shall be of the gland or screw-in type, manufactured of either brass or cadmium or zinc plated mild steel. The requirements of paragraphs 9.5.9 are applicable.

Where the possibility exists that the conduit can come into contact with moisture, suitable covering and/or packing shall be installed to isolate the conduit from the moisture.

Flexible conduit connections shall be provided with an internal or external earth wire connection as required by the local Supply Authority, with preference given to internal earth wires where no specific local regulations apply.

E09.5.26

Stove connection

A freestanding stove, rated above 16A must be plugged in by means of a stove coupler (see figure 1). The stove coupler, which shall comply with SABS IEC 60309-with a minimum of 45Amp single-phase and 16 A per phase for three-phase. The open end of the connector tube shall point downwards. The switch-disconnector for the cooking appliance shall

- (a) be in the same room as the appliance,
- (b) be at a height above floor level of not less than 0, 5 m and not more than 2, 2 m,
- (c) not be above the cooking appliance,
- (d) be within 3 m of the appliance, but within 0, 5 m of the appliance if the switch-disconnector's purpose is not clearly indicated, and
- (e) not be fixed to the appliance.



Figure 1: Stove coupler

E09.5.27 Expansion Joints

Where conduits cross expansion joints in the structure, approved type draw boxes which provide a flexible connection in the conduit installation shall be installed.

The draw box shall be installed adjacent to the expansion joint of the structure and a conduit sleeve, one size larger than that specified for the circuit, shall be provided on the side of the draw box nearest the joint. The one end of the sleeve shall terminate at the edge of the joint and the other shall be secured to the draw box by means of locknuts.

The circuit conduit passing through the sleeve shall be terminated 40mm inside the draw box. The gap between the sleeve and the conduit at the joint shall be sealed to prevent the ingress of wet cement.

The conduit boxes shall be drilled and tapped and the earth wire shall be bonded to the boxes by means a 2,5mm² copper wire(minimum) with lugs and brass screws.

Draw boxes at the expansion joint shall be provided with a suitable steel cover plate fixed to the boxes by means of screws. The cover plates shall be installed before the ceilings are painted by others.

E09.5.28 Chases and Builder's Work

Except where otherwise specified, the Contractor shall be responsible for the builder's work connected with conduits, outlet boxes, switchboard trays, bonding trays and other wall outlet boxes as well as the necessary chasing and cutting of walls and the provision of openings in ceilings and floors for luminaires and other electrical outlets. The Contractor shall notify the Main Contractor of his requirements and the responsibility lies with the Contractor to ensure that these requirements are met.

Electrical materials to be built in must be supplied, placed and fixed in position by the Contractor when required by the Main Contractor. The Contractor shall also ensure that these materials are installed in the correct positions.

Where no Main Contractor is on site the Contractor is required to cover conduits installed in chases by a layer of 4 : 1 mixture of coarse sand and cement, finished 6mm below the face of the plaster and roughened. In all cases chases shall be deep enough to ensure that the top of conduits are at least 12mm below the finished plaster surface.

The Contractor is responsible for the cutting of chases and the building-in of conduits or other equipment. , He will be held responsible for all damage as a result of this work and will be required to make good to the satisfaction of the Engineer. Chases shall be made by means of a cutting machine.

Under no circumstances shall face brick walls or finished surfaces be chased or cut without the written permission of the Engineer. Where it is necessary to cut or drill holes in the concrete structure, then prior permission of the Structural Engineer shall be obtained to ensure that the structure is not weakened.

The Contractor shall maintain close co-operation with the Main Contractor and all his Contractors throughout the course of the contract. Should the Contractor not comply with this requirements, any additional costs resulting from lack of his co-operation will be recovered from him.

E09.5.29 Connections to Switchboards

Wherever possible conduits connected to switchboards shall terminate in a common fabricated sheet steel draw box installed in the vicinity of the switchboard. In open roof spaces this draw box shall be placed in a roof space of not less than 900mm clearance. Lighting and plug circuits may be separately grouped in common conduits or metal ducts (trunking) from the distribution board to the draw box.

The draw box shall be of sheet steel with a minimum thickness of 1,6mm and shall be provided with a removable cover plate.

E09.5.29.1 Flush Mounted Switchboards

Where flush mounted switchboards are required, the recessed switchboard tray shall be built into the brick or concrete wall. All conduits from the floor or roof shall be fully recessed and shall be bonded directly to the tray.

E09.5.29.2 Surface Mounted Switchboards

Where surface mounted switchboards are specified but where the conduits can be fully recessed, the conduit shall be connected to a recessed connection box installed behind the switchboard. An opening with the same dimensions as the connection box shall be cut in the back of the switchboard and be provided with a suitable grommet.

E09.6 **CABLE TRAYS AND LADDERS**

Please refer to the specification E02: Electrical Cable Racks.

E09.7 **WIRING DUCTS**

E09.7.1 Responsibility of the Contractor

The Contractor shall supply and install all wiring ducts as specified or as required by the cable and wiring installation including the necessary supports, hangers, fixing materials, bends, angles, junction T-pieces end caps, etc.

E09.7.2 Materials and Finishes

Wiring ducts shall be rolled from 1,2mm minimum sheet steel and shall be finished as follows:

(a)	In boiler rooms (or boiler houses), laundries, dewatering buildings, pump stations or other damp areas damp areas.	Stainless steel 3CR12 and epoxy powder coated
(b)	False ceiling voids	Pre-galvanised
(c)	Vertical building ducts	Hot-dipped galvanised to SANS 32 and SANS 121
(d)	Surface mounted in plant rooms, substations, service tunnels, basement, offices	Epoxy powder coated or electro-galvanised
(e)	Undercover industrial applications	Hot-dipped galvanised to SANS 32 and SANS 121.

The abovementioned finishes shall apply unless specifically to the contrary in the Detailed Technical Specification. Epoxy powder coats shall comply with paragraph EO9.12.9. Hot-dipped galvanised or electro-galvanised wiring ducts shall be cold galvanised at all joints, sections that have been cut and at places where galvanising has been damaged. Powder coated ducts shall likewise be touched up at joints, cuts and damaged portions using spray canisters recommended by the manufacturers of the channels.

E09.7.3 Cover Plates

All wiring ducts shall have metal snap-in cover plates. Cover plates for wider ducts shall be fixed by means of screws that shall permanently be tapped into the cover plates spaced at suitable intervals to prevent warping. The finish of the covers shall comply with paragraph EO9.7.2

E09.7.4 Connections

Adjoining lengths shall be correctly aligned and securely joined by means of fishplates and mushroom bolts, washers and nuts or connection pieces that are pop-riveted to both adjoining sections. All adjoining sections shall be rectangular and shall butt tightly. Covers shall fit tightly across the joint.

E09.7.5 Support for Conductors

All conductors in inverted wiring ducts shall be retained by means of metal clips or metal spacer bars at not less than 1m centres.

E09.7.6 Vermin Proofing

All wiring ducts shall be vermin proof after installation. Holes shall be covered by means of screwed metal plugs or by means of metal strips that are bolted or pop-riveted to the channel. Wooden or other plugs which are driven into holes or other temporary plugs or covers are not acceptable.

E09.7.7 Earth Continuity

Electrical and mechanical continuity shall be maintained throughout the wiring duct installation. A tinned copper bonding strip (6mm²) shall be installed across each joint and secured to both adjoining ducts by means of galvanised bolts, nuts and washers. The duct shall be bonded to the earth bar of the associated switchboard.

E09.7.8 Internal Finishes

All bends shall be of easy sweep design with 45° gussets. Burrs and sharp edges shall be removed and the inside edges of all joints shall be lined with rubber cement or other suitable rubberised or plastic compound to prevent conductor insulation laceration.

E09.7.9 Services

Multiple duct runs or internal metal partitions shall be used where conductors for power, control and other services are present.

E09.7.10 Vertical Installation

Where vertical duct lengths exceed 5m, conductors shall have intermediate fixings.

E09.7.11 Number of Conductors

Wiring ducts shall be large enough to ensure that the combined total cross-sectional area (including insulation) of all conductors does not exceed 40% of the cross-sectional area of the duct.

E09.7.12 Fixing

The Contractor shall supply and install all hangers, supports or fixings for the ducts. Ducts up to 75 x 75mm shall be supported at maximum intervals of 1m and larger channels at maximum intervals of 2m. Duct runs shall be carefully planned to avoid clashes with other services and to ensure that all covers can be removed after completion of the entire installation. The method of fixing the ducts or supports to the structure shall comply with paragraph EO9.4 with particular

reference to paragraphs E09.4.f and E09.4.h. Purpose made cable clamps, hangers, etc. shall be used as required.

E09.7.13 Installation in Concrete

The installation of wiring ducts in concrete will not be allowed.

E09.7.14 Fire Barrier

Where wiring ducts pass through walls, non-asbestos filling shall be installed around the conductors to serve as a fire barrier.

E09.7.15 Conduit Connection

All conduit connections shall be terminated by means of two lock nuts and a brass female bush. All holes through which conductors pass shall be equipped with grommets.

E09.8 INSTALLATION OF LUMINAIRES

E09.8.1 Positions

The mounting positions of luminaires shall be verified on site. All luminaires shall be placed symmetrically with respect to ceiling panels, battens, beams, columns or other architectural features of the space. The layout as shown in the documents shall generally be adhered to but any discrepancies or clashes with structural or other features must be referred to the Engineer before commencing erection of the installation. Should the Contractor neglect to refer such discrepancies to the Engineer, costs incurred as a result of subsequent alterations to suit the architectural features shall be to the Contractor's account.

E09.8.2 Cover Plates

Cover plates shall be fitted over all draw boxes and outlets for luminaires that are not covered by the luminaire canopy, lamp-holder, ceiling rose or similar accessories.

E09.8.3 Hanger and Supports

Where provision has not been made for the fixing of luminaires, the Contractor shall supply the necessary supports, hangers, conduit extensions, angle brackets or any fixing method approved by the Engineer.

E09.8.4 Suspended Cable Channels

Luminaires (especially fluorescent luminaires) may also be suspended from ceilings by means of suspended metal channels. The channel may be supported by conduits or threaded rods.

Should metal rods be utilised, these shall be screwed to anchor bolts fixed in the roof slab.

Wiring shall either be installed in conduits fixed to the metal channel or in the metal channels. Purpose-made clamps shall be used to fix the fittings to the cable channel.

E09.8.5 False Ceilings

In all cases where luminaires are fixed to false ceilings, the Contractor shall ensure that the ceiling is capable of carrying the weight of the luminaires before commencing installation.

Should any doubt exist in this regard, the matter shall be referred to the Engineer.

In cases where the mass of the luminaire is not carried by the ceiling but by a support or other suspension method, provision shall be made to prevent relative movement between the ceiling and luminaire, ceiling rose or connection point.

E09.8.6 Fluorescent Luminaires Fixed to Concrete Slabs

Fluorescent luminaires to be installed directly against concrete slabs or walls shall be fixed to the outlet box and at two additional points. The additional fixing can be effected by:

- (a) bolts built into the ceiling or wall,
- (b) screws and approved plugs, or
- (c) anchor bolts.

Shot-fired fixings are not acceptable. If specified or where approved by the Engineer, fluorescent fittings may be fixed to metal channels installed against concrete slabs or walls. The metal channel fixing may in this case be short-fired or fixed by any of the abovementioned methods. Purpose-made clamps shall be used to fix fittings to cable channels.

E09.8.7 Fluorescent Luminaires Fixed to False Ceilings

When fixing fluorescent luminaires to false ceilings, a gap shall not be visible, except where the ceiling tile is of non-fire resistant material, between the fitting and the ceiling. The luminaire shall be fixed directly to the ceiling beams by means of 40mm round-head wood screws and washer or alternatively be fixed to 50 x 76mm wooden supports that are fixed to the ceiling beams. In the case of tiled ceilings with exposed or concealed T-section supports, the luminaires shall be fixed to the metal supports by means of butterfly screws, pop-rivets or bolts with nuts and washers. Self-tapping screws may not be used.

E09.8.8 Continuous Rows of Luminaires

In cases where fluorescent luminaires are installed in tandem, only one connection outlet need be supplied per circuit. All luminaires shall be coupled to one another by means of nipples or brass bushes and lock nuts to ensure that wiring is not exposed and that earth continuity is maintained. Luminaires on the same circuit may be wired through the channel formed by the fitting canopies. In this case silicon-rubber insulated conductors shall be used and internal connections shall be made at terminal blocks.

Screw connectors are not acceptable. The wiring for any other circuits or outlets, even though these may be in the same row may not be installed through the fitting canopies. The Contractor shall ensure that continuous rows are straight and parallel to the relevant building lines.

E09.8.9 Recessed Luminaires

Where recessed luminaires are required, the Contractor shall maintain close liaison with the Ceiling Contractor. In the case of tiled ceilings, the luminaires shall be installed while the metal supports are being installed and before the tiles are placed in position. The Contractor shall be responsible for the co-ordination of the cutting of ceiling tiles with the Main Contractor and the Ceiling Contractor concerned. All mounting rings and other accessories shall fit closely into cut-outs to ensure a proper finish.

E09.8.10 Special Ceilings

In cases where special ceilings e.g. aluminium strips, decorative glass, metal leaves, etc., are to be installed, the Contractor and the manufacturer of the ceiling shall agree upon the method of fixing of luminaires to the ceiling.

E09.8.11 Waterproof Luminaires

Waterproof and flameproof luminaires shall be screwed directly to the conduit end. Draw boxes that may be required must be approved by the Engineer beforehand.

E09.8.12 Bulkhead Luminaires

Surface mounted bulkhead luminaires shall not be screwed directly to conduit ends. The conduit shall terminate in a round draw box at the top or back of the fitting. The PVC-insulated conductors shall terminate in a porcelain terminal strip in the draw box. Asbestos or silicon-rubber insulated conductors shall be used from the terminal strip to the luminaire lamp-holder. Porcelain-screw connectors will also be allowed.

E09.9 **INSTALLATION OF LIGHT SWITCHES**

E09.9.1 Mounting

All light switches shall be installed 1400mm above the finished floor level unless specified to the contrary. Mounting heights given shall be measured from the finished floor level to the centre of the switch.

E09.9.2 Doors

Unless specified to the contrary, switches adjacent to doors shall be installed on the side containing the lock. If the position of the lock is not shown on the drawings, the position shall

be verified before the switch box is installed. Switch boxes in brick or concrete walls, shall be installed 150mm from the door frame. Light switches installed in partitions or door frames shall be of the type designed for that purpose.

E09.9.3 Walls

Where the lower portion of a wall is face brick and the upper portion plastered, light switches shall be installed wholly in the plaster, provided that the lower edge of the plaster is not higher than 1600mm above the finished floor level. In general where different wall finishes are used in the same area, switches shall be installed within the same finish and not on the dividing lines between finishes.

E09.9.4 Switch Boxes

Switches shall be installed in standard rustproof (galvanised) pressed steel switch boxes with the necessary knock-outs for the proper termination of conduits. The installation of switch boxes shall comply with the requirements of paragraph E09.5 of this specification. Boxes shall be flush mounted or recessed as specified for the whole installation.

E09.9.5 Cover Plates

Cover plates which overlap the switchbox and which fit tightly against the wall finishes shall be installed in the case of flush mounted switch-boxes. All fixing screws in cover plates and switch grids shall be supplied and securely fitted.

E09.9.6 Escutcheon Plates

Where flush mounted switches are installed in special wall finishes, e.g. wood or board panels, acoustic tiles or other cladding, etc., and where the wall finishes have to be cut to accommodate the switch, it may be necessary to fix an escutcheon plate to the wall to cover the cut-outs. The escutcheon plate shall fit closely around the switch box and shall be fixed independently of the switch box and cover plate. Bevelled cover plates that overlap the switch boxes shall be used. Cover plates shall be fixed to the switch boxes and shall fit firmly against the escutcheon plate.

E09.9.7 Surface Mounted Switches

Surface mounted switches shall consist of a metal switch-box, cover plate and switch specially manufactured for the purpose. Switch boxes shall be fixed to the surface as described in paragraph E09.4 of this specification.

E09.9.8 Cutting of Cover Plates

Cover plates shall under no circumstances be cut unless specifically authorised in exceptional cases by the Engineer.

E09.9.9 Partitions

Light switches installed in partitions shall preferably be of the type designed for this purpose to be accommodated in the partition design. Switches installed in the metal support do not require switch boxes. Switches may not be flush mounted in partition walls without switch boxes.

E09.9.10 Waterproof Switches

Switches that are exposed to the atmosphere or are installed in damp areas, shall be of the waterproof type.

E09.9.11 Appearance

The sides of adjacent switches, plugs, push-buttons, etc., shall be parallel or perpendicular to each other and uniformly spaced. A common escutcheon plate shall be used for flush mounted outlets and accessories where the cover plates do not cover the cut-outs in the finishes.

E09.10 INSTALLATION OF SOCKET OUTLETS

E09.10.1 Mounting Heights

Unless otherwise specified socket outlets (flash or service mounted) shall be installed at the

following heights above finished floor level:

Socket outlets in general	300mm
Above working counter (kitchens, laboratories and prep areas)	1200mm
Shops	300mm
Offices	300mm

All mounting heights shall be measured from finished floor level to the centre of the outlet box
Socket outlet boxes shall comply with paragraph E09.9.4.

E09.11 PROVISION FOR TELEPHONE INSTALLATION

E09.11.1 General

This specification covers only the supply and installation of outlet points and wiring channels and/or conduits for telephones in buildings. The telephone installation will be carried out by Telkom personnel or Specialist Contractor.

E09.11.2 Regulations

All provisions for telephones in buildings shall comply with the latest issue of "FACILITIES FOR TELECOMMUNICATION SERVICES IN BUILDINGS" as issued by Telkom. In cases where the provision of this publication and the requirements of the Detail Technical Specification are in conflict, the latter shall take precedence.

E09.11.3 Sleeves for Main Cables

One or more asbestos-cement or PVC sleeves as specified, shall be installed from a point at the boundary of the stand, (position indicated by the Engineer), to the main telephone distribution board or the main telephone building duct , 600mm below ground level.

A manhole with steel cover (as specified in Part 2, Detail specification) shall be installed at each bend in the underground route or at intervals not exceeding 50m in straight sections.

The inner radius of bends shall not be less than 12 times the outside diameter of the sleeves.

All sleeves, manhole covers and accessories shall be supplied by the Contractor including the building work of the manhole, unless specified to the contrary.

E09.11.4 Separation of Services

Cables or conductors for telephone services shall be separated from all other services by:

- (a) Installation in separate metal channels or conduits, or
- (b) Installing the cables at a minimum distance of 300mm from all power cables, conductors and accessories, or
- (c) An earthed metal barrier installed to ensure that the minimum distance through free air space between the telephone cables and other services is at least 300mm.

Conduits or wiring channels installed for telephone services may not be used for any other purpose. Where non-metallic channels are used, the separation as stated in (b) above shall be maintained through the installation.

E09.11.5 Main Telephone Distribution Board

The size and position of the Main Telephone Distribution Board where required, shall be installed according to the requirements of the Detailed Technical Specification.

The board shall consist of a metal tray, architrave frame and hinged doors and shall be flush mounted in the position shown on the drawings.

A 20mm thick wooden panel shall be installed in the main telephone distribution board and shall cover the entire back of the board.

The finish of the board shall comply with the requirements of paragraph E09.16.9.

All conduits to telephone outlets or sub-distribution boards in the building as well as the main incoming sleeves, shall terminate at the main distribution board as indicated on the drawing.

Where 100 x 100 x 50mm draw boxes are specified, the boxes shall be provided with a cover plate. A wooden panel need not be provided in these cases.

E09.11.6 Telephone Outlets

The Contractor shall make provision for outlets with blank cover plates only.

Telephone outlets in walls shall consist of flush mounted 100 x 50 x 50mm draw boxes with blank cover plates.

Telephone outlets in floors shall be of the same type as floor outlets for power sockets which may be specified in the Detailed Technical Specification.

These provisions also apply to underfloor ducting. If no floor outlets are specified, 100 x 100 x 50mm flush mounted draw boxes with blank cover plates shall be provided in the floor at the positions indicated on the drawings.

Where twin underfloor ducts are provided and where the one duct is intended for telephone cables, the separation between the ducts shall be maintained throughout the underfloor ducting installation, including power outlets and telephone outlets.

Where power skirting is specified for telephone installations, the Contractor need only install the skirting with covers since the telephone socket outlet will be fixed directly to the cover.

Where multiple power skirting is provided containing other services, no other cables may be installed in the section intended for telephone cables and the separation between the sections shall be maintained throughout the installation.

E09.11.7 Connection of Telephone Outlets

Telephone outlets shall be inter-connected and connected to the telephone distribution boards as shown on the drawings.

If the inter-connecting conduits are not specified, conduit sizes shall be 25mm diameter for a maximum of 10 outlets and 32mm diameter for 11 to a maximum of 20 outlets.

Metal channels or power skirting installed on the same floor level on opposite walls of the same area as well as parallel runs of underfloor ducting intended for the installation of telephone cables, shall be inter-connected at intervals of 8 metres. Conduits may be used for these inter-connections.

All conduit and all ducts or channels which do not have removable covers, shall be provided with galvanised steel draw wires.

Conduit connections to power skirting or surface mounted metal channels, shall be made by means of a 100 x 100 x 50mm draw box which is flush mounted immediately behind the duct or channel in which the telephone cables are to be installed. A hole shall be cut in the back of the duct or channel, immediately opposite the draw box. The edges of the hole shall be grommetted. The draw box shall be accessible from the front when the cover is removed.

Purpose-made accessories for the connection of conduits to underfloor ducts shall be used. Where these are not available a 100 x 100 x 50mm draw box shall be installed below the underfloor duct opposite a floor telephone outlet. A hole shall be cut in the back of the duct opposite the draw box. The draw box shall be accessible from the top via the floor outlet.

E09.12 **SWITCHBOARDS AND DISTRIBUTION BOARDS**

Please see Specification E04: Electrical Low Voltage Distribution Boards and Motor Control Centres.

E09.13 **NOISE AND VIBRATION**

If in the opinion of the Engineer, any equipment operates with, or transmits from it, objectionable noise or vibration, it will be necessary to rectify or replace such plant in order

that the system operates at conditions acceptable to the Engineer. Remedial measures taken to achieve satisfactory noise and vibration levels shall be at no additional cost to the Employer.

The following measures shall be taken where necessary, whether specifically stipulated in these documents or not, all to ensure quiet, vibration-free operation of the installations:

- (a) Equipment shall be mounted on vibration isolators of the correct type and selection, dependent upon deflection requirements versus vibrating frequency.
- (b) Pipework and ductwork shall be suspended or mounted using suitable supports with vibration isolators to prevent transmission of vibration from them to the structure to which they are attached.

E09.14

COMMISSIONING AND TESTING

The Contractor shall commission and test the entire installation at his own expense, including provision of all test equipment, such testing to be done in the presence of the Engineer, who shall have been notified of the dates and approximate duration of the tests sufficiently early to allow him to witness tests if necessary.

The Contractor shall properly test and call for inspection by the Engineer any work which is to be covered, concealed, built-in, otherwise closed up or rendered inaccessible, before such closing up takes place. The Engineer may require any work of this nature which he has not been called on to inspect before closing up, to be uncovered or made accessible to him entirely at the Contractor's expense, making good included.

It is in the interest of the Contractor to notify the Engineer when the installation reaches various stages of completion (e.g. before plastering, final finishes, before casting concrete, etc) in order that the Engineer may inspect the installation and point out discrepancies. These inspections shall be considered informal and under no circumstances will they, in part or in whole, invalidate the requirements of the document. Any costs incurred in correcting discrepancies shall be to the Contractor's account.

The Contractor shall keep full and proper written records of all tests conducted and commissioning information, such data to be properly indexed and submitted to the Engineer for his records.

The Contractor shall test electrical wiring for compliance with regulations and have the complete installation tested by the relevant authorities.

The Engineer reserves the right to inspect any item of equipment during manufacture or before delivery to site. The Contractor shall make available any item for such inspection. The Engineer shall also be furnished with manufacturer's test certificates whenever these are required by law or called for by the Engineer.

The Contractor shall commission the complete installation prior to inviting the Engineer to accept it, commissioning including inter alia the following services, as relevant:

- (a) The Contractor shall record all motor running currents and set overload protection devices to correct values.
- (b) The Contractor shall adjust and set all time clocks, time delay relays, automatic control devices and check their function for correctness and response.
- (c) The Contractor shall remedy any defects apparent on the installation prior to calling upon the Engineer to accept the plants.

Thermal images of the panels and distribution board must be taken once the units are more than one week in operation. The images must be taken while in normal operating condition. The images should be reviewed and then presented as part of the Operations and maintenance manuals.

E09.15

LABELLING AND IDENTIFICATION

All equipment shall be labelled and identified using white trifoliate labels having black lettering engraved on them; where two similar items exist, they shall additionally be numbered for clarity in identification.

Labels shall be secured by means of white rivets, slotted label holders or screwed on. Self-tapping screws will not be allowed.

All other equipment including metres, instruments, indicator lights, switches, push-buttons, circuit breakers, fuses, etc., shall be identified. The function of the equipment and circuits shall be clearly identified. Flush mounted equipment within doors or front panels shall be identified with labels fixed to the doors or front panels respectively.

E09.16

OPERATING AND MAINTENANCE MANUALS; “AS BUILT” OR “AS INSTALLED” RECORD DRAWINGS

Provide three hard copies and one disk of all operating and maintenance manuals and record drawings.

Provide a MSWORD for WINDOWS disk copy for any word processed elements of the operating and maintenance manuals. Employ a specialist to prepare manuals for the form and content of the operating and maintenance manuals.

Agree format and contents with the Employer Operating and maintenance manuals must include, but are not limited to the following:

- Index of Contents
- A full description of each of the systems installed, written to ensure that the Employer's staff fully understand the scope and facilities provided. Description to include data on general design parameters, normal associated operating conditions and manufacturer's information concerning correct operation, etc., based on commissioning results.
- A description of the mode of operation of all systems.
- **Diagrammatic** drawings to each system (including distribution boards) indicating principal items of plant, equipment, valves, etc.
- A photo-reduction of all record drawings, together with an index.
 - Size A4
 - Size A3
- Legend for all colour-coded services.
- Schedules (system by system) of plant, equipment, valves, etc., stating their locations within the building, duties and performance figures. Ensure each item has a unique code number cross-referenced to the record and diagrammatic drawings and schedules.
- The name, address and telephone number of the manufacturer of every item of plant and equipment together with catalogue list and order acknowledgement numbers.
- Manufacturer's technical literature for all items of plant and equipment, assembled specifically for the project, excluding irrelevant matter and including detailed drawings, electrical circuit details and operating and maintenance instructions.
- A copy for all Test Certificates, Certificates of Compliance, Inspection and Test Records, Commissioning and Performance Test Records (including, but not limited to, electrical circuit tests, corrosion tests, type tests, start and commissioning tests) for the installations and plant, equipment, valves, etc., used in the installations.
- A copy of all manufacturers' guarantees or warranties.
- Copies of Insurance and Inspecting Authority Certificates and Reports.
- Starting up, operating and shutting down instructions for all equipment and systems installed.
- Details of procedures to maintain plant in safe working conditions.
- Control sequences for all systems installed.
- Schedule of all fixed and variable equipment settings established during commissioning.
- Back-up copies of any system software.
- Documentation of the procedures for updating and/or modifying software operating systems and control programs.

- Instructions for the creation of Control procedure routines and Graphic diagrams
- Details of the software revision for all programs provided.
- Two back-up copies of all software items, as commissioned.
- Details of lubrication systems and lubrication schedules for all lubricated items.
- A list of normal consumable items.
- A list of recommended maintenance spares to be kept in stock by the Employer, being those items subject to wear or deterioration and which may involve the Employer in extended deliveries when replacements are required at some future date.
- A list of any special tools needed for maintenance cross referenced to the particular item for which required.
- Procedures for fault finding.
- Emergency procedures, including telephone numbers for emergency services.
- Copies of all items incorporated in the plant room and switch room schedules and schematics.
- Encase the Manuals in A4 size, plastic-covered, loose leaf, four ring binders with hard covers, each indexed, divided and appropriately cover-titled. Fold drawings larger than A4 and include in the binder so that they may be unfolded without being detached from the rings.
- Provide record drawings. Include the provision of relevant framed plasticised drawings in all electrical rooms.
- Three copies of all "AS BUILT" or "AS INSTALLED" record drawings, in print form, are required to be handed to the Engineer before completion of the project. There shall have been previously submitted to the Electrical Engineer for comment and approval. The Electrical Engineer also requires 2 copies of all record drawings to be made available on disk on CAD format. All "AS BUILT" or "AS INSTALLED" record drawings are to be prepared by the Electrical contractor in CAD format.

E09.17

TESTING AND COMMISSIONING

The contractor shall supply factory test certificates for each drum of cable supplied under the Contract.

After the installation is complete, the contractor and the Engineer shall inspect the installation. The Engineer must be notified in advance of the inspection dates. The contractor will keep a snag list, reflecting all items not acceptable to the Engineer. The contractor will correct the snag items as required to the Engineers approval, updating the snag list as the items are completed and signed off by the Engineer.

The contractor shall carry out all the tests for the Main distribution board and will also conduct all tests and complete copies of the tests for each distribution board and for each supply (normal and alternative supplies), and attach as annexes to the completion report. The tests required will be the following as a minimum:

- (a) Continuity of bonding
- (b) Resistance of earth continuity conductor
- (c) Continuity of ring circuits (if applicable)
- (d) Earth loop impedance test
- (e) Elevated voltage between incoming neutral and external earth (ground)
- (f) Earth resistance at electrode (if required)
- (g) Insulation resistance M Ω
- (h) Voltage at main distribution board with no load for each phase to neutral
- (i) Voltage at main distribution board with load (as calculated for full load) for each phase to neutral V
- (j) Voltage at available load (worst condition as calculated for full load) for each phase to neutral
- (k) Operation of all earth leakage units
- (l) Operation of all earth leakage test buttons

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- (m) Polarity of points of consumption
- (n) Phase rotation at points of consumption for three-phase systems
- (o) All switching devices, make-and-break circuits

On completion of his work, the Contractor will issue an Electrical Certificate of Compliance (CoC). All tests deemed necessary to issue the CoC should be included. The Contractor shall make all arrangements, pay all fees and provide all equipment for these tests. The Contractor shall notify the Engineer timeously so that he may witness the tests.

Each installed cable shall be tested in accordance with:

- (a) The Occupational Health and Safety Act (OHSA) 1994;
- (b) The requirements of the Local and Supply Authorities.

E09.18 MAINTENANCE INSTRUCTIONS AND GUARANTEES

Retain copies of all maintenance instructions and guarantees delivered with components and equipment (failing which, obtain), register with manufacturer as necessary and handover to the Employer on or before Practical Completion. Notify the Employer of telephone numbers for emergency services by Specialist Contractors and Suppliers after Practical Completion.

E09.19 MEASUREMENT AND PAYMENT

<u>Item</u>	<u>Unit</u>

Supply and deliver distribution boards	No

The unit of measurement shall be the number of distribution boards supplied and installed. The tendered rate shall include full compensation for the supply and delivery of the distribution board as specified in the detail specification complete with all the electrical equipment specified.

<u>Item</u>	<u>Unit</u>

Install, test and commission the distribution boards	No

The unit of measurement shall be the number of distribution boards installed, tested and commissioned. The tendered rate shall include full compensation for the installing, testing and commissioning of the distribution boards complete with all the specified electrical equipment in the distribution board. The tendered rate shall furthermore include for the wiring of the distribution board.

<u>Item</u>	<u>Unit</u>

Supply and deliver isolators	No

The unit of measurement shall be the number of isolators supplied and delivered.

The tendered rate shall include full compensation for the supply and delivery of the isolators where the isolators are specified separately.

<u>Item</u>	<u>Unit</u>

Install isolators	No

The unit of measurement shall be the number of isolators installed.

The tendered rate shall include full compensation for the installing of the isolators where the isolators are specified separately.

<u>Item</u>	<u>Unit</u>

Supply and deliver circuit breakers	No

The unit of measurement shall be the number of circuit breakers supplied and delivered.

The tendered rate shall include full compensation for the supply and delivery of the circuit breakers where the circuit breakers are specified separately.

<u>Item</u>	<u>Unit</u>

Install circuit breakers No

The unit of measurement shall be the number of circuit breakers installed.

The tendered rate shall include full compensation for the installing of the circuit breakers where the circuit breakers are specified separately.

Item **Unit**

Supply and deliver fuse switches No

The unit of measurement shall be the number of fuse switches supplied and delivered.

The tendered rate shall include full compensation for the supply and delivery of the fuse switches where the fuse switches are specified separately.

Item **Unit**

Install fuse switches No

The unit of measurement shall be the number of fuse switches installed.

The tendered rate shall include full compensation for the installing of the fuse switches where the fuse switches are specified separately.

Item **Unit**

Supply and deliver earth leakage units No

The unit of measurement shall be the number of earth leakage units supplied and delivered.

The tendered rate shall include full compensation for the supply and delivery of the circuit breaker earth leakage units where the earth leakage units are specified separately, e.g. (30 mA)

Item **Unit**

Install earth leakage units No

The unit of measurement shall be the number of earth leakage units installed.

The tendered rate shall include full compensation for the installing of the circuit breaker earth leakage units where the earth leakage units are specified separately, e.g. (30 mA)

Item **Unit**

Supply and deliver contactors No

The unit of measurement shall be the number of contactors supplied and delivered.

The tendered rate shall include full compensation for the supply and delivery of the contactors where the contactors are specified separately.

Item **Unit**

Install contactors No

The unit of measurement shall be the number of contactors installed.

The tendered rate shall include full compensation for the installing of the contactors where the contactors are specified separately.

Item **Unit**

Supply and deliver light fittings No

The tendered rate shall include full compensation for the supply and delivery to site of the specified light fitting, complete with lamp/s, wiring, control gear where applicable, diffusers, etc.

Separate items shall be scheduled for each type of light fitting required.

Item **Unit**

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Install light fittings No

The tendered rate shall include full compensation for the handling, inspection, fastening, connecting and testing of the light fitting.

Separate items shall be scheduled for each type of light fitting. This rate shall furthermore include full compensation for the cost of providing and installing all hardware, timber backing, plugs, screws connector terminals and other materials required to install the light fitting in accordance with the specification.

Item **Unit**

Supply and deliver switches No

The tendered rate shall include full compensation for the supply and delivery to site of the specified switch complete with cover plate and fastening screws.

Separate items shall be scheduled for each type of switch.

Item **Unit**

Install switches No

The tendered rate shall include full compensation for the handling, inspection, fastening, connecting, fitting of cover plate and testing of the switch.

Separate items shall be scheduled for each type of switch.

This rate shall furthermore include full compensation for the cost of providing and installing all hardware screws and wall plugs in the case of surface mounted switches, required to install the switch in accordance with the specification.

Item **Unit**

Supply and deliver photo-electric switch No

The tendered rate shall include full compensation for the supply and delivery to site of the specified photo-electric daylight switch complete with mounting bracket and around bulkhead light enclosure.

Item **Unit**

Install photo-electric switch No

The tendered rate shall include full compensation for the handling, inspection, fastening of the bulkhead enclosure and photo electric switch, connecting and testing of the switch.

This rate shall furthermore include full compensation for the cost of providing and installing all hardware, screws, wall plugs and other material required to install the photo electric light switch in accordance with the specification.

Item **Unit**

Supply lighting track m

The unit of measurement shall be the linear metre of track supplied.

The tendered rate shall include the supply and delivery to site of the track as specified in the detail specification.

Item **Unit**

Install lighting track m

The unit of measurement shall be the linear metre of lighting track installed.

The tendered rate shall include full compensation for cutting to size and fixing to the ceiling or wall with appropriate fasteners of the lighting track and shall include the wiring connections of the supply circuit.

Item **Unit**

Supply and install lighting track accessories No

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The unit of measurement shall be the number of splices, bends, elbows, connector units and end caps.

The tendered rate shall include full compensation for the supply, connecting, installation and fixing of accessories as detailed in the schedule of quantities.

<u>Item</u>	<u>Unit</u>

Supply consumer distribution kiosks	No

The unit of measurement shall be the number of distribution kiosk supplied.

The rate shall include full compensation for the supply of the distribution kiosks complete as specified.

<u>Item</u>	<u>Unit</u>

Install consumer distribution kiosks	No

The unit of measurement shall be the number of distribution kiosks installed.

The rate shall cover the cost of the sitting, handling, transporting, installing, painting, testing and commissioning of each kiosk.

<u>Item</u>	<u>Unit</u>

Supply and erect concrete plinths for consumer distribution kiosks	No

The unit of measurement shall be the number of plinths supplied and erected.

The rate shall include full compensation for the supply of precast plinths and bases and the erection thereof as specified.

<u>Item</u>	<u>Unit</u>

Supply consumer distribution pillars	No

The unit of measurement shall be the number of distribution pillars supplied.

The rate shall include full compensation for the supply of the distribution pillars fully equipped as specified.

<u>Item</u>	<u>Unit</u>

Install consumer distribution pillars	No

The unit of measurement shall be the number of distribution pillars installed.

The rate shall include full compensation for the installing of the distribution pillars and shall include for the excavation for the installing of the pillar and the backfilling, compacting and disposal of the surplus material once the pillar has been installed.

<u>Item</u>	<u>Unit</u>

Supply service connection cable	m

The unit of measurement shall be the length in metres of service connection cables supplied.

The tendered rate shall include full compensation for the supply and delivery of the cable to site.

<u>Item</u>	<u>Unit</u>

Lay service connection cable	m

The unit of measurement shall be the length in metres of service connection cable laid.

The tendered rate shall include full compensation for the handling, inspection, laying, cutting and testing the cable. Cables will be measured linearly over all lengths laid.

<u>Item</u>	<u>Unit</u>

Terminate service connection cable	No

The unit of measurement shall be the number of service connection cable terminated.

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The tendered rate shall include full compensation for the termination cable including all material and labour to render complete terminations of the cables.

<u>Item</u>	<u>Unit</u>

Supply socket outlets	No

The unit of measurement shall be the number of socket outlets supplied.

The tendered rate shall include full compensation for the supply and delivery of single or double single phase, three pin socket outlets.

Separate items shall be scheduled for the following:

- (a) socket outlets flush mounted
- (b) socket outlets surface mounted
- (c) socket outlets to be installed in power skirting
- (d) socket outlets to be installed in pedestals for floor ducting
- (e) socket outlets to be installed in recessed service outlets for floor ducting.

Separate items shall be scheduled for standard and dedicated switched socket outlets. All socket outlets shall be supplied complete with cover plates and boxes where required. The tendered rate shall therefore include for the supply of the cover plates and fixing screws where applicable.

<u>Item</u>	<u>Unit</u>

Install socket outlets	No

The unit of measurement shall be the number of socket outlets installed.

The tendered rate shall include full compensation for the installing of the socket outlets. Separate items will be scheduled for the various type of socket outlets specified in item 6.6.8. The tendered rate shall furthermore include for the installing of the cover plates where applicable.

<u>Item</u>	<u>Unit</u>

Supply plug tops for dedicated socket outlets	No

The unit of measurement shall be the number of plug tops supplied.

The tendered rate shall include full compensation for the supply of plug tops for each of the dedicated socket outlets supplied and installed under this contract.

<u>Item</u>	<u>Unit</u>

Supply and deliver double pole isolator for geyser supply	No

The unit of measurement shall be the number of double pole isolators supplied.

The tendered rate shall include full compensation for the supply and delivery of double pole isolators for the geyser supplies.

<u>Item</u>	<u>Unit</u>

Install double pole isolator for geyser supply	No

The unit of measurement shall be the number of double pole isolators installed.

The tendered rate shall include full compensation for the installing of double pole isolators for the geyser supplies.

<u>Item</u>	<u>Unit</u>

Supply and install connections to heaters, stoves, fans and air conditioners units	No

The unit of measurement shall be the number of connections made.

The tendered rate shall include full compensation for the installing of the connections to the heaters, stoves, fans and air conditioners and shall include for the supply and installing of the

double pole isolator or control unit which ever is applicable.

Separate items shall be scheduled for each type of connections.

<u>Item</u>	<u>Unit</u>

Supply double pole isolators for power skirting.....	No

The unit of measurement shall be the number of double pole isolators supplied for the power skirting.

The tendered rate shall include full compensation for the supply and delivery to site of the double pole isolators.

<u>Item</u>	<u>Unit</u>

Install double pole isolators for power skirting	No

The unit of measurement shall be the number of double pole isolators installed.

The tendered rate shall include full compensation for the installation of the double pole isolators in the power skirting and shall include the connections of the conductors to the isolators.

<u>Item</u>	<u>Unit</u>

Supply junction boxes	No

The unit of measurement shall be the number of junction boxes supplied.

The tendered rate shall include full compensation for the supply and delivery to site of the junction boxes.

Separate items shall be scheduled for each type of junction box.

<u>Item</u>	<u>Unit</u>

Install junction boxes	No

The unit of measurement shall be the number of junction boxes installed.

The tendered rate shall include full compensation for the installation of the junction boxes as specified.

Separate items shall be scheduled for each type of junction box.

<u>Item</u>	<u>Unit</u>

Supply and delivery of conduit	m

The unit of measurement shall be the linear metre of conduit supplied and delivered.

The tendered rate shall include for full compensation for the supply and delivery of the specified conduit and shall include full compensation for the supply of the couplings to join the conduits. Separate items shall be scheduled for the different types of conduit specified.

<u>Item</u>	<u>Unit</u>

Installing of conduit	m

The unit of measurement shall be the linear metre of conduit installed.

The tendered rate shall include for full compensation for the installing of the conduit including jointing and bending the conduit and fixing the conduit using saddles as specified. Separate items shall be scheduled for the different types of conduit and for installing the conduit in concrete, fixing the conduit in brick work, including the chasing thereof, fixing the conduit on the surface of structures or installing the conduit in ceiling voids.

<u>Item</u>	<u>Unit</u>

Terminate conduit	No

The unit of measurement shall be the number of terminations made.

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The tendered rate shall include full compensation for terminating the conduit in draw boxes and outlet boxes and shall include for all locknuts and bushes.

<u>Item</u>	<u>Unit</u>

Supply and install draw boxes	No

The unit of measurement shall be the number of draw boxes supplied and installed.

The tendered rate shall include full compensation for supplying and installing the draw boxes including the cover plates. Separate items shall be scheduled for installing the boxes in concrete, in brickwork including chasing, and on the surface of structures.

<u>Item</u>	<u>Unit</u>

Supply and install conduit outlet boxes	No

The unit of measurement shall be the number of conduit outlet boxes supplied and installed.

The tendered rate shall include full compensation for supplying and installing conduit outlet boxes and shall include blank cover plates where no equipment is installed in the boxes. Separate items shall be scheduled for 1, 2, 3 and 4 way outlet boxes and for installing the boxes in concrete, in brick walls, including the chasing thereof, and surface on structures.

<u>Item</u>	<u>Unit</u>

Supply power skirting	m

The unit of measurement shall be the linear metre of power skirting supplied.

The tendered rate shall include full compensation for the specified power skirting including cover plates. Separate items shall be scheduled for one, two and three compartment power skirting.

<u>Item</u>	<u>Unit</u>

Install power skirting	m

The unit of measurement shall be the linear metre of power skirting installed.

The tendered rate shall include full compensation for installing the power skirting including all material required to install the power skirting.

<u>Item</u>	<u>Unit</u>

Supply and install power skirting end caps, bends, conduit outlets & accessories	No

The unit of measurement shall be the number of power skirting end caps, bends and conduit outlets supplied and installed.

The tendered rate shall include full compensation for the supply and installing of the power skirting end caps, internal and external bends and outlets and shall include for the supply of all material required to complete the installing thereof.

<u>Item</u>	<u>Unit</u>

Supply under floor ducting	m

The unit of measurement shall be the linear metre of under floor ducting supplied.

The tendered rate shall include full compensation for the supply of under floor ducting. Separate items shall be scheduled for the two and three compartment ducting.

<u>Item</u>	<u>Unit</u>

Supply under floor ducting accessories	No

The unit of measurement shall be the number of accessories supplied.

The tendered rate shall include full compensation for the supply of the required accessories for the completion of the under floor installation. Separate rates shall be scheduled for cross-over, T-junction and right angle bend draw boxes and up-bends.

<u>Item</u>	<u>Unit</u>

Supply pedestal units No

The unit of measurement shall be the number of pedestals supplied.

The tendered rate shall include full compensation for the supply of the specified pedestal units.

Item **Unit**

Install under floor ducting m

The unit of measurement shall be the linear metre of ducting installed.

The tendered rate shall include full compensation for the installation of the under floor ducting.

Item **Unit**

Install under floor ducting accessories No

The unit of measurement shall be the number of accessories installed.

The tendered rate shall include full compensation for the installation of the accessories.
Separate items shall be scheduled for the cross-over, T-junction and right angle bend draw
boxes and up-bends.

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER
PARTICULAR SPECIFICATION
E10 : ELECTRICAL BUSAR TRUNKING

Johannesburg Water (SOC) Ltd.
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4	2019-08-20	B Pieterse	Review of Electrical Standards, plus New Design Guidance
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1	2009-05-12		Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance

PARTICULAR SPECIFICATION: VOLUME E10: ELECTRICAL BUSBAR TRUNKING

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E10.1 SCOPE

This section covers the supply and installation of busbar trunking.

E10.2 STATUTORY DOCUMENTS AND STANDARDS

E10.2.1 Standards

The latest edition of the following particular specifications and Codes of Practice shall be read in conjunction with this section:

- (a) SANS 10142-1 : The wiring of premises Part 1: Low-voltage installations
- (b) SANS 121 : Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods
- (c) SANS 60439-2 : Low-voltage switchgear and controlgear assemblies Part 2: Particular requirements for busbar trunking systems (busways)
- (d) SANS 61439-6 : Low-voltage switchgear and controlgear assemblies Part 6: Busbar trunking systems (busways)
- (e) SANS 1195 : Busbars
- (f) BS 159 : Specification for high-voltage busbars and busbar connections
- (g) BS EN 13601 : Copper and copper alloys. Copper rod, bar and wire for general electrical purposes
- (h) SANS 61439 : Low voltage switchgear and control gear assemblies

E10.2.2 Particular Specifications to be read in conjunction with this specification

The following particular specifications shall be read in conjunction with the Project Specification:

- (a) E26 : ELECTRICAL SPECIFICATION FOR COLOUR CODE
- (b) G02 : PARTICULAR SPECIFICATION FOR CORROSION PROTECTION
- (c) E06 : ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE INSTALLATION

E10.3 BUSBAR TRUNKING

E10.3.1 General

This section covers the supply and installation of trunking and accessories in buildings.

E10.3.2 Materials

Rising and overhead busbar trunking shall be fully enclosed in a metal duct which shall form part of the busbar support. The metal enclosure shall form an integral part of the bus section and shall be of the same length as the conducting sections of the busbar. The covers of the busbar trunking shall be secured to the framework by at least four points per section. Busbar covers shall be so designed that they are easily removable after installation of the trunking. Sections of the busbars which pass through walls and floors shall have separate covers.

Two fire barriers of non-flammable, non-conducting material in the busbar trunking shall form an integral part of each section of rising busbars.

The fire barriers shall be so placed as to prevent the spreading of fire from one floor to another but shall not restrict the ventilation of the busbar.

Overhead busbars shall be equipped with fire barriers where the busbars pass through walls or partitions.

E10.3.3 Rating

Busbars shall be manufactured from either aluminium or solid drawn high conductivity copper with a rectangular cross-section, as specified in the "detail specification". Busbars shall be in accordance with SANS 60439-2, SANS 1195 and BS EN 13601, BS 159 where applicable.

The rating shall be as specified in the detail specification with the maximum allowable temperature of the busbars (including joints) carrying full load current in an ambient temperature as specified not exceeding 80 °C.

Busbars shall not be tapered and the neutral busbar in three-phase, four wire supplies shall have a cross-section equal to 100% of the cross-section of the phase busbars.

An earth busbar shall be installed along the entire length of the busbar trunking and shall be calculated according to SANS 61439 with a minimum cross-section of 6,3 mm x 20 mm.

E10.3.4 Construction

The busbar rating must match that of the transformer with respect to load and fault currents.

The busbars shall be supported at a minimum of two points in each section and shall be supported by a suitable resin bound synthetic material. The surface of these supports shall be treated to prevent surface tracking. The fixing of the busbars shall be designed to withstand the mechanical and thermal stresses during fault conditions at the specified fault level. Where concrete roofs are available, the busbar can be hung from the roof.

Busbar support must not impede with the rest of the electrical installation.

All non-current carrying metal parts of the trunking shall be bonded to the earth busbar.

Expansion joints shall be provided at intervals not exceeding 10 m to allow for a temperature variation of 0 °C to 90 °C. These expansion joints shall have the same current rating as the rest of the busbar trunking.

All accessories shall be purpose-made and shall conform to the same specification as the busbars.

All ratings and the name and address of the manufacturer shall be indicated on a metal label fixed to each section of the busbar trunking.

E10.3.5 Installation

Trunking shall be of the size and type as specified in the detail specification.

The electrical subcontractor shall ensure that the trunking is installed in accordance with the routes indicated on the relevant drawings.

However should the electrical subcontractor discover that the indicated route is not practically possible, or for some other reason the route clashes with other services, he shall immediately contact the engineer for clarification in this regard.

E10.3.6 Testing and commissioning

All busbar trunking must be type tested. A type test certificate must be supplied at tender stage.

The busbar trunking must be subjected to site acceptance tests to verify the integrity and performance prior to commissioning. A schedule of the SAT must be provided and approved by the engineer prior to commencement of manufacture.

The contractor shall supply factory test certificates for all bus trunking supplied under the Contract.

After the installation is complete, the contractor and the Engineer shall inspect the installation. The Engineer must be notified in advance of the inspection dates. The contractor will keep a snag

list, reflecting all items not acceptable to the Engineer. The contractor will correct the snag items as required to the Engineers approval, updating the snag list as the items are completed and signed off by the Engineer.

On completion of his work, the Contractor will issue an Electrical Certificate of Compliance (CoC). All tests deemed necessary to issue the CoC should be included. The Contractor shall make all arrangements, pay all fees and provide all equipment for these tests. The Contractor shall notify the Engineer timeously so that he may witness the tests.

Each installed bus trunking shall be tested in accordance with:

- (a) The Occupational Health and Safety Act (OHSA) 1994;
- (b) The requirements of the Local and Supply Authorities.

Once commissioned the assembly should be scanned and a thermal image obtained. The image should be reviewed after which they will form part of the Operations and Maintenance Manuals to be presented to the engineer.

E10.4

MEASUREMENT AND PAYMENT

<u>Item</u>	<u>Unit</u>

Supply and deliver busbar trunking.....m

The unit of measurement shall be the linear metre of busbar trunking supplied and delivered.

The tendered rate shall include for full compensation for the supply of the specified busbar trunking including all material needed for the installation of the busbar trunking.

<u>Item</u>	<u>Unit</u>

Supply and deliver busbar trunking end feed units..... No

The unit of measurement shall be the number of trunking end feed units supplied and delivered.

The tendered rate shall include for the full compensation for the supply and delivery of the specified busbar end feed units including all material needed for the installation of the busbar end feed unit.

<u>Item</u>	<u>Unit</u>

Supply and deliver busbar trunking directional change units No

The unit of measurement shall be the number of busbar trunking directional change units supplied and delivered.

The tendered rate shall include for full compensation for the supply and delivery of the specified busbar directional change units including all material needed for the installation of the busbar trunking directional change unit.

<u>Item</u>	<u>Unit</u>

Supply and deliver busbar trunking fire barriers No

The unit of measurement shall be the number of busbar trunking fire barriers supplied and delivered.

The tendered rate shall include for the full compensation for the supply and delivery of the specified busbar trunking fire barriers including all material needed for the installation of the busbar trunking fire barriers.

<u>Item</u>	<u>Unit</u>

Supply and delivery of busbar trunking expansion units No

The unit of measurement shall be the number of busbar trunking expansion units supplied and delivered.

The tendered rate shall include for the full compensation for the supply and delivery of the specified busbar trunking expansion units including all material needed for the installation of the busbar trunking expansion units.

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<u>Item</u>	<u>Unit</u>
Install busbar trunking	m

The unit of measurement shall be the linear metre of busbar trunking installed.

The tendered rate shall include for full compensation for the installation of the specified busbar trunking including all material needed for the installation of the busbar trunking.

<u>Item</u>	<u>Unit</u>
Install busbar trunking end feed units	No

The unit of measurement shall be the number of busbar trunking end feed units installed.

The tendered rate shall include for the full compensation for the installation of the specified busbar end feed units including all material needed for the installation of the busbar end feed unit.

<u>Item</u>	<u>Unit</u>
Install busbar trunking directional change units	No

The unit of measurement shall be the number of busbar trunking directional change units installed.

The tendered rate shall include for full compensation for the installation of the specified busbar directional change units including all material needed for the installation of the busbar trunking directional change unit.

<u>Item</u>	<u>Unit</u>
Install busbar trunking fire barriers	No

The unit of measurement shall be the number of busbar trunking fire barriers installed.

The tendered rate shall include for the full compensation for the installation of the specified busbar trunking fire barriers including all material needed for the installation of the busbar trunking fire barriers.

<u>Item</u>	<u>Unit</u>
Install busbar trunking expansion units	No

The unit of measurement shall be the number of busbar trunking expansion units installed.

The tendered rate shall include for the full compensation for the installation of the specified busbar trunking expansion units including all material needed for the installation of the busbar trunking expansion units.

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER
PARTICULAR SPECIFICATION
E11 : ELECTRICAL EARTHING AND
LIGHTING PROTECTION

Johannesburg Water (SOC) Ltd.
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PARTICULAR SPECIFICATION: VOLUME E11: GENERAL ELECTRICAL GENERAL EARTHING AND LIGHTNING PROTECTION

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E11.1 SCOPE

This specification covers the detail requirements of the general protection against lightning to be installed under the contract, including:

- a) General notes on the lightning protection measures;
- b) The risk management and definition of the risk to a structure due to lightning strikes;
- c) A Lightning Protection System (LPS) describing principles to be followed for the protection against physical damage to a structure including the installations within the structure as well as injury to living beings due to touch and step voltages;
- d) Surge Protection Measures (SPM) to reduce the risk of permanent failures of electrical and electronic installations within a structure due to a Lightning Electromagnetic Pulse (LEMP).
- e) Information for the design, installation, inspection, maintenance and testing of the above.

E11.2 STATUTORY DOCUMENTS AND STANDARDS

E11.2.1 Standards

The latest edition, including all amendments up to date of tender of the following particular national and international specifications, publications and codes of practice which shall be read in conjunction with this specification and shall be deemed to form part thereof:

- a) SANS 10142-1 The wiring of premises Part 1: Low-voltage installations.
- b) SANS 10142-2 The wiring of premises Part 2: Medium-voltage installations above 1 kV ac not exceeding 22 kV ac. and up to and including 3 MVA installed capacity.
- c) SANS 62305-1 Protection against lightning Part 1: General principles
- d) SANS 62305-2 Protection against lightning Part 2: Risk management
- e) SANS 62305-3 Protection against lightning Part 3: Physical damage to structures and life hazard
- f) SANS 62305-4 Protection against lightning Part 4: Electrical and electronic systems within structures.
- g) SANS 62561 Lightning protection system components (LPSC).
- h) SANS 1063 Earth rods, couplers and connections.
- i) SANS 10199 The design and installation of earth electrodes.
- j) SANS 10313 Protection against lightning — Physical damage to structures and life hazard.
- k) SANS 10292 Earthing of low-voltage (LV) distribution systems.

E11.2.2 Particular Specifications to be read in conjunction with this Specification

The following particular specifications shall be read in conjunction with the Project Specification:

- a) Automation and Control Design Standards, Volume 5: Clean Power and Surge Protection.

E11.3 CERTIFICATE OF COMPLIANCE

E11.3.1 New or modified installations

The Contractor shall appoint a competent and experienced lightning protection design engineer for the design, supply, installation, inspection and testing of the Lightning Protection System (LPS) as well as the Surge Protection Measures (SPM).

After installation and testing of the LPS and SPM, the lightning protection design engineer will issue a Lightning Protection System Installation Safety Report as prescribed in SANS 10313: Annex A as well as SANS10142-1, for each area of protection. The Engineer will witness the installation as well as all tests conducted.

Two copies of this report shall be submitted to the Engineer before handing over of any repair, modification or new installation involving LPS or SPM systems.

E11.3.2 Maintenance of installations

The Client shall appoint a competent and experienced lightning protection engineer to maintain and inspect the Lightning Protection System (LPS) as well as the Surge Protection Measures (SPM) on an annual basis. Tests and inspections should be done prior to the start of the lightning season.

The lightning protection engineer will issue a Lightning Protection System Maintenance Certificate as prescribed in SANS 10313: Annex B, for each area of protection.

E11.4 PROTECTION MEASURES

The following protective measures should be installed as far as possible. The most suitable protective measure shall be selected during the design phase, considering technical and economic aspects based on a risk assessment.

E11.4.1 Protection measures to reduce injury of living beings by electric shock

- a) Adequate insulation of exposed lightning conductive parts;
- b) Equipotential bonding of equipment and conductive parts and connection to a meshed earthing system;
- c) Physical restrictions and warning notices where the above is not achievable.

E11.4.2 Lightning Protection System (LPS) to reduce physical damage

- a) Air-termination system on high points;
- b) Down-conductor system;
- c) Earth-termination system;
- d) Equipotential bonding;

E11.4.3 Surge Protection Measures (SPM) to reduce failure of electrical and electronic systems

- a) Earthing and bonding measures;
- b) Magnetic shielding;
- c) Line routing;
- d) Isolating interfaces;
- e) Coordinated Surge Protection Device (SPD) system.

E11.5 RISK MANAGEMENT

Risk to a structure exposed to lightning flashes is managed by a process based on risk evaluation or assessment. Appropriate protection measures are selected to reduce the risk to or below the tolerable limit.

The following basic procedure must be followed during the risk assessment:

- a) Identification of the structure to be protected;
- b) Partitioning of the structure into zones;
- c) Identification of all the types of loss in the structure;
- d) The identification and calculation of the corresponding risk components for each type of loss;
- e) Evaluation of need of protection;
- f) Selection of protective measures (LPS, SPM or other protection measure);
- g) Evaluate the cost-effectiveness of the protection measures;
- h) Re-evaluation of the corresponding risk components and the need for further protection.

The risk assessment and the evaluation of loss and risks as well as protection selection must be done by a competent and experienced lightning protection design engineer. It is the responsibility of the contractor to appoint a lightning protection design engineer for this purpose.

E11.6 EXTERNAL LIGHTNING PROTECTION SYSTEM (LPS)

An external LPS is installed on a structure to intercept a direct lightning flash to the structure, conduct the lightning current safely towards earth and to disperse the lightning current into the earth. It consist out of an air-termination system, a down-conductor system and an earth-termination system.

E11.6.1 Design of the LPS

The design of the LPS must be done in accordance with SANS 62305-3 with specific reference to Annex E.

The LPS should be designed and installed by competent and experienced LPS design engineer and LPS installer (person who is competent to install, construct and test an LPS for compliance with this SANS 10313). It is the responsibility of the contractor to appoint a competent and experienced LPS design engineer and installer. The Contractor is responsible to manage consultation between the various parties involved in the project (client, local authorities, LPS design engineer, LPS installer, architect, civil contractor/builder and electrical engineer). In new structures, the LPS should be installed during the construction phase; proper timing for soil resistivity test and the design of the LPS is of utmost importance.

The LPS design engineer and installer will be responsible for the quality assurance on the project.

E11.6.2 Isolated LPS

On structures at risk of explosion and fire an isolated external LPS must be installed.

E11.6.3 Air-termination systems

Air-termination systems can be composed of any combination of the following elements:

- a) Rods (including free-standing masts);
- b) Catenary wires;
- c) Meshed conductors.

Air terminals installed shall be located at corners, exposed points and edges on a structure. To determine the exact location one or more of the following methods should be followed:

- a) Protection angle method;
- b) Rolling sphere method;
- c) Mesh method.

All types of air terminals shall comply in full with SANS 62305-3. The positioning of air termination system shall comply with SANS 62305-3 (Annexure A).

All air-termination components must be fixed and secured in such a way to withstand accidental external mechanical forces as well as electromechanical forces during a lightning strike.

E11.6.4 Down-conductor systems

If the air-termination system is supported by one or more non-conductive columns, at least one down-conductor is required for each column. Steel columns do not require additional down-conductors.

All down-conductor components must be fixed and secured in such a way to withstand accidental external mechanical forces as well as electromechanical forces during a lightning strike.

Down conductors may be placed on the surface of non-combustible walls. On structures at risk of explosion and fire, all down conductors must be isolated from the structure walls.

E11.6.5 Earth-termination system

For lightning protection, a single integrated structure earth-termination system is preferable and is suitable for all purposes (i.e. lightning protection, power systems and telecommunication systems).

An earthing resistance not exceeding 3Ω (measured at low frequency) is required for earth termination systems. Should it be impossible to achieve this earthing resistance value, the Engineer must approve the value obtained and deemed reasonable.

Type A earthing arrangement

Each down connector is connected to a horizontal or vertical earth electrode installed outside the protected structure. A minimum of two earth electrodes will be installed, buried at an upper end depth of minimum 0.5 m with a separation distance to minimize electrical coupling effects in the earth. The minimum length of the earth electrodes will be calculated during the design phase, based on the soil resistivity.

Type B earthing arrangement

A ring conductor is installed external to the protected structure, buried at an upper end depth of at least 0.5 m and at a distance of about 1 m away from the external walls. The radius of protection will be calculated during the design phase, based on the soil resistivity. Additional electrodes should be added to obtain the desirable protection radius. The number of electrodes shall not be less than the number of down conductors (with a minimum of two electrodes).

Test points

A test point must be installed at the connection between each down-conductor and earth termination electrodes. The joint will only be opened for testing and will remain closed at all times.

Conductor connections

Conductor connections shall be made secure by exothermic welding. Clamping or bolting of conductor connection points shall only be accepted with permission from the Engineer. All points of connection must be covered with a cold applied anti-corrosion and sealing tape based on a synthetic fabric, impregnated and coated with a neutral petrolatum compound.

E11.6.6 LPS Installation

Type B earthing will be installed as the preferred arrangement. Type A earthing will only be accepted with prior approval from the Engineer (in writing). The installation of the earth electrodes will be inspected and approved by the Engineer during the construction phase.

The LPS shall be bonded to the fixed electrical installation protective earthing in accordance with the requirements of SANS 10142-1. Where an installation may typically consist of a main building or plant and one or more satellite subsystems, the various earth networks shall be interconnected to form one earth system. Only in the rare instance of a subsystem being totally isolated, with no cables, pipes, fences or other conductive structures connecting it to the rest of the installation, may a system be provided with a separate earth network.

E11.6.7 Components

All material and components used in a LPS must conform to the requirements specified in SANS 62561.

Minimum cross-sectional area of conductors

a) Air-termination conductors, air-termination rods and down-conductors:

Configurations and minimum cross-sectional areas of air-termination conductors, air-termination rods and down-conductors are given in SANS 62305-3: Table 6 "Material, configuration and minimum cross-sectional area of air-termination conductors, air-termination rods, earth lead-in rods and down-conductors".

The following material and dimensions will be specifically applicable. No copper conductors will be accepted.

Material	Configuration	Cross-sectional area (sq. mm)
Aluminium	Solid tape	70
	Solid round	50
Stainless steel	Solid tape	50
	Solid round	50

Table 1: Specific configurations and minimum cross-sectional areas of air-termination conductors, air-termination rods and down-conductors.

b) Earth conductors and electrodes:

Configurations and minimum dimensions of earth electrodes are given in SANS 62305-3: Table 7 "Material, configuration and minimum dimensions of earth electrodes".

The following material and dimensions will be specifically applicable. No copper conductors will be accepted.

Material	Configuration	Dimensions	
		Earth rod diameter (mm)	Earth conductor (sq. mm)
Copper coated steel	Solid round	14	
Stainless steel	Solid round	15	78
	Solid tape		100

Table 2: Specific configurations and minimum dimensions of earth conductors and electrodes

E11.7

LPS FOR STRUCTURES WITH A RISK OF EXPLOSION

The design, construction, extension and modification of lightning protection systems for structures with a risk of explosion must comply with SANS 62305-3: Annex 3.

- The LPS must be isolated from the structure. This includes the air termination conductors as well as all down conductors. Under no circumstances may any parts of the structure be used as part of the LPS
- The distance between down conductors will not exceed 5m. The down conductor count and spacing will be determined during the design phase with a minimum of two down conductors installed.
- The earth-termination system will be a type B arrangement
- All installations/structures/equipment will be equipotential bonded to the lightning protection system. Junctions shall be provided for the joining of connection and earthing leads to containers, metal construction parts, drums and tanks
- Aboveground metal piping shall be earthed at least every 30 m. Bonding conductors will

be connected to the piping at tap holes in the flanges for taking up screws. Where this is not possible, welded-on lugs or bolts will be used

- f) Such devices shall be suitable for the environment in which they are installed.

The above will be applicable to aeration basins, bioreactors, HOW, digester (high risk areas)

E11.8 INTERNAL LIGHTNING PROTECTION SYSTEM (LPS)

An internal LPS is intended to prevent flashover between electrically conducting elements within the structure and the external LPS components using either equipotential bonding or an adequate separation distance.

E11.8.1 Equipotential bonding

All equipment likely to be subjected to surge currents shall be securely bonded together and to the earth network.

Bonding bar

A single bonding bar shall be installed for equipotential bonding. The bar shall be manufactured from electrical grade hard drawn aluminium 80sq mm complete with mounting insulators. The bar will be pre-drilled with ten M8 holes, fitted with stainless steel high tensile hex bolts with nuts and washers. The bar will be fitted with two removable test links, one on each end of the bar.

The bonding bar shall be connected to the earth-termination system at two connection points with two separate cables.

A ring bonding bar where more than one interconnected bonding bars are installed can be used for larger installations.

External conductive parts

External conductive parts shall be bonded to the bonding bar from a point as near as possible to the point of entry into the structure. This will include all electrical conductive pipes, cable ladder, fences and gates.

External electrical lines

Live conductors shall be bonded to the bonding bar via SPD's. (See Paragraph E11.1 Surge Protection Measures). All gland plates in electrical panels will be bonded to the earth network. Power cable armouring shall be bonded to the earth network at both ends of the cable via the cable glands on the gland plates.

Telecommunication and Instrumentation lines

Please refer to Automation and Control Design Standards, Volume 5: Clean Power and Surge Protection.

Internal systems

Screened cables installed in the internal system must be bonded to the bonding bar via the screen. Cables in metal conduits installed in the internal system must be bonded to the bonding bar via the conduits. Unscreened cables must be connected to the bonding bar via SPD's (See Paragraph E11.1 Surge Protection Measures).

Bonding conductors

Bonding conductors shall be short and shall run in straight or smoothly contoured routes. Material, dimensions and conditions of use shall comply with SANS 62305-3. The minimum cross-section for bonding components shall comply with SANS 62305-4 Table 1 "Minimum cross-sections for bonding components".

The following material and dimensions will be specifically applicable.

Bonding component	Material	Cross-section (sq. mm)
Bonding bars	Aluminium	80
Bonding to LPS	Aluminium	70
Connecting conductors from internal metal installations to bonding bars (carrying a partial lightning current)	Aluminium	70

Table 3: Specific material and cross-section area for bonding components

E11.9 INSPECTION AND MAINTENANCE OF LPS

E11.9.1 Inspection

Inspections should be conducted during the construction period as well as after completion of the installation. A Lightning Protection System Installation Safety Report as described in SANS 10313 Annex A (or similar) must be issued by the LPS installer after completion of the installation. All tests conducted during the commissioning of the LPS must be witness by the Engineer. Inspections must be conducted after any alteration or repair of the LPS.

Regular periodic inspections must be conducted on the LPS system of explosives facilities. A maintenance and inspection plan shall be developed for the installed protection systems. The system shall be tested every 12 months. A register shall be kept for this purpose. Only qualified personnel having the necessary training and expertise shall be permitted to maintain, inspect, test and sign off these facilities.

E11.9.2 Maintenance

Routine inspections should be conducted on a 12-monthly basis. Any observed faults must be repaired immediately.

E11.10 INJURY TO LIVING BEINGS DUE TO TOUCH AND STEP VOLTAGES

The area surrounding the down-conductor (within a 3-meter radius) may be hazardous despite measures described in this specification. Additional measure must be installed to reduce this risk to acceptable values:

E11.10.1 Touch voltage

- The area is demarcated to prevent access and relevant notices are displayed (ISO 3864-1), or
- The number of down-conductors are increased to above 10, which will reduce the current and induced voltages, or
- Increasing the contact resistance of the soil to above 100kΩ, or
- The down conductors are insulated against the lightning impulse (100 kV, 1, 2/50 μs impulse withstand voltage).

E11.10.2 Step voltage

- The area is demarcated to prevent access and relevant notices are displayed (ISO 3864-1), or
- The number of down-conductors are increased to above 10, which will reduce the current and induced voltages, or
- Increasing the contact resistance of the soil to above 100kΩ, or
- The down conductors are insulated against the lighting impulse (100 kV, 1,2/50 μs impulse withstand voltage), or

- e) The installation of a meshed earth-termination system.

E11.11 SURGE PROTECTION MEASURES (SPM)

Surge Protection Measures (SPM) are implemented to reduce the risk of permanent failures of electrical and electronic installations within a structure due to a Lightning Electromagnetic Pulse (LEMP).

Equipment failure due to LEMP is caused by surges conducted by connected wiring or by radiated electromagnetic fields. The effect of line surges is reduced by the installation of Surge Protection Devices (SPD's). The effect of radiated electromagnetic fields is reduced by shielding of equipment and shielded lines. Equipment generally complies with EMC product standards, which is sufficient to protect such equipment against LEMP.

E11.11.1 Design and installation of SPM

The SPM should be designed, installed and signed off by a competent and experienced SPM design engineer and SPM installer (person who is competent to design, install, construct and test an SPM with a broad knowledge of Electromagnetic compatibility (EMC)). It is the responsibility of the contractor to appoint a competent and experienced SPM design engineer and installer.

The design of the Surge Protection Measures (SPM) must be done in accordance with SANS 62305-4 as well as the Risk Assessment study done as described in SANS 62305-2.

E11.11.2 Earthing and bonding

A meshed network with a 5m mesh width is installed around the structure. This mesh is connected to the Type B ring earth electrode as well as the structure's interconnected mesh reinforced concrete floor to form a meshed earth termination system. The earth-termination systems of all internal systems should be bonded together to prevent potential differences between the systems.

Bonding bars in a stand-alone or ring configuration should be used to bond all conductive parts and incoming services (metal pipes, power lines, signal lines) together. Incoming lines should be bonded with SPD's. The material and minimum cross-sections for bonding component must comply with SANS 62305.

E11.11.3 Magnetic shielding and line routing

Spatial shielding is used to define protection zones. It can be grid like and can use electrical conductive reinforcement in the building. Internal lines can comprise of shielded cables or metallic enclosures of cables. Cables must be routed close conductive parts in the shielding system (reinforced concrete) to minimise induction.

The requirement of SANS 62305 concerning the material and minimum cross-sections or thickness of air-termination and down conductors must be followed.

E11.11.4 Coordinated SPD system

Please read this section in conjunction with the document Automation and Control Design Standards, Volume 5: Clean Power and Surge Protection for system compatibility.

The principle of a coordinated SPM is based on the division of the protected area/s into Lighting Protection Zones (LPZ), where the first LPZ_n is the overall protection zone which borders the inner zone LPZ (LPZ_{n+1}). The effect of the LEMP is reduced with each zone employed. LPZ 0 is the unprotected outer zone where equipment will be exposed to full LEMP and lighting surge currents. LPZ 1...n is the inner zones where equipment is exposed to limited surge current and attenuated electromagnetic field. (Refer to SANS 62305-4 typical drawings.)

SPD's must be selected to reduce the surge overvoltage between the live conductors and earth to a value lower than the equipment's rated impulse withstand voltage U_w at its terminals (common mode withstand voltage). The type of SPD, the location of the SPD (as close as possible to the point of entrance of the line vs as close as possible to the equipment to be protected) as well as the connecting conductors must be considered.

Types of SPD's:

There are three types of SPD's:

a) Type 1 SPD

The Type 1 SPD is recommended in the specific case of service-sector and industrial buildings, protected by a lightning protection system or a meshed cage. It protects electrical installations against direct lightning strokes. It can discharge the back-current from lightning spreading from the earth conductor to the network conductors. Type 1 SPD is characterized by a 10/350 μ s current wave.

b) Type 2 SPD

The Type 2 SPD is the main protection system for all low voltage electrical installations. Installed in each electrical switchboard, it prevents the spread of overvoltages in the electrical installations and protects the loads. Type 2 SPD is characterized by an 8/20 μ s current wave.

c) Type 3 SPD

These SPDs have a low discharge capacity. They must therefore mandatorily be installed as a supplement to Type 2 SPD and in the vicinity of sensitive loads. Type 3 SPD is characterized by a combination of voltage waves (1.2/50 μ s) and current waves (8/20 μ s).

E11.11.5 SPM management

A Management Plan must be implemented by a competent and experienced SPM design engineer:

- a) Risk analysis;
- b) SPM planning;
- c) SPM design;
- d) Installation of the SPM;
- e) Approval of the SPM;
- f) Recurrent inspections (documented);
- g) Maintenance (following defects noted during recurrent inspections).

E11.12 EARTHING OF THE LV DISTRIBUTION SYSTEM

E11.12.1 TN-S system earthing – Separate neutral and protective conductors

The protective conductor (PE) is a separate conductor connected to the transformer neutral (star point). The transformer neutral is connected to the structure earth-termination system.

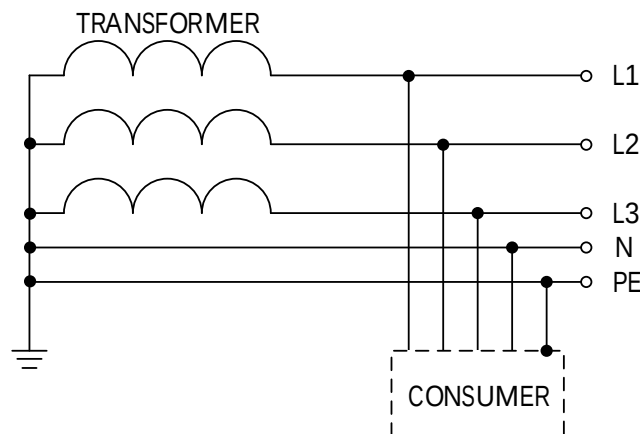


Figure 1. TN-S System earthing

E11.12.2 Requirements of the TN-S system earthing

- a) In a single-phase TN-S system, the equivalent area of the neutral (N) conductor should be not less than the area of the phase conductor.
- b) In a three-phase TN-S system, the equivalent area of the N conductor should be not less than half the area of one phase conductor.
- c) In a three-phase TN-S system, all power cables will be four core, with the fourth (black) core used as the N conductor.
- d) The protective earth (PE) conductor shall be able to carry the maximum fault current for the duration of the fault. This applies to any point in the distribution system.
- e) The PE conductor should be of copper not less than 10mm².
- f) The minimum cross-sectional area of the PE conductor for phase conductors 16mm² to 35mm² is 16mm².
- g) The minimum cross-sectional area of the PE conductor for phase conductors above 35mm² is at least 50% of the phase cross-sectional area.
- h) No mechanism (circuit breaker, disconnector, fuse or removable link) which can separate the neutral conductor from the neutral point may be installed.

E11.12.3 Installation of the TN-S system earthing

- a) The PE conductor will be installed next to the associated LV power cable.
- b) Where the PE conductor is installed directly in the ground, bare copper earth wire will be used.
- c) Where the PE conductor is installed in a covered cable trench or on a cable rack, black PVC insulated earth wire will be used. Both ends of the PE conductor will be identified with yellow/green crimp sleeves.

E11.14

LIGHTNING PROTECTION SYSTEM (LPS)

Figure 2 shows a typical LPS as implemented by Johannesburg Water

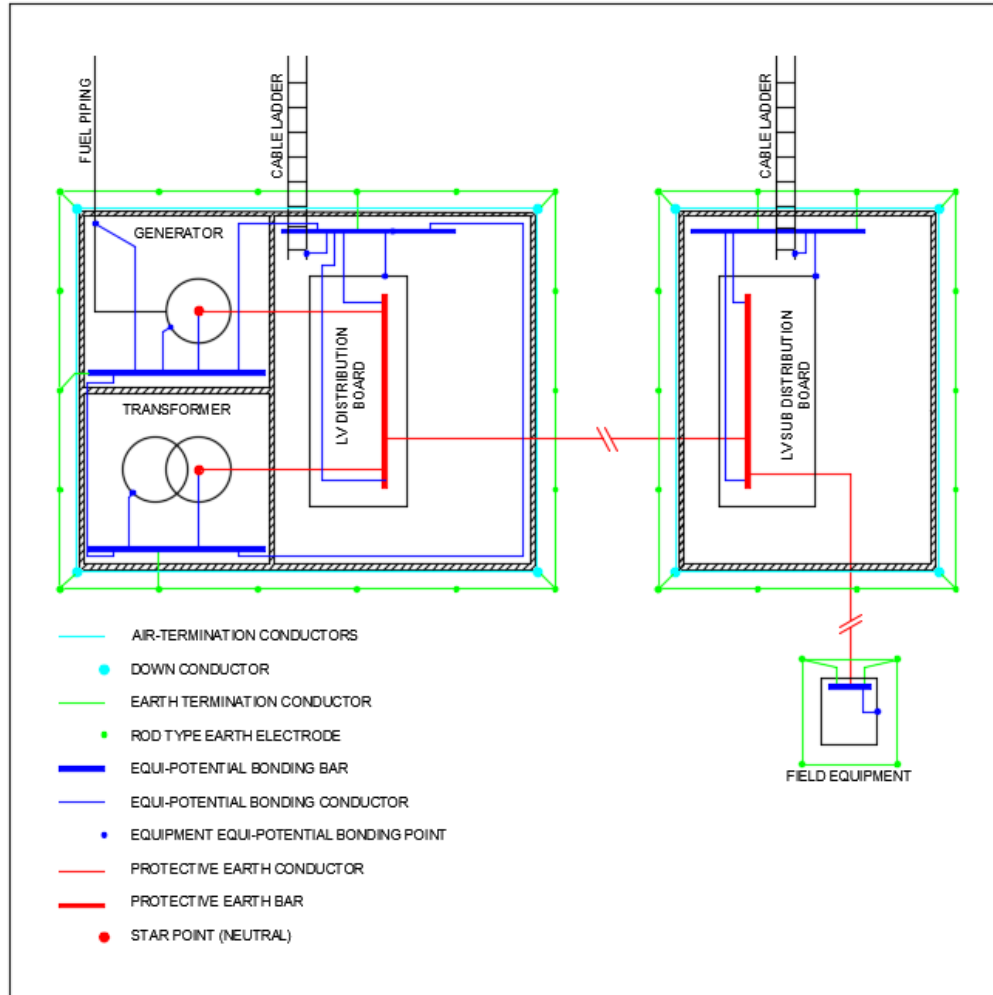


Figure 2. *Lighting Protection System (LPS)*

E11.16

MEASUREMENT AND PAYMENT

<u>Item</u>	<u>Unit</u>
Earth resistivity tests	No
The tendered rate shall include for the carrying out of the earth resistivity tests by a competent and experienced LPS engineer. The unit for measurement shall be per point where such tests have to be carried out.	
<u>Item</u>	<u>Unit</u>
Design of a Lightning Protection System (LPS).....	No
The tendered rate shall include for the design by a competent and experienced LPS engineer and must include the design of the Surge Protection Measures (SPM). The unit for measurement shall be an area of design.	
<u>Item</u>	<u>Unit</u>
Installation of a structure LPS	Sum
The tendered rate shall include full compensation for the supply of all material required and the installation of the Lightning Protection system as per the design by a competent and experienced LPS engineer. It shall include for the testing of the LPS by a competent and experienced LPS engineer.	
<u>Item</u>	<u>Unit</u>
Extra over for the supply and installation of additional rod type earth electrodes of specified length including welding/clamps for the connection of earth-termination conductors	No
The tendered rate shall include full compensation for the supplying and installation of the earth electrodes.	
<u>Item</u>	<u>Unit</u>
Provision for additional earthing as required	Provisional sum
The provisional sum provided shall include for any additional earthing which may be specified by the Engineer after the acceptance of the contract.	
The Contractor shall submit a written quotation to the Engineer when requested to by the Engineer and shall not commence with the installation of any additional earthing without the written instruction of the Engineer.	
<u>Item</u>	<u>Unit</u>
Testing of a LPS.....	No
The unit of measurement shall be the number of tests undertaken by a competent and experienced LPS engineer, including the supply of the equipment required to do the test.	

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PARTICULAR SPECIFICATION
E16 : ELECTRICAL UNINTERRUPTIBLE
POWER SUPPLY UNIT

Johannesburg Water (SOC) Ltd.
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Revision 4

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PARTICULAR SPECIFICATION: VOLUME E16: ELECTRICAL UNINTERRUPTIBLE POWER SUPPLY UNIT
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E16.1 INTRODUCTION

This specification is for the supply and installation of Single Online Double Conversion Static Uninterrupted Power Supply Units (UPS) for use in office and industrial environments.

The UPS Unit will be used for backing up critical electrical loads, such as lighting, dedicated sockets, air conditioning in computer rooms etc.

The UPS Unit will be installed via Normal Power or via a Diesel Standby Generator.

E16.2 SCOPE

The scope of work includes the furnishing of all labour, material and services for the design, supply, manufacture, delivery to site, off load, install in position, fix on site, testing, commissioning and inspection of the equipment and installation works at the manufacturers premises and on site of an UPS Unit and its installation.

The Tenderer has to complete all required returnable schedules. Failure to comply with this request will lead to immediate disqualification.

The Tenderer will be responsible for connecting electrical cables to their own equipment that is supplied and installed under this contract. All cables will be properly glanded to the units.

E16.3 STATUTORY DOCUMENTS AND STANDARDS

E16.3.1 Standards

In addition to any client specifications and general operating procedures, the UPS Units shall comply with the requirement of the following specifications, and any amendments thereto, the SANS specification taking preference:

The equipment offered and work performed, shall comply with the requirements of the governing occupational Health and Safety act, at time of tender.

The Uninterruptible power supply system shall comply with the requirements of SANS 1474 or an International standard such as BS or DIN, and shall be produced in a factory with ISO9000 rating and the applicable quality assurance standards.

(a) SANS 60439	:	Low Voltage Switchgear and Control Gear Assemblies
(b) SANS 60529/IEC 529	:	Degrees of Protection Provided by Enclosures (IP Code)
(c) SANS 60947/IEC 947	:	Low-voltage switchgear and controlgear
(d) IEC 60146	:	General requirements and line commutated converters
(e) IEC 747	:	Semi-conductor Devices (including Thyristors)
(f) IEC 60269-4	:	Low-voltage fuses - Part 4: Supplementary requirements for fuse-links for the protection of semiconductor devices
(g) IEC 60269-5	:	Low-voltage fuses - Part 5: Guidance for the application of low-voltage fuses
(h) SANS 10142-1	:	The wiring of premises Part 1: Low-voltage installations
(i) SANS 156	:	Moulded-case circuit-breakers
(j) SANS 1195	:	Busbars
(k) SANS 61238	:	Compression and mechanical connectors for power cables for rated voltages up to 30 kV (Um = 36 kV)

The following particular specifications shall be read in conjunction with the Project Specification:

(a) E23	:	ELECTRICAL SPECIFICATION FOR COLOUR CODE
(b) G02	:	PARTICULAR SPECIFICATION FOR CORROSION PROTECTION
(c) E06	:	ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE INSTALLATION
(d) E05	:	LOW VOLTAGE POWER AND CONTROL CABLE
(e) E08	:	WIRING
(f) E11	:	GENERAL EARTHING AND LIGHTNING PROTECTION

E16.4.1 General

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- (n) The UPS must be supplied complete with maintenance free batteries and with a capacity to run the system for 30 minutes at full load. If external battery packs are provided, the battery charger must be adequately rated to re-charge the additional batteries at the C/10 rate.
- (o) The UPS system shall be suitable for operation from a 230V AC single-phase supply and must supply a nominal single phase 230 Volt, 50 Hz output.
- (p) Tenderers must satisfy themselves that the UPS rating is adequate to supply all the equipment which they are offering
- (q) The units shall be able to sustain an overload of 125% for one minute or 150% for ten seconds whereupon it shall switch itself off. A full short circuit shall cause the unit to switch off without sustaining damage.
- (r) The UPS must be able to operate normally in an ambient service temperature of 0°C to +35°C and a relative humidity of 5 to 95% non-condensing at 1500 to 3000m above sea level.
- (s) The rated output voltage must be user selectable from 220/230/240V.
- (t) The output frequency must not vary by more than 3Hz.
- (u) The UPS module shall consist of the following main components:
 - i. Transformer - choke input stage,
 - ii. Rectifier/Charger and DC link,
 - iii. Static Inverter,
 - iv. Static Bypass Switch and Manual Bypass Switch,
 - v. Control Panel and Mimic Panel with LCD Display,
 - vi. Output Isolation Transformer,

E16.4.2 UPS Rating

- (a) The UPS should be able to supply a load with a power factor of 0.7 to unity. Tenderers must submit both the VA and Wattage rating of each UPS offered.
- (b) The UPS efficiency must be no less than 89% from zero to full load.
- (c) The UPS must be suitably rated to supply all the required equipment specified in this tender and any attached specifications and provide backup to this equipment for no less than 30 minutes at full load. Even if the equipment does not require it however, the UPS must not have a rating of less than 3kVA

E16.4.3 UPS Backup Batteries

- (a) Tenderers must state the exact number of batteries that will be used.
- (b) Tenderers must state the type of batteries that will be used.
- (c) Tenderers must state the Ah rating of the batteries that will be used.
- (d) Tenderers must state the design life of batteries that will be used (3-5years, 10 years, etc.).

E16.4.4 UPS Standards

- (a) All imported UPSs must have a CE rating
- (b) The UPS must have CE, LGA/GS markings.
- (c) The UPS must comply with safety conformance to EN-50091-1.
- (d) The UPS must have EMC conformance to EN-50091-2 and EN-61000-3-2.

E16.4.5 Module Modes of Operation

The UPS unit will operate as an online, fully automatic system in the following modes:-

- (a) Normal:
 - i. The inverter shall continuously supply the critical load.
 - ii. The Rectifier/Charger shall derive power from the commercial AC source and shall supply DC power to the Inverter while simultaneously float charging the batteries.
- (b) Batteries:
 - i. Upon failure of the commercial AC power, the critical load shall continue to be supplied by the Inverter, which shall obtain power from the batteries without any operator intervention. There shall be no interruption to the critical load upon failure or restoration of the commercial AC source.
 - ii. The UPS must have a battery low voltage/DC cut-off which is not lower than 1,67 Vpc.
- (c) Recharge:
 - i. Upon restoration of the AC source, the Rectifier/Charger shall recharge the batteries and simultaneously provide power to the Inverter.
 - ii. This shall be an automatic function and shall cause no interruption to the critical load.
- (d) Bypass:
 - i. No-break transfer to and from Bypass mode shall be capable of being initiated manually, without operation of the static switch.

E16.4.6 Cabinets/Enclosures

The UPS Unit and the back-up batteries must each be supplied and installed in a freestanding double front steel metal cabinet/enclosure (safety shield behind doors) on adjustable/levelling feet, all pre-powder coated. The cabinets/enclosures shall be designed for industrial and computer room applications in accordance with the environment requirements. The cabinets will have a minimum standard Ingress Protection of 20 (IP20) in office environments and a minimum Ingress Protection of 23 (IP23) in dusty conditions.

Cabinets will be provided with lockable removable doors/panels and seal protection as required. These doors/panels will be cut to accommodate the control panel displays and metering as required. Cabinets must be provided with forced air-cooling ventilation fans. Should the fans be installed on the top section, the cabinets must be fitted with drip trays.

The cabinets must ensure that cable entry and connection will be from the bottom and additional support is provided for cable glands. A dedicated wire way shall be provided within the UPS module for routing user input and output wiring.

UPS Unit plus Battery Cabinet must line up and match up in style and colour.

Service Area Requirements: The UPS module shall require no more than 1 meter of front and side service access room.

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Refer to Environment Conditions – Cabinets/Enclosures must be built to suit all temperatures and humidity conditions.

Cabinets/Enclosures must be labelled with 50mm high black engraved letters on white background fixed to cabinet with screw in centre of units.

E16.4.7

Manufacturer's Field Service

(a) Field Engineering Support:

- i. The UPS manufacturer shall have a countrywide field service department staffed by factory-trained field service engineers dedicated to start-up, maintenance, and repair of UPS equipment. The organization shall consist of local offices managed from a central location.
- ii. Field engineers shall be deployed in key population areas to provide on-site emergency response within 24 hours 80% of the time.
- iii. Location of all field service offices must be submitted with the proposal.
- iv. Third-party maintenance will not be accepted.

(b) Spare Parts Support:

- i. Parts be available within 24 hours.

(c) Operational Training:

- i. Before leaving the site, the field service engineer shall familiarize responsible personnel with the operation of the UPS. The UPS equipment shall be available for demonstration of the modes of operation.

(d) Product Enhancement Program:

- i. The UPS manufacturer shall make available feature upgrade service offerings to all users as they are developed. These products shall be proposed as a field-installable, optional kit.

E16.4.8

UPS Data Sheets (Returnable Schedule)

The tenderer must complete the data sheet below with his tender:

Technical Data Sheet: UPS

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model (E.g. true on-line, double conversion)	
Transformer-based unit (Y/N?)	
Technology employed (E.g. pulse width modulation)	
Output voltage variation	
Output frequency variation	
UPS rating (VA and Watts)	
UPS efficiency from zero to full load	
Maximum harmonic distortion at full load	

Overload handling capabilities (E.g. "x"% load for "y" minutes)	
Power backup period from batteries at full rated load	
Compliance with standards rating and markings (E.g. "Yes, full compliance" or "No".	
Tenderer to provide complete factory load test that can be witnessed by the Engineer	
Staff available for installation, testing and backup service?	
Number of batteries to be used	
Type of batteries to be used	
Ah rating of batteries	
Design life of batteries	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

E16.5

QUALIFICATIONS

- (a) The UPS manufacturer shall have a minimum of ten years' experience in the design, manufacture and testing of solid-state UPS. A list of installed UPS of the same type as the manufacturer proposes to furnish for this application shall be supplied with the proposal.
- (b) The UPS manufacturer shall have ISO 9001 certification for engineering/R&D and manufacturing facilities.
- (c) If it is an imported UPS, the vendor must be the ACTUAL importer of the UPS. In other words, a middleman who cannot provide factory load tests or suitable after-sales service and backup will not be acceptable.

E16.6

GUARANTEE

The successful vendor/supplier will guarantee the installation works and equipment for a period of twelve months after first delivery was taken by the Engineer.

E16.7

TESTING AND INSPECTION:

- (a) The testing and inspection procedures shall be approved prior to the commencement of manufacture.
- (b) The Contractor shall assemble the complete UPS for inspection and factory testing, and present the system to the Engineer, to who it shall be demonstrated that the equipment meets the requirements of the specification.
- (c) The tenderer must be willing and able to provide a complete factory load test, which can be witnessed by the engineer and/or client.
- (d) The Contractor shall provide suitably qualified personnel and all necessary equipment to carry out the tests to demonstrate conformance with the specification and simulate the operation of the system in its final operating state.
- (e) The Contractor shall prepare a set of completed test and inspection certificates for approval.

- (f) The contractor is required to perform site acceptance tests (SAT) on the UPS witnessed by the employer and the engineer, prior to commissioning the UPS. A schedule of the checks, tests and results of the SAT must be available for signing by the engineer at the completion of the SAT.
- (g) A thermal imaging record of the UPS shall be taken after the UPS has been in operation for a minimum one week under typical normal conditions and while running. The thermal imaging record will form part of the deliverable documentation together with Operation and Maintenance Manuals and delivered to the employer on completion of the works.

E16.8 PACKING AND MARKING

E16.8.1 Packing

The Contractor shall protect the equipment against scratching and damage by suitable wrapping, packing and crating of the equipment items.

E16.8.2 Marking

Each separately packed and transported piece of equipment shall be clearly marked.

E16.10

MEASUREMENT AND PAYMENT

<u>Item</u>	<u>Unit</u>
Supply and deliver UPS	No
The tendered rate shall include full compensation for the manufacture, supply, testing and delivery of the UPS incorporating all options/extras as detailed in the detail specification.	
<u>Item</u>	<u>Unit</u>
Install UPS	No
The tendered rate shall include full compensation for the installation, site testing and commissioning plus the 12 months maintenance of the UPS incorporating all options/extras as detailed in the detail specification.	
<u>Item</u>	<u>Unit</u>
Supply and deliver support platform/stand for UPS	No
The tendered rate shall include full compensation for the manufacture, supply, testing and delivery of the support platform/stand for UPS as detailed in the detail specification.	
<u>Item</u>	<u>Unit</u>
Install support platform/stand for UPS	No
The tendered rate shall include full compensation for the installation of the support platform/stand as detailed in the detail specification.	

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER
PARTICULAR SPECIFICATION
E21 : ELECTRICAL LIGHTING AND
ILLUMINATION

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PARTICULAR SPECIFICATION: VOLUME E21: ELECTRICAL LIGHTING AND ILLUMINATION

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E21.1 SCOPE

This section covers the requirements for lighting and illumination. Lighting and illumination shall be supplied, delivered, installed and commissioned as specified.

E21.2 STANDARDS

The latest edition, including all amendments up to date of tender of the following particular national specifications, publications and codes of practice shall be read in conjunction with this specification and shall be deemed to form part thereof:

(a) SANS 475	:	Luminaires for interior lighting, street lighting and floodlighting - Performance requirements
(b) SANS 10389-1	:	Exterior lighting Part 1: Artificial lighting of exterior areas for work and safety
(c) SANS 10114-1	:	Interior lighting Part 1: Artificial lighting of interiors
(d) SANS 10114-2	:	Interior lighting Part 2: Emergency lighting
(e) SANS 10142-1	:	The wiring of premises Part 1 Low-voltage installations
(f) SANS 1019	:	Standard voltages, currents and insulation levels for electricity supply
(g) SANS 60081	:	Double-capped fluorescent lamps - Performance specifications
(h) SANS 60598-1	:	Luminaires - Part 1: General requirements and tests
(i) SANS 60901	:	Single-capped fluorescent lamps - Performance specifications
(j) SANS 60968	:	Self-ballasted lamps for general lighting services - Safety requirements
(k) SANS 61547	:	Equipment for general lighting purposes - EMC immunity requirements
(l) SANS 1777	:	Photoelectric control units for lighting (PECUs)
(m) SANS 60947-4-1	:	Low-voltage switchgear and controlgear Part 4-1: Contactors and motor-starters - Electromechanical contactors and motor-starters
(n) SANS 10225	:	The design and construction of lighting masts
(o) IEC 62031	:	LED modules for general lighting – Safety specifications
(p) IEC 61347-2-13	:	Lamp controlgear - Part 2-13: Particular requirements for d.c. or a.c. supplied electronic controlgear for LED modules
(q) IEC 62560	:	Self-ballasted LED-lamps for general lighting services by voltage > 50 V-Safety specifications

E21.3 SPECIFICATIONS

E21.3.1 Manufacture and Assembly of Luminaires

Body

- (a) The bodies and relevant sheet metal parts of all fittings shall be manufactured from minimum 0,8mm sheet steel, to precise tolerances, with joints neatly formed and spot-welded.
- (b) Metal parts shall be painted with a suitable primer utilized for epoxy or polyester powder coat finishes. The final finish shall be a high reflectance, white epoxy or polyester powder coating (other colours applicable as well).
- (c) Bodies of lay-in fittings shall fit neatly into the specified ceiling grid, with no visible light

leaks from below.

- (d) Access for lamp replacement and maintenance shall be simple and easy.

Lamp holders

- (a) Lamp holders shall be of a good quality, manufactured from polycarbonate, with heat resistant centres.
- (b) Lamp holders for all fluorescent luminaries (recessed, surface, open channel) shall be good quality roto-lock type from a known manufacturer.

Control gear

- (a) All luminaires, except the metal halide types, shall be equipped with electronic ballast/control gear. Metal halide/High pressure Sodium fittings shall use ballasts/chokes.
- (b) Ignitors shall be digital in nature with time control pulse break for optimum control gear and lamp protection. (Ignitors will also allow enclosed rated lamps to be used in open luminaires).
- (c) Only capacitors supplied by reputable manufacturers shall be offered. Power factor correction in luminaires shall be done to ≥ 0.90 .

Wiring

- (a) All internal wiring shall be done with high temperature PVC insulation (105°C).
- (b) Wiring shall be neatly grouped and retained.
- (c) The wiring shall terminate in a 3-way, 6A screw terminal block, with the earth conductor terminated onto a welded earth stud.

Cord Sets

- (a) Cord sets shall be fitted on all indoor luminaires and as specified in the luminaire schedule.
- (b) Cord sets will be 3m long as a minimum.
- (c) Cord sets shall 3-core PVC cable, 0.75mm² measured from the side of the fittings with a 6A, three pin moulded plug top. The cord shall terminate in the luminaire by means of compression gland.

Lamps

- (a) All lamps shall be as specified in the lamp schedule.
- (b) Only lamps from known manufacturers shall be offered.
- (c) All fluorescent tubes shall be tri-phosphor.

E21.3.2

Manufacturing and assembly of Fluorescent luminaires

- (a) Luminaires shall be supplied and delivered complete with lamps, control gear and flexible cords and plug tops as specified.
- (b) Luminaires shall be designed to prevent excessive high temperatures and components and materials shall be selected so that they are not adversely affected by the operating temperature.
- (c) The voltage and wattage ratings shall be clearly and indelibly marked on control gear and related control equipment and apparatus.
- (d) Bodies of lay-in fittings shall fit neatly into the specified ceiling grid, with no visible light leaks from below.
- (e) Access for lamp replacement and maintenance shall be simple and easy.
- (f) Lamp holders shall be of a good quality, manufactured from polycarbonate, with heat resistant centres.
- (g) Lamp holders for all fluorescent luminaires shall be good quality roto-lock type.

- (h) All luminaires shall be equipped with quick start electronic ballast/control gear.
- (i) All internal wiring shall be done with high temperature PVC insulation (105C).
- (j) Wiring shall be neatly grouped and retained.
- (k) The wiring shall terminate in a 3-way, 6A screw terminal block, with the earth conductor terminated onto a welded earth stud.
- (l) Cord sets shall be fitted as specified in the luminaire schedule.
- (m) Cord sets shall consist of 3 metre 0.75mm² 3-core PVC cabtyre cable with a 6A, three pin moulded plug top. The cord shall terminate in the fitting by means of compression glands.
- (n) Integrated dimming and or switching control capability utilizing an external 0-10 VDC control signal, dry NO or NC contact.

E21.3.3 Manufacturing and assembly of LED luminaires

General

- (a) The life of all led luminaires and lamps shall be >50 000 hours.
- (b) Output beam angle shall be as specified.

Construction

- (a) Preference shall be given to modular luminaires designed for ease of component replacement: LED luminaires shall be equipped with replaceable or upgradable LED modules.
- (b) Ingress protection rating of the LED luminaire should be prescribed for the intended applications under specific environmental conditions.
- (c) Housing to be manufactured from die cast or extruded aluminium.
- (d) There should be additional room available in the wiring compartment for third-party adaptive controls to be retrofitted.
- (e) Luminaires should be designed for ease of component replacement, including LED engines/modules, drivers, surge devices, and they should accommodate end-of-life disassembly.
- (f) Power supply driver shall be specified as dimmable or non-dimmable in the luminaire schedule and will operate as follows:
 - Reliable operation up to $\geq 45^{\circ}\text{C}$ ambient temperature;
 - Will last >80,000 hours;
 - Driver housing IP66 rated
 - Integrated dimming and or switching control capability utilizing an external 0-10 VDC control signal, dry NO or NC contact, DALI shall be specified if required.

2ft/4ft/5ft Vapour Proof LED Light

(a)	Body length	:	660mm or 1277mm or 1572mm
(b)	Body construction	:	Polycarbonate with stainless steel latches and mounting hangers
(c)	Cover lens	:	UV stable Polycarbonate
(d)	Lumen	:	660mm: 25W - 3200 lumen 1277mm: 50W - 6400 lumen 1573mm: 90W - 12000 lumen
(e)	CCT options	:	4000K or 5000K
(f)	Supply voltage	:	230V AC
(g)	IP rating	:	IP 65

LED Flood light

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(a)	Wattage	: 220W, 440W, 880W
(b)	Body construction	: Die cast LM6 aluminium - powder coated
(c)	Front glass cover	: 5mm tempered safety glass
(d)	Lighting performance	: 146 lumens per W at source
(e)	CCT	: 4000K or 5000K
(f)	CRI	: +80 minimum
(g)	Supply voltage	: 230V AC/50hz
(h)	Additional protection	: 10KV
(i)	IP rating	: IP 65

LED Bulkhead/Street light

(a)	Body construction	: Glass filled Nylon / Yoke and Bulkhead bracket Stainless Steel 316
(b)	Lens type	: 3mm Polycarbonate (UV stabilised) toughened glass or impact modified Acrylic
(c)	Wattage	: 20W/40W/50W
(d)	Lumen options	: 20W – 3520 Lumens at source 40W – 7040 Lumens at source 50W – 8800 Lumens at source
(e)	CCT	: 4000K or 5000K
(f)	CRI	: +80 minimum
(g)	Supply voltage	: 230V AC/50hz
(h)	IP Rating	: IP65
(i)	Power factor	: 0.94 or better

2ft/4ft/5ft Utility LED light

(a)	Body Construction	: Extruded aluminium - either anodized or powder coated
(b)	Lens and Reflector	: 190-degree ultra wide distribution Opal lens with 80% transmission.
(c)	Length/Lumen options	: 600mm – 24W 3072 lumens at source 1200mm – 48W 6144 lumens at source 1800mm – 72W 9216 lumen as source
(d)	Supply Voltage	: 230V AC 50HZ
(e)	CCT options	: 4000K or 5000K
(f)	CRI	: +80 minimum
(g)	IP Rating	: IP 44
(h)	Control Gear	: Internally mounted

LED High bay

(a)	Body construction	: ABS end caps Anodised aluminium reflectors Powder coated or anodised aluminium body
(b)	Lens type	: 4mm Polycarbonate or toughened glass
(c)	Supply voltage	: 230V AC 50HZ

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- (d) Load/lumen options : 75W – 13200 lumens at source
90W – 15750 lumens at source
150W – 26400 lumens at source
180W – 31500 lumens at source
300W – 52800 lumens at source
360W – 63000 lumens at source
- (e) CRI : +80 minimum
- (f) CCT : 4000K and 5000K
- (g) IP Rating : IP 65
- (h) Power factor : Better than 0,97

Luminaire LED Performance

- (a) Minimum Luminaire Efficacy : 75 lumens per watt
- (b) Correlated Colour Temperature (CCT) : 4000K - 5000K
- (c) Minimum Colour Rendering Index (CRI) : 80
- (d) Lumen Output: - Initial lumen output shall be $\geq 10\%$ higher than required for the luminaire to meet recommended values for the specific locations indicated, in order for the luminaire to maintain compliance over its entire lifetime.

E21.3.4 Manufacturing and assembly of Emergency fittings

General

- (a) The fittings shall be manufactured according to the standard fittings as described above.
- (b) The fittings shall be self-contained emergency modules. I.e. The modules (emergency control units plus battery packs) can be fitted inside recessed and surface mounted luminaires including CFL bulkhead fittings.
- (c) The emergency fittings should have a switched live for Normal ON/OFF operation and an unswitched live for Emergency light battery charging.
- (d) The module should be able to maintain 50% light output for 1hour or alternatively 100% light output for $\frac{1}{2}$ hour.

E21.3.5 High Masts Lighting

General

- (a) All work on the high mast lighting must be done from ground level.
- (b) All high mast poles will be of the hinging/tilting type. The hinging action allows the floodlights to be lowered to the ground for ease of access. Enough clearance space must be allowed to lower the pole.

Mast Shaft

- (a) All poles must be designed to SABS 0225 by a registered Professional Engineer.
- (b) The mast shall be constructed to form an enclosed tapered shaft. All steelwork must be hot dip galvanised, by an SABS approved galvaniser, to SABS ISO1461.
- (a) The lower mast portion shall be fitted with a suitably designed base plate bolted onto the mast foundation. The bolts will be reusable security bolts (tamper proof bolts) where a special tool is required to remove the bolts.
- (c) All mast foundations must be designed by a professional engineer, taking into account the mounting requirements of the pole baseplate.
- (d) The upper portion will be counterbalanced and hinged at midpoint.
- (e) The mast must be designed to safely withstand any loading (wind and own weight) in the upright and hinged position.

Floodlight Mounting Assembly

- (a) The mast shall be fitted with a suitable luminaire mounting assembly fabricated from steel sections and capable of carrying the specified number and type of luminaires.

Electrical Equipment

- (a) The Electrical distribution board shall be mounted in the base section of the mast and accessible only once the lid cover has been removed. The cover will be permanently fixed to the mast by means of a chain.
- (b) The lid cover will be fitted with reusable security bolts (tamper proof bolts) where a special tool is required to remove the bolts.
- (c) A multicore trailing cable shall be installed from the distribution board to a splitter box mounted on top of the mast.
- (d) The cable supplying power to the floodlight luminaires need not be disconnected during the lowering procedure thus allowing testing of the floodlights with the mast in the hinged down position.

E21.3.6

Sensors

Daylight Sensors

Daylight sensors must be provided to switch lights on at dusk and off at dawn by detecting natural light changes. All day light sensors shall have the following minimum requirements:-

- (a) Conduit entry with wall bracket mounting.
- (b) Efficient lighting solution.
- (c) Ultra violet stabilized materials.
- (d) Fail-safe position "ON".
- (e) Capacity switching - Incandescent or fluorescent 2.2Kw HID 1,8W.
- (f) Impact and hail resistant 0-4mm.
- (g) IP Rating: 54.
- (h) Amp Rating: 16A.
- (i) Voltage: 200 - 250Vac (50Hz).

Occupancy Sensors

- (a) Sensor shall activate the electrical load upon entry into the controlled area and deactivate it after the area is vacated.
- (b) Sensor shall be able to detect moderate types of motion.
- (c) Sensor shall maintain a constant level of sensitivity to motion regardless of changes in environmental conditions including airflow.
- (d) Sensor shall utilize passive infrared sensing technology to activate lights and other equipment connected to it.
- (e) Sensor shall contain timing circuitry to provide adjustable "time to lights off" delay of 15 seconds or less (for installer checkout) to 30 minutes. A 10-minute delay shall automatically default if the potentiometer is left at minimum.
- (f) Sensor shall provide a ten-second "grace period" that allows lights to be turned on by motion anywhere in an area after they are turned off due to inactivity.
- (g) Sensor shall self-adjust sensitivity (range) and time delay in real-time to optimize performance.
- (h) Sensor shall provide a Building Automation system (BAS) option interface via (1) a built-in isolated Form C relay output, (2) an open collector output, with or without pull-up option, or (3) a direct BAS connection.
- (i) Sensor shall be designed for parallel wiring to allow coverage of large areas.

E21.4

LIGHTING DESIGN

- (a) The contractor must do an area illuminance design in accordance with the applicable lux levels listed in SANS 10389-1 (Table 7 — Recommended values for illuminance, uniformity ratios and glare rating limits) and SANS 10114-1 (Table 1 — Minimum maintained illuminance values).
- (b) All exit routes must be lit with emergency lights in accordance with the latest Occupational Health and Safety Act (Act 85 of 1993) and the Building Code.
- (c) The contractor must submit the design to the Engineer for approval prior to the procurement of any material.
- (d) After installation, the contractor must do an illuminance study to confirm compliance to SANS 10389-1. The contractor must supply calibrated instruments to be used during the study. The compliance study must be witnessed by the Engineer.
- (e) Should the illuminance study indicated insufficient lux levels, the contractor must take steps to increase the lux levels to the required level.
- (f) Luminaire must be supplied as listed in the table below, specific to the area of installation (see paragraph E21.3.3 for minimum requirements)

#	AREA	LUMINAIRE (See E21.3.3)
1	Analyser Rooms	2ft/4ft/5ft Vapour Proof LED Light
2	Balancing Tanks	LED Flood Light on high mast
3	Belt Filter Press Sludge Dewatering	2ft/4ft/5ft Vapour Proof LED Light or LED Bulkhead/Street light
4	Biogas Collection and Storage (Gas Holder)	LED Flood Light on high mast
5	Bioreactors	LED Flood Light on high mast
6	Boiler Rooms	2ft/4ft/5ft Vapour Proof LED Light Ex-Rated fittings (Zone 2)
7	Chemical Dosing areas (Ferric Chloride and Hypochlorite)	LED Flood Light on high mast or 2ft/4ft/5ft Vapour Proof LED Light
8	Control Rooms	2ft/4ft/5ft Vapour Proof LED Light
9	Degritters	LED Flood Light on high mast In case of shed, use LED High bay
10	Digester Area	LED Flood Light on high mast
11	Fermenters	LED Flood Light on high mast
12	Final Clarifiers	LED Flood Light on high mast
13	Head Of Works (Buildings)	2ft/4ft/5ft Vapour Proof LED Light (LED High bay for areas under Sheds)
14	Head Of Works (Open area)	LED Flood Light on high mast (LED High bay for areas under Sheds)
15	Lime Preparation and Dosing (Open Area)	LED Flood Light on high mast
16	Liquor treatment (Open Area)	LED Flood Light on high mast
17	MCC/PLC Rooms	Utility LED
18	Open channels	LED Flood Light on high mast
19	Poly make-up, storage and transfer (Buildings)	2ft/4ft/5ft Vapour Proof LED Light
20	Poly make-up, storage and transfer (Open area)	LED Flood Light on high mast
21	PSTs	LED Flood Light on high mast

#	AREA	LUMINAIRE (See E21.3.3)
22	Screening and Washing areas (Buildings)	2ft/4ft/5ft Vapour Proof LED Light
23	Screening and Washing areas (Open area)	LED Flood Light on high mast
24	Screw Pump Station	2ft/4ft/5ft Vapour Proof LED Light or LED Flood Light on high mast
25	Skip areas for grit or screenings removal	2ft/4ft/5ft Vapour Proof LED Light
26	Sludge Pumping Station	2ft/4ft/5ft Vapour Proof LED Light
27	Sludge storage sumps or tanks (Open area)	LED Flood Light on high mast
28	Solar Sludge Drying Slabs (Drying Beds)	LED Flood Light on high mast
29	Thickeners	LED Flood Light on high mast
30	Perimeter of the sites	LED Bulkhead/Street light
31	Cable tunnels (Inside/Underground)	LED Bulkhead/Street light
32	Drying Bed Conveyors	2ft/4ft/5ft Vapour Proof LED Light
33	Perimeter of the sites (outside)	LED Flood Light on high mast
34	Access gates (Outside)	LED Bulkhead/Street light
35	Cable Pipe Bridge/Gantry (with walkway)	2ft/4ft/5ft Vapour Proof LED Light
36	Blower House (Inside)	2ft/4ft/5ft Vapour Proof LED Light
37	Digester Feed Sump	LED Flood Light on high mast
38	GTL pump station	LED Bulkhead/Street light or 2ft/4ft/5ft Vapour Proof LED Light
39	BPU (Belt Press Underflow) pump station (Inside and outside)	LED Bulkhead/Street light or 2ft/4ft/5ft Vapour Proof LED Light
40	Biogas Generator plant (Inside and outside)	LED Bulkhead/Street light
41	Elutriation (Inside)	2ft/4ft/5ft Vapour Proof LED Light
42	Compost Shed (Inside)	LED High bay
43	Flammable Stores	2ft/4ft/5ft Vapour Proof LED Light Zone 2 Ex Rated
44	Workshops	2ft/4ft/5ft Utility LED light
45	Admin Buildings	Architect to specify: For refurbished offices - check and propose to Joburg Water
46	Change Rooms (showers)	2ft/4ft/5ft Vapour Proof LED Light
47	Laboratory	2ft/4ft/5ft Vapour Proof LED Light

E21.5

INSPECTION AND TESTING

E21.5.1

General

All tests in accordance with the test requirements of this specification shall be performed prior to shipment.

Test certificates will be submitted with tender submission for all the units that are proposed.

All fittings shall be tested in accordance with SANS 475 and shall bear the performance mark.

The fittings shall also comply with ISO 9000 certification and the testing requirements of IEC 60598-1 publication.

E21.6 COMMISSIONING

The datasheet shall indicate whether the contractor is to allow a site technician to be present when the lighting system is to be commissioned. In such a case, the contractor shall quote a separate price for the provision of all personnel, materials and equipment for the site commissioning of the lighting.

Contractors shall provide a commissioning procedure, stating the tests that shall be performed with the results forecast.

The commissioning tests carried out on site shall be tests stipulated in the contractor's commissioning procedure.

E21.7 GUARANTEE

All equipment shall be guaranteed against defect for a period of twelve months, from the date of mutually agreed successful hot commissioning, fair wear and tear accepted.

Tenderers shall submit a written undertaking at the time of tender that a complete range of spares for the equipment offered will be held by the manufacturer for a minimum period of 10 years from the date of tender.

E21.8 TRANSPORTATION/SHIPPING

The costs of preparation for shipping will be included in the contractor's price.

The contractor is responsible to ensure that no damage will be sustained while shipping and he will prepare the appropriate packaging to ensure this.

The specification sheet shall indicate whether the contractor is to deliver the luminaires to site and whether the contractor is to offload the luminaires on site or if the delivery and offloading on site shall be carried out by a third party.

Where delivery and/or offloading by the contractor are specified on the specification sheet, the costs thereof shall be included in the contractor's price.

E21.9 DRAWINGS & DOCUMENTATION

The contractor shall supply all drawings and documentation as indicated in the Specification sheet.

E21.10 MEASUREMENT AND PAYMENT

Item

Unit

Supply and delivery of luminaire No

The unit of measure shall be the number of luminaire supplied and delivered.

The tendered rate shall include all costs related to the manufacture, supply and delivery of the luminaire (as detailed in the schedule of quantities), including the additional requirements detailed in the detail specification.

Separate items will be scheduled in the schedule of quantities for different types and sizes, defined by the type of luminaire.

<u>Item</u>	<u>Unit</u>

Install luminaire	No

The unit of measure shall be the number of luminaire installed.

The tendered rate shall include full compensation for installing, testing and commissioning of the luminaire as specified. The rate shall further include for an illuminance study.

Separate items will be scheduled in the schedule of quantities for different types of luminaire.

Separate items will be scheduled in the schedule of quantities for different types and sizes, defined by type of luminaire.

<u>Item</u>	<u>Unit</u>

Supply and delivery of high mast lighting	No

The unit of measure shall be the number of high masts supplied and delivered.

The tendered rate shall include all costs related to the manufacture, supply and delivery of the high mast (as detailed in the schedule of quantities), including the additional requirements detailed in the detail specification.

Separate items will be scheduled in the schedule of quantities for different types and lengths, defined by the type of high mast.

<u>Item</u>	<u>Unit</u>

Install high mast lighting.....	No

The unit of measure shall be the number of high masts installed.

The tendered rate shall include full compensation for installing, testing and commissioning of the high mast lighting as specified. The rate shall further include for the pole plinth, crainage and other services required completing the installation.

Separate items will be scheduled in the schedule of quantities for different types of high masts.

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER
PARTICULAR SPECIFICATION
E26 : ELECTRICAL COLOUR CODING OF
EQUIPMENT

Johannesburg Water (SOC) Ltd.
PO Box 61542
Marshalltown
2107

Revision 1

August 2019

DOCUMENT CONTROL SHEET

Document Title: Particular Specification – E26 : Electrical Colour Coding of Equipment

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Approved	Regional Maintenance Manager	T Thabeng	August 2019	

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1	2019-08-20	B Pieterse	First Issue (Based on G01 Colour Coding of Equipment)

ELECTRICAL SPECIFICATION: VOLUME E26: COLOUR CODING OF EQUIPMENT

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E26.1 SCOPE

This Specification has been adopted by Johannesburg Water to ensure the colour coding of electrical equipment located on Johannesburg Water's Wastewater Treatment Works shall conform to the ruling Occupational Health and Safety Act.

Table 1 gives the colours adopted for certain electrical equipment and mechanical plant.

Throughout the Specification, the colours used shall match the corresponding colours given in SANS 1091, National colour standard (as amended).

Where a colour code is not covered by this Specification, the matter shall be referred in writing to the Divisional Manager: Investment Delivery for ratification.

Item	Colour	Remarks	Code to SANS 1091
Electrical panels : (external)	Light Orange	NOSA	B.26
Electrical panels : (external) emergency power on	Signal Red		A.11
Electrical panels : (Internal)	White		G.80
Coupling guards and motor guards	Golden Yellow	SANS 10140-2	B.4
Motor cowls	Light Orange	Historical	B.26
Electrical motors, pumps and compressors	Deep Pastel Green		H.28

Table 1: Colour Coding of Electrical Equipment

E26.1.1 Machined Components

All machined components shall be protected by "Tectyl" or similar proprietary coating after manufacture. The coating shall be sufficiently durable to prevent corrosion during storage and installation and shall be removed using the manufacturers recommended solvent after final adjustment of the equipment. Final painting shall be carried out in accordance with the system specified.

E26.1.2 Records

The contractor shall maintain records of the application environment, dates of applications, conditions of surfaces before preparation, blast profiles, wet and dry film thicknesses, over-coating times, paint types and batch number, method of application, tests and type of instruments used, which shall be incorporated into the Component Quality Plan and be available to the Engineer or his Representative for review and surveillance. Two copies of the completed Component Quality Plan shall be provided within 2 weeks of completion of the corrosion protection system.

E26.2 MEASUREMENT AND PAYMENT

For the purpose of this Contract, the electro-mechanical items shall be supplied and installed conforming to this specification. The cosmetic painting application shall be included and the surface preparation, transporting of equipment to and from the applicator shall be included. No separate measurement item shall be included for the application of these coatings.

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

PARTICULAR SPECIFICATION
VOLUME 3 : PROGRAMMABLE LOGIC
CONTROLLER (PLC) PANELS

Johannesburg Water (SOC) Ltd.
PO Box 61542
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DOCUMENT CONTROL SHEET

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2012-07-27	10	C. Du Toit	Updated headers & footers.
2012-03-08	9	C. Du Toit	Changed (Pty) to (SOC).
2011-07-11	8	C. Du Toit	Removed 2010 logo.
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2010-03-12	6	C. Du Toit	Altered submission time of PLC panel drawings.

2009-08-18	5	C. Du Toit	New logos added.
2009-03-25	4	C. Du Toit	JW Wastewater Partnership deleted & logos altered as per client's requirements.
2008-10-08	3	C. Du Toit	"Joburg" & "JW" Logos added to top & partnership logos removed.
2007-06-05	2	C. Du Toit	Revision block updated and "Joburg" logo added
2007-03-28	1	C. Du Toit	Final copy issued for approval and sign-off

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3 PROGRAMMABLE LOGIC CONTROLLER (PLC) PANELS

3.1 Scope

3.1.1 This specification covers the manufacturing, supply and installation of Programmable Logic Controller panels used for process monitoring and control applications at Johannesburg Water wastewater sites.

3.2 Abbreviations

3.2.1 In this specification the following abbreviations will apply :-

BS	: British Standards
PLC	: Programmable Logic Controller
I/O	: Input/Output
CPU	: Central Processing Unit
UPS	: Uninterruptible Power Supply
MCC	: Motor Control Centre
MCB	: Miniature Circuit Breaker

3.3 Standards

3.3.1 All design standards for cabling shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 10142-1	: National Standards for the wiring of premises.
SANS 1091:2004	: National Colour Standard.
SANS 1274-2005	: Coatings applied by the powder-coating process.
BS 381C:1980	: Paint colour chart.

3.4 General Requirements

3.4.1 The PLC control panel shall house the following items:-

- 3.4.1.1 The PLC and all I/O modules and racks.
- 3.4.1.2 Fibre-optic network interface modules.
- 3.4.1.3 All network switches and hubs.
- 3.4.1.4 All field instrumentation and MCC interface cables shall be marshalled in this panel.
- 3.4.1.5 All power supply and distribution circuitry and equipment.
- 3.4.1.6 All lightning and surge protection devices as required.
- 3.4.1.7 Marshalling terminals as required

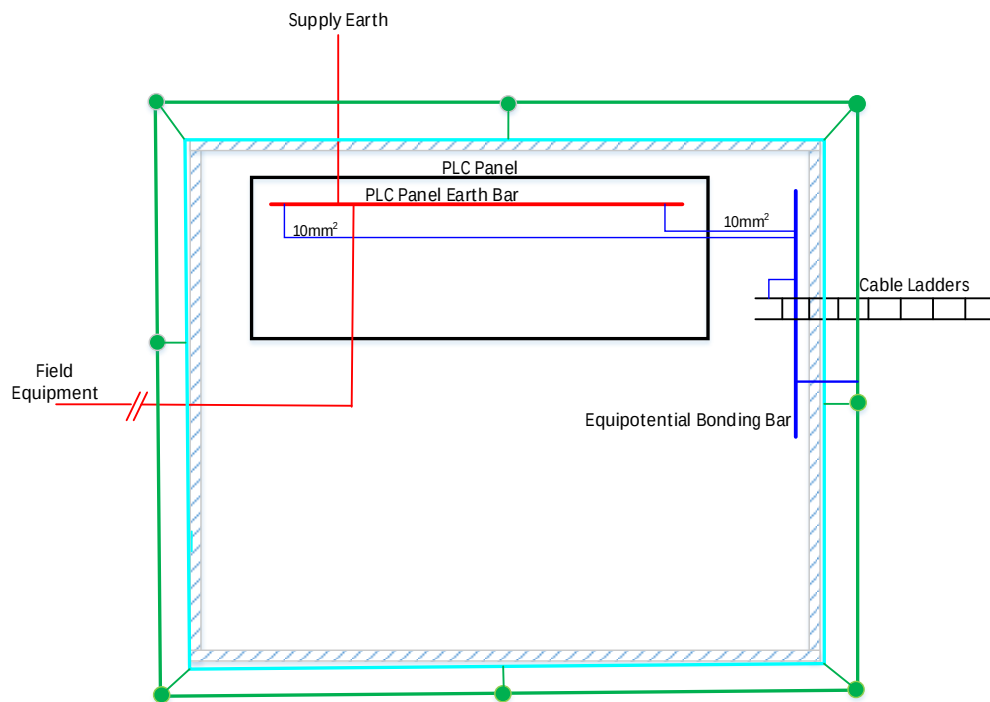
- 3.4.1.8 Interposing relays as required.
- 3.4.2 The supply and installation shall in general comply with the relevant clauses in all specifications attached to the tender documentation.
- 3.4.3 The panels shall be free standing units with bottom cable entry (via a glanding plate) and have front door access (hinged and lockable).
- 3.4.4 The panel should be manufactured from sheet steel not less than 2,0 mm thick. The panel will have a door on the front which opens to practically the full width and height of the panel. The panel shall be free standing and shall not be more than 2 200 mm high, 2 400mm wide and 600mm deep and it should be sized to accommodate all the PLC and associated equipment required for the actual PLC I/O and future spare capacity as indicated in the PLC schematic diagram.
- 3.4.5 Once the door is open there should be no obstruction to prevent full access to every point inside the panel.
- 3.4.6 The panel shall be epoxy powder coated electric orange (Shade B26) finish. Interior chassis mounting plates will be finished in appliance white. All removable parts and hardware will be cadmium yellow passivized.
- 3.4.7 Each panel and control function should be clearly labelled with labels engraved on laminated engraving board with black letters on a white background. All labels must be attached with chrome plated, screws and nuts or screws and tapped holes. On the backing plate only tapped holes may be used. Screws with nuts on the backing plate will not be acceptable.
- 3.4.8 The panel must be vermin-proof and must have a protection rating of no less than IP 55.
- 3.4.9 This specification must be read in conjunction with the PLC Hardware Specification (Volume 2 of the Automation And Control Standards).
- 3.4.10 All labelling must comply with the requirements as specified in the Labelling Specification (Volume 25 of the Automation And Control Standards).

3.5 Standard Features

- 3.5.1 Each panel shall have the following features as standard:-
- 3.5.1.1 Ventilation fans with air filters shall be mounted on the PLC panel at high level with no air outlets. The fans must pressurise the panel to prevent the ingress of dust.
- 3.5.1.2 Ventilation fans must have proper screw terminals in an enclosed terminal box. No exposed terminations, soldered connections or push-on lugs will be accepted.
- 3.5.1.3 A 230V AC switch socket outlet shall be mounted inside the panel (supplied from the UPS section). This socket must have a shaved earth which shall be used for the PLC programmer only.
- 3.5.1.4 Interior lighting at the top of the panel must be arranged to switch on, via a micro switch, when the panel door is opened. This light must be an LED

light with a CCT (Correlated Colour Temperature) of 4000K to 6000K. The light must be fitted with a diffuser and it must supply no less than 680 lm (Net luminous flux). The lamp must have proper screw terminals in an enclosed terminal box. No exposed terminations, soldered connections or push-on lugs will be accepted.

- 3.5.1.5 A substantial area of removable gland plates on the floor of the panel, split into two or more sections.
- 3.5.1.6 A sheet steel pocket welded onto inside of the door to hold A4 sized drawings, books etc.
- 3.5.1.7 No holes may be drilled for tapping, riveting, bolts & nuts, etc. in any section of the panel where it will compromise the protection rating of the panel. I.e. only in the backing plate or in the glanding plate may holes be drilled. Where drilling is unavoidable, e.g. to affix labels, the holes must be sealed so that the protection rating of the panel is not compromised.
- 3.5.1.8 Bolts with nuts shall not be used to attach equipment to any mounting plate at any point. On mounting plates only bolts in tapped holes will be acceptable. Bolts with nuts will be allowed on enclosure doors however, where the bolts and nuts are easily accessible.
- 3.5.1.9 Where bolts are used on the door or any outside panels of the enclosure, a sealing method (e.g. rubber washers) must be used to ensure that the IP protection rating of the enclosure is not compromised.
- 3.5.1.10 Wherever bolts are used, the bolts must be as short as practically possible so that there are no long protrusions that can injure people or snag clothing, wiring, other equipment, etc. If bolts are cut to the correct length, the ends of the bolts must be neatly de-burred and smoothed so that there are no sharp edges that can cause injuries and so that the nuts can be easily screwed on and off. No more than four threads of the bolt end must be visible beyond the nut. It is however preferred that the correct length of bolts are used so that shortening is not required.
- 3.5.1.11 A copper earth bar running the full width (i.e. left-end to right-end) of the panel at the bottom with solid electrical connection to the panel doors and to the steel of the panel at two or more places and provided with terminals for connection of equipment and screen earth wires. This earth bar must be connected to the equipotential bonding bar of the building via at least 2 x 10mm² earth conductors (one from each end of the panel earth bar), as shown in the sketch below.



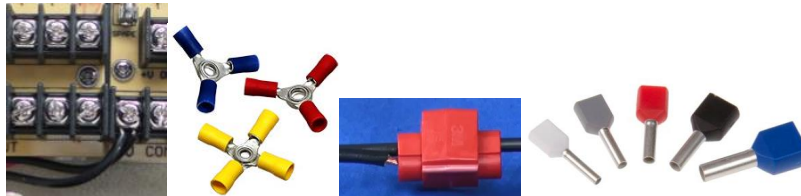
- 3.5.1.12 Separate AC and DC distribution sections if both AC and DC are used.
- 3.5.1.13 A free-standing (i.e. not the PLC rack mounted) 24V DC Power supply for all analogue I/O cards or I/O sub-bases (where required), 24V DC I/O distribution (if required), field instrumentation supplies (if required), etc.
- 3.5.1.14 Where stopper plugs are used to seal holes that are not used, no plastic stopper plugs will be acceptable. All stopper plugs must be threaded, non-corrodible, metal plugs with rubber washers on both sides of the panel to ensure at least an IP65 seal (see examples below).



3.6 Wiring, Relays and Terminals

- 3.6.1 All terminals shall be screw-type terminals and shall be mounted on raised DIN terminal rail, secured to the chassis plate at the back of the panel.
- 3.6.2 Proprietary type wire strippers shall be used and no stranded conductor shall be terminated if one or more strands have been damaged.

- 3.6.3 Not more than one wire shall be connected to any terminal unless the terminal can accept pin lugs on either side of a screw or unless proper connecting material is used (see examples below).



- 3.6.4 Every wire shall be marked at both ends with a numbering system approved by the Engineer, and all terminating wires shall also be suitably crimped to a terminal lug. Not more than one wire shall be crimped into a single lug.
- 3.6.5 All wiring shall be flexible, tinned, annealed, multi-strand copper wire not less than:-
- 3.6.5.1 1,5mm² for 230V AC or 110V AC power
 - 3.6.5.2 1,0mm² for 24V DC or AC power
 - 3.6.5.3 0,5mm² for all PLC I/O wiring between modules and marshalling terminals
 - 3.6.5.4 4,0mm² for earth drain
- 3.6.6 Irrespective of the minimum wire sizes allowed in this specification, contractors must ensure that all cables and wiring are capable of carrying the full system currents, inclusive of de-rating factors as specified in the latest version of SANS 10142.
- 3.6.7 All wire terminations must be done by using suitable lugs. No more than one wire may be crimped into a single lug. Where pin lugs are crimped onto the ends of wires, correctly sized pin lugs must be used, which fit into the terminals properly and such that the tightening of the terminal does not result in the loosening of the pin lug.
- 3.6.8 All panel wiring shall run in suitably sized slotted trunking for as much of their course as possible, thereafter in spiral band or similar conduit to its destination if the exposed run would exceed 100mm.
- 3.6.9 The distance between the terminals and the trunking or between equipment (such as relays, surge protection, circuit breakers, etc.) and trunking shall not be less than 50mm.
- 3.6.10 Control wiring should not run with power wiring and all cross-overs shall be at ninety degrees.
- 3.6.11 A block of terminals shall be allocated to each I/O module. The terminal block shall be labelled with the PLC rack number and module slot allocation.
- 3.6.12 The terminals allocated for the various I/O modules must be as per the design drawings submitted by the Engineer. If it forms part of the contractor's scope of work to submit design drawings, the terminals allocated for the various I/O modules must be approved by the Engineer. All terminals shall be sequentially numbered from top to bottom for each I/O channel for every type of I/O card.

- 3.6.13 Each analogue and digital input and output channel shall have surge protection units as specified in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).
- 3.6.14 Internal wiring shall be colour coded as follows:-
- | | | |
|----------|-------------------------|------------------|
| 3.6.14.1 | <u>230V AC Power</u> | |
| | Live | Brown |
| | Neutral | Blue |
| | Earth | Green and Yellow |
| 3.6.14.2 | <u>24V DC Power</u> | |
| | Positive | Red |
| | Negative | Black |
| 3.6.14.3 | <u>Digital Inputs</u> | |
| | 230V AC | Yellow |
| | 24V DC | Red |
| 3.6.14.4 | <u>Digital Outputs</u> | |
| | 230V AC | Grey |
| | 24V DC | Red |
| 3.6.14.5 | <u>Relay Outputs</u> | |
| | 230V AC | Grey |
| | 24V DC | Red |
| 3.6.14.6 | <u>Analogue Signals</u> | |
| | Positive | Orange |
| | Negative | Purple |
- 3.6.15 A terminal section for AC and DC power distribution shall be included in the PLC panel where both voltages are used for PLC I/O. The terminal groups shall be clearly identified to indicate the various voltages.
- 3.6.16 A separate power distribution section shall be used for the AC and DC supplies where both voltages are used. Miniature circuit breakers (MCB's) shall be used to feed the various items of equipment such as PLC I/O cards, fans, lights, field instruments, etc. Fused terminals may be used if it is indicated as such on the design drawings submitted by the Engineer.
- 3.6.17 Two types of mains supplies shall be made available to the PLC panels: Raw Mains and UPS Mains. The raw mains incomer shall feed the non-critical items such as fans, 24V DC power supplies, 230V AC terminal section, 230V AC I/O modules, relay output modules, etc. The UPS supply shall feed the critical items required for PLC communications in the event of a raw mains power supply interruption. Such items are plugs (for PC), lights (inside the PLC panel), fibre-optic interface modules, PLC Processor, etc. Unless otherwise specified, PLC I/O and field instruments need not be supplied by UPS power.
- 3.6.18 All wiring must be continuous from one termination (in a terminal strip or device such as a relay, contactor, surge arrester, etc.) to the next. No spliced wiring will be accepted.
- 3.6.19 Where relays (not relays that are part of the PLC hardware, such as in I/O sub-bases) are used, such relays must be pluggable, so that relays can be replaced

without the need to disconnect wiring and the relays must have visible indication when it is energised.

3.7 Existing PLC Panels

- 3.7.1 All modifications and wiring changes to existing panels must comply with the specifications as laid down for new panels.

3.8 Factory Acceptance

- 3.8.1 Before delivery of the PLC systems and/or the PLC panels, a comprehensive system factory acceptance test must take place. The Engineer must be notified one week in advance of the proposed test.

- 3.8.2 The test shall comprise of at least, but not be limited to:

- 3.8.2.1 Checking the panel manufacturing and assembly for compliance with this specification.
- 3.8.2.2 Layout, numbering and labelling of equipment.
- 3.8.2.3 Wiring – sizes, numbering, colours, termination, etc.
- 3.8.2.4 Wiring as per drawings, I/O schedules, etc. (i.e. loop checks).

3.9 Loop Isolators

- 3.9.1 Loop isolators are required where the instruments and the relevant PLC are fed from different power sources. Loop isolators must provide isolation between the instrument signals and the power supply. Separately powered isolators are preferred.

3.10 Uninterruptible Power Supply (UPS)

- 3.10.1 An Uninterruptible power supply must be installed to isolate the PLC from the "raw" mains supply.
- 3.10.2 The UPS must comply with the UPS requirements as specified in the Clean Power And Surge Protection specification (Volume 5 of the Automation And Control Design Standards).
- 3.10.3 The raw mains incomer to the PLC panel shall feed the non-critical items such as fans, 24V DC power supplies, 230V AC terminal section, 230V AC I/O modules, relay output modules (if required), etc. The UPS supply shall feed the critical items that keep PLC communications established should the raw mains power supply be interrupted, such as plugs, lights, fibre-optic interface modules, PLC (CPU), etc.
- 3.10.4 Tenderers must satisfy themselves that the UPS rating is adequate to supply all the equipment which they are offering.

3.11 Over-Voltage/Lightning Protection

- 3.11.1 The function of the over-voltage/lightning protection units is to prevent damage

from occurring to the electrical and electronic devices due to destructive voltages, by resistive coupling, capacitive coupling or inductive coupling, arising from extraneous events such as lightning discharges, switching surges etc. All lightning and surge protection must be in accordance with the requirements in the Clean Power And Surge Protection specification (Volume 5 of the Automation And Control Design Standards).

3.11.2 The protection units on the 230V AC mains incomers of the PLC panel (if not provided on the mains elsewhere) shall consist of at least IEC Class II protection. Preferably Class I and Class II, or a combined Class I + Class II protection must be used.

3.11.3 Each individual supply from the 24V DC distribution and from the 230V AC distribution to field instruments or other field supplies must be equipped with at least Class II medium surge protection.

3.12 Spares

3.12.1 The tenderer will be required to provide at least 10% spare fuses and other consumable items which may be required during commissioning. In addition to commissioning spares, a recommended spare list for three years maintenance, should be submitted. This item must be completed so that spares may be ordered as part of the capital contract. Tenderers ignoring this condition may be disqualified.

3.13 Painting (Powder Coating Method)

3.13.1 General

Switchboards and panels shall be epoxy powder coated in accordance with Type 1 coatings to SANS 1274-2005.

Unless specified otherwise, a high gloss finish in the following colour shall be provided:

Colour - Light Orange, Colour No. B26, Munsell Ref. 2,5 YR C/14 to SANS 1091 : 2004 and Colour No. 381C-557 to BS 381C : 1980.

Paintwork must be guaranteed against blistering, peeling, cracking and general deterioration which can lead to rusting, corrosion, etc. for a period of no less than three years. If the tenderer cannot comply with this requirement, it must be clearly stated as such in the tender.

3.13.2 Specifications

The following specifications in accordance with SANS 1274-2005 shall be provided:-

<u>Property</u>	<u>Requirement</u>	<u>Test Method</u>
Thickness, minimum	50 micron	6.7
Marking Resistance (400g)	No marking	6.20
Impact Resistance, J, minimum	6,78	6.10
Water Resistance, h, minimum	720	6.13
Humidity resistance, h, minimum	1000	6.14
Resistance to salt fog, h, minimum	1000	6.16

3.13.3 Surface Preparation

Surface preparation of sheet steel components shall be carried out by means of the multi-bath zinc phosphate/chromate passivation treatment.

All fabricated sheet steel components are to be degreased and de-rusted ready for treatment.

A steel surface is considered ready for treatment when all dirt, grease, rust, mill scale, moisture or other contaminants have been removed in an alkaline degreaser to give a dry, clean, bright, metallic surface.

Steel plate less than 4mm thick - black steel sheet shall be pickled to white metal condition while pre-pickled, bright, cold rolled sheet steel shall be solvent cleaned. These surfaces shall be treated within eight hours in all cases while still uncontaminated and rust-free.

The prepared steel surface shall be treated by means of immersion in a heated zinc phosphate solution bath, rinsing and thereafter chromate passivated by means of immersion in the final treatment bath.

3.13.4 **Powder Coating**

A thermosetting powder consisting of epoxy/polyester resin shall be applied by means of an electrostatic spray gun to give a uniform coating thickness of 50 to 60 micron. Less than 50 micron will not be acceptable.

The powder coating shall be baked at a metal temperature of 185°C so as to melt the powders to form a continuous film over the metal substrate.

3.14 **Drawings And Diagrams**

3.14.1 The tenderer must submit layout drawings, showing the PLC panel size, cable entry, location of equipment, details of equipment (such as fans, lights, plugs, trunking size, circuit breakers, fuses, terminals, etc.), panel colour, material of construction (e.g. 2mm mild steel), etc. for approval by the Engineer before any manufacturing commences.

3.14.2 The drawings must be accompanied with data lists of the proposed equipment. These data sheets must show the type, supplier, make, model, size, etc. of equipment where applicable. For example:

Terminals	- Phoenix SK12, 4mm, white.
MCB's	- Merlin Gerin, 5A, 10kA, single-pole.
Etc.	

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

PARTICULAR SPECIFICATION
VOLUME 5 : CLEAN POWER AND SURGE
PROTECTION

Johannesburg Water (SOC) Ltd.
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DOCUMENT CONTROL SHEET

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DOCUMENT APPROVAL

ACTION	FUNCTION	NAME	DATE	SIGNATURE
Prepared	HOD	C. Du Toit	2019-08-26	
Reviewed	Engineer	L. Gobinca	2019-08-26	
Approved	Manager	T. Thabeng		

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2019-08-26	14	C. Du Toit	Cover page updated
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2018-11-30	12	C. Du Toit	Requirements for static and manual bypass switches on UPS corrected & added reference to Labelling
2014-04-17	11	C. Du Toit	Added more detail to "transformer-based" UPS description
2013-10-07	10	C. Du Toit	Updated numbering in item 5.7 and clarified "transformer-based" UPS
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2009-08-18	5	C. Du Toit	Logos altered and UPS size altered.

2009-03-25	4	C. Du Toit	JW Wastewater Partnership deleted & logos altered as per client's requirements.
2007-11-22	3	C. Du Toit	Item number referred to in item 5.11.3 corrected.
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5 CLEAN POWER AND SURGE PROTECTION

5.1 Scope

5.1.1 This specification covers the selection, installation, testing, marking and termination of Uninterruptible Power Supplies and Surge Protection used for low voltage power and control installations at Johannesburg Water wastewater sites.

5.2 Abbreviations

5.2.1 In this specification the following abbreviations will apply :-

SANS	: South African National Standards
IEC	: International Electrotechnical Commission
PLC	: Programmable Logic Controller
UPS	: Uninterruptible Power Supply
CE	: Official marking to indicate compliance with essential requirements of European Union directives
LGA	: Local Government Association
GS	: Geprüfte Sicherheit ("Tested Safety") is a voluntary certification mark
EMC	: Electromagnetic Compatibility
EN	: British Standard (BS EN)
PWM	: Pulse Width Modulation
THD	: Total Harmonic Distortion
Vpc	: Volts per cell
Ah	: Ampere hour
SPD	: Surge Protection Device
LPZ	: Lightning Protection Zone
ICASA	: Independent Communication Authority of South Africa

5.3 Standards

5.3.1 All design standards for cabling shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 10142-1	: National Standards for the wiring of premises.
SANS 61643-1	: Surge protection devices – performance requirements and testing methods
IEC 61643-1	: Surge protection devices – performance requirements and testing methods
EN 50091-1, -2	: General and safety requirements for UPS
EN 61000-3-2	: Limits for harmonics

5.4 Uninterruptible Power Supply (UPS) General Requirements

- 5.4.1 The UPS must be a **TRUE** on-line, double conversion transformer-based unit (i.e. using a transformer which is an integral part of the UPS, on the **input** to the UPS). Hybrids, transformerless units or units with external, separate transformers will not be acceptable.
- 5.4.2 The UPS must employ PWM technology.
- 5.4.3 The UPS must have battery backup for at least 30 minutes at the **FULL RATED LOAD** of the UPS.
- 5.4.4 The output wave form shall be sinusoidal in form with the THD at full line load not exceeding 3%.
- 5.4.5 The output voltage variation must not exceed 2%.
- 5.4.6 Interference shall not exceed the limits laid down by ICASA.
- 5.4.7 The UPS must have a battery low voltage/DC cut-off which is not lower than 1,67 Vpc.
- 5.4.8 The UPS must be accompanied by the tenderer's proof of their ability to install, test, service, repair, etc. these devices in the field and that they have a suitable after-sales infrastructure.
- 5.4.9 The UPS must be equipped with an integral static bypass switch as well as an integral manual/maintenance bypass switch.
- 5.4.10 The UPS static bypass switch must be upgradable in order to be matched to the load inrush current.
- 5.4.11 The tenderer must be willing and able to provide a complete factory load test, which can be witnessed by the engineer and/or client.
- 5.4.12 If it is an imported UPS, the vendor must be the **ACTUAL** importer of the UPS. In other words, a middleman who cannot provide factory load tests or suitable after-sales service and backup will not be acceptable.
- 5.4.13 A voltage free contact rated for 230V AC at 2 amps shall be provided in all the UPS units. This general alarm relay shall be internally wired to energise when a collective signal from all alarms is healthy. Alternatively, this relay shall de-energise when a fault occurs, raw mains is interrupted or the battery power is low.
- 5.4.14 The UPS must be supplied complete with maintenance free batteries and with a capacity to run the system for 30 minutes at full load. If external battery packs are provided, the battery charger must be adequately rated to re-charge the additional batteries at the C/10 rate.
- 5.4.15 The UPS system shall be suitable for operation from a 230V AC single phase supply and must supply a nominal single phase 230 Volt, 50 Hz output.
- 5.4.16 Tenderers must satisfy themselves that the UPS rating is adequate to supply all the equipment which they are offering.

- 5.4.17 The units shall be able to sustain an overload of 125% for one minute or 150% for ten seconds whereupon it shall switch itself off. A full short circuit shall cause the unit to switch off without sustaining damage.
- 5.4.18 The UPS must be able to operate normally in an ambient service temperature of 0°C to +35°C and a relative humidity of 5 to 95% non-condensing at 1500 to 3000m above sea level.
- 5.4.19 The rated output voltage must be user selectable from 220/230/240V.
- 5.4.20 The output frequency must not vary by more than 3Hz.
- 5.4.21 All labelling must comply with the requirements as specified in the Labelling Specification (Volume 25 of the Automation And Control Standards).

5.5 UPS Rating

- 5.5.1 The UPS should be able to supply a load with a power factor of 0.7 to unity. Tenderers must submit both the VA and Wattage rating of each UPS offered.
- 5.5.2 The UPS efficiency must be no less than 89% from zero to full load.
- 5.5.3 The UPS must be suitably rated to supply all the required equipment specified in this tender and any attached specifications and provide backup to this equipment for no less than 30 minutes at full load. Even if the equipment does not require it however, the UPS must not have a rating of less than 3kVA.

5.6 UPS Backup Batteries

- 5.6.1 Tenderers must state the exact number of batteries that will be used.
- 5.6.2 Tenderers must state the type of batteries that will be used.
- 5.6.3 Tenderers must state the Ah rating of the batteries that will be used.
- 5.6.4 Tenderers must state the design life of batteries that will be used (3-5years, 10 years, etc.).

5.7 UPS Standards

- 5.7.1 All imported UPSs must have a CE rating.
- 5.7.2 The UPS must have CE, LGA/GS markings.
- 5.7.3 The UPS must comply with safety conformance to EN-50091-1.
- 5.7.4 The UPS must have EMC conformance to EN-50091-2 and EN-61000-3-2.

5.8 UPS Data Sheets

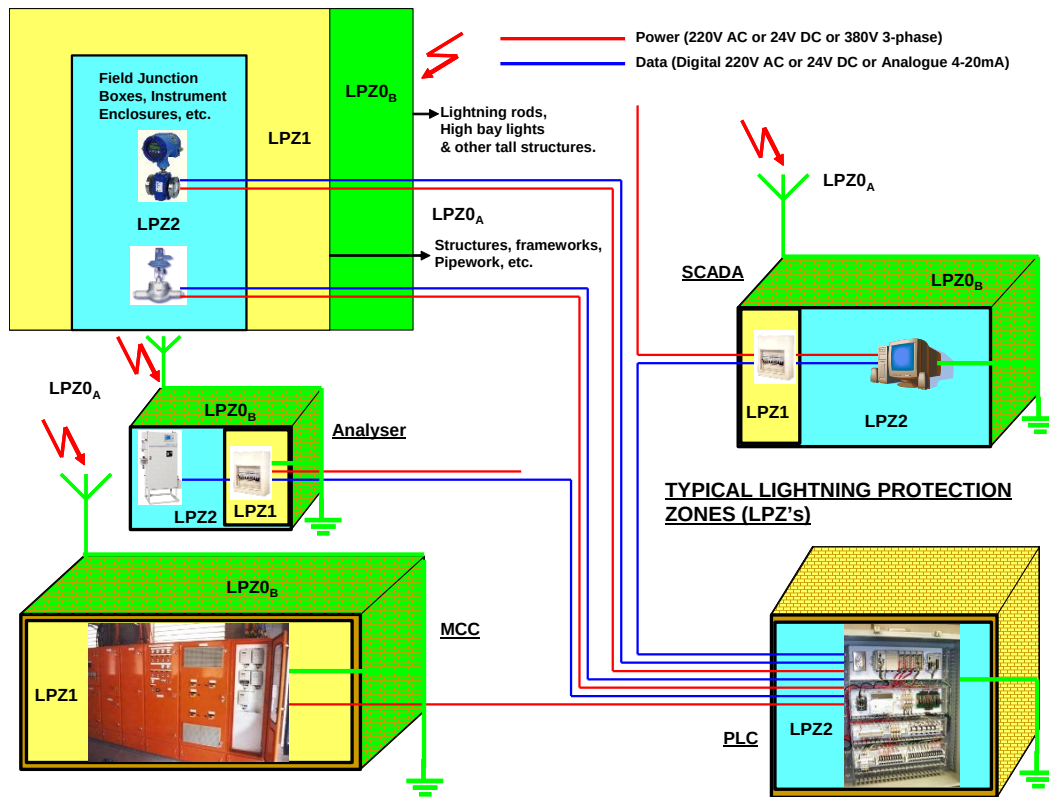
5.8.1 The tenderer must complete the data sheet below with his tender:

Technical Data Sheet: UPS

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model (E.g. true on-line, double conversion)	
Transformer-based unit (Y/N?)	
Technology employed (E.g. pulse width modulation)	
Output voltage variation	
Output frequency variation	
UPS rating (VA and Watts)	
UPS efficiency from zero to full load	
Maximum harmonic distortion at full load	
Overload handling capabilities (E.g. "x"% load for "y" minutes)	
Power backup period from batteries at full rated load	
Compliance with standards rating and markings (E.g. "Yes, full compliance" or "No".	
Tenderer to provide complete factory load test that can be witnessed by the Engineer?	
Staff available for installation, testing and backup service?	
Number of batteries to be used	
Type of batteries to be used	
Ah rating of batteries	
Design life of batteries	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

5.9 Surge Protection General

- 5.9.1 All labelling must comply with the requirements as specified in the Labelling Specification (Volume 25 of the Automation And Control Standards).
- 5.9.2 The **Protection Level** required (i.e. Level I, Level II or Level III-IV in accordance with Table L.2 in SANS 10142-1:2003 Annex L) needs to be established for every installation where there is doubt about these requirements. This requirement looks at the consequential loss resulting from potential lightning hazards. Generally for all JHB Water wastewater sites in the Gauteng area, Level III-IV will suffice. In other words, a lightning impulse level of 100kA (10/350µs) needs to be considered when designing protection systems.
- 5.9.3 The function of the Surge Protection Device (SPD) is to prevent damage from occurring to the electrical and electronic devices due to destructive currents and voltages arising from extraneous events such as lightning discharges, switching surges etc. All lightning and surge protection must comply with SANS 10142-1:2003 Annex L, SANS 61643-1/IEC 61643-1 and any other specifications referred to in SANS 10142-1:300 Annex L.
- 5.9.4 The definition of lightning protection zones (LPZs), as specified in SANS 61643-1/IEC 61643-1, must be used to determine the **Class** of SPD to be used (i.e. Class I, Class II or Class III in accordance with SANS 61643-1/IEC 61643-1). These classes (also referred to as IEC Classes or IEC Category Classes or Types) define the surge handling ability which SPDs must have for use in each Class.

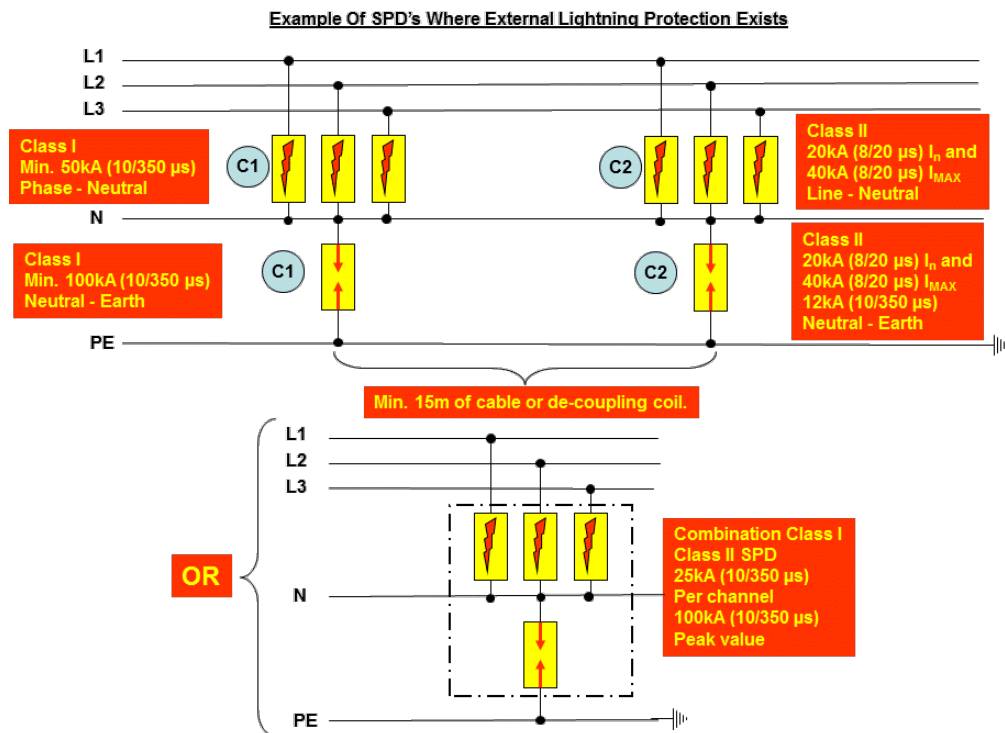


5.9.5 Notwithstanding the requirements of SANS 10142-1:2003 Annex L, the surge handling ability of the SPDs installed in the various LPZs for JHB Water applications must be as follows:

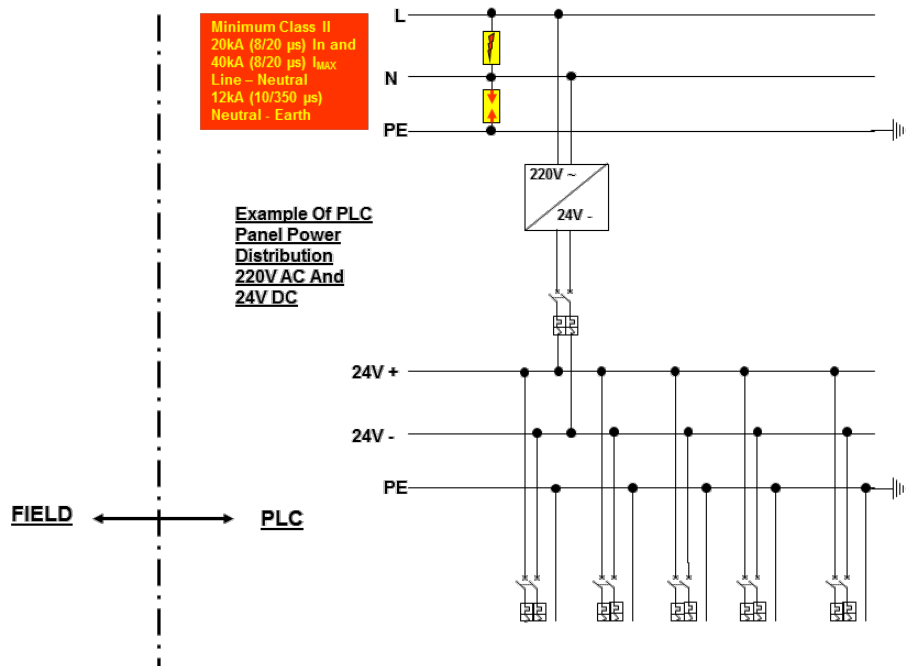
At the Interface Between:	IEC Class SPD Required	Min. Required SPD Rating
LPZ 0 _A and LPZ 1	Class I	For Single Units: $I_{imp} = 50\text{kA}$ (10/350 μs) for SPDs between PHASE and NEUTRAL $I_{imp} = 100\text{kA}$ (10/350 μs) for SPDs between NEUTRAL and PE and For Combination Units: $I_{imp} = 25\text{kA}$ (10/350 μs) per channel
LPZ 0 _B and LPZ 1	Class II	$I_{sn} = 20\text{kA}$ (8/20 μs) for SPDs between PHASE and NEUTRAL $I_{sn} = 12\text{kA}$ (10/350 μs) for SPDs between NEUTRAL and PE
LPZ 1 and LPZ 2	Class III	$I_{sn} = 5\text{kA}$ (8/20 μs)

Where: I_{imp} = The standard impulse current curve with a 10/350 μs waveform
 I_{sn} = The nominal discharge current or peak value of the current flowing through the SPD. It has an 8/20 μs impulse current waveform.

- 5.9.6 All SPDs used must limit the voltage to less than two times the nominal operating voltage for systems below 60V (AC or DC) and for systems above 60V it must limit the voltage to the values given in Table L.1 in SANS 10142-1:2003 Annex L.
- 5.9.7 In order to ensure that individual protective devices are selectively effective, i.e. each protection stage only takes on the amount of interference energy which it is designed for, if one protection stage is faced with the threat of an energy overload, the upstream, more powerful arrester must "respond" and thus take over the discharge of the interference energy.
- 5.9.8 Even though surge arresters (i.e. Class II and Class III devices), by definition, are only tested to pulse waveforms of 8/20 μ s, it is imperative to determine the ability of the device to carry an impulse current of the partial lightning currents with the waveform 10/350 μ s for the co-ordination between surge arrester (i.e. Class II and Class III devices) and lightning current arrester (i.e. Class I devices), and also for the SPD.
- 5.9.9 All SPDs must be DIN rail mounted.
- 5.9.10 Should the building (where the PLC, distribution board, etc. and surge protection is installed) have external lightning protection, then a combination of Class I lightning current arresters (min. rating of 50kA (10/350 μ s) each phase to neutral) plus one Spark Gap (min. rating of 100kA (10/350 μ s) neutral to earth) and Class II nominal discharge current $I_n = 20$ kA (8/20 μ s) and maximum discharge current $I_{MAX} = 40$ kA (8/20 μ s), non-linear surge arresters from each phase to neutral and one Spark Gap, nominal discharge current $I_n = 20$ kA (8/20 μ s) and maximum discharge current $I_{MAX} = 40$ kA (8/20 μ s) surge arresters must be installed as per SANS 10142-1:2003 Annex L (see the diagram below). In all other cases a minimum of Class II SPDs are required.
- 5.9.11 These surge arresters (Class I and II or combination Class I/Class II above) must be installed from each Phase to Neutral and from Neutral to Earth. It must be borne in mind that if Class I **and** Class II SPDs are used, a minimum of 15m of cabling is required between these two systems for de-coupling. Another alternative is to use the correct coils available on the market to simulate the 15m difference. Preference will however be given to **combination** Class I and Class II units with pluggable modules because this eliminates coils and long cables and it allows replacement/inspection without the need to disconnect cables.

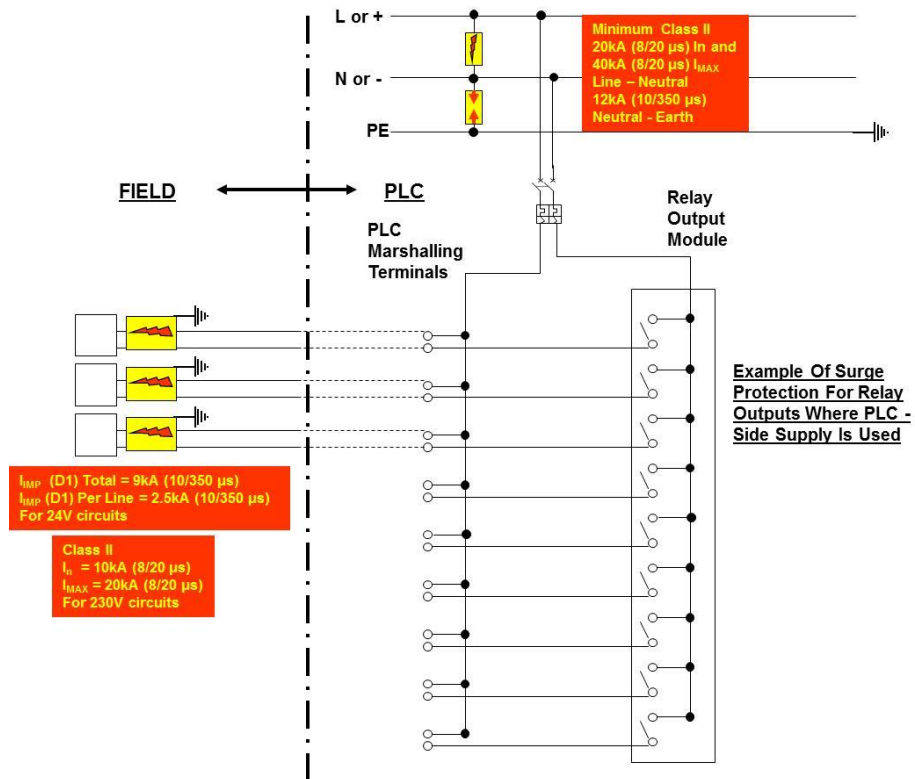


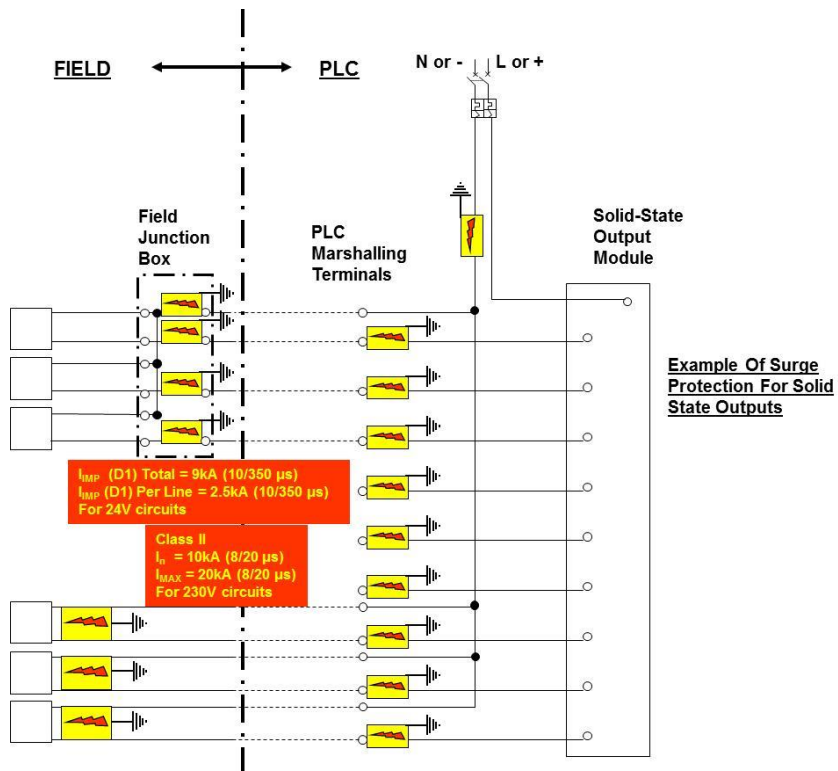
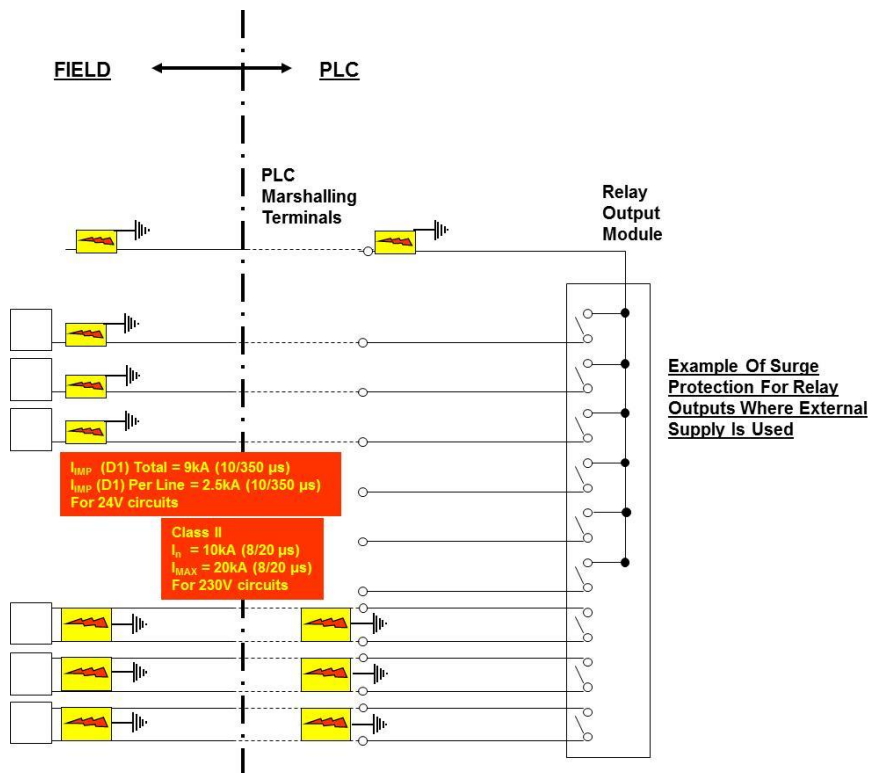
- 5.9.12 For Class I lightning arresters the minimum conductor size is 16mm² and pre-fusing of 315 Amps is required if the upstream protection is greater than 250 Amps. Fuses must be connected in series with the SPDs and must have the same fault current level or higher than that of the panel or board where they are installed.
- 5.9.13 For Class II the minimum conductor size is 6mm² and pre-fusing of 125 Amps is required if the upstream protection is greater than 250 Amps. Fuses must be connected in series with the SPDs and must have the same fault current level or higher than that of the panel or board where they are installed.
- 5.10 Surge Protection On Mains Power**
- 5.10.1 If there is no external lightning protection on the building, the protection units on the mains supply of the PLC panel must consist of at least IEC Category Class II, nominal discharge current $I_n = 20\text{kA}$ (8/20 μ s) and maximum discharge current $I_{MAX} = 40\text{kA}$ (8/20 μ s), non-linear surge arresters from each phase to neutral and one Spark Gap, nominal discharge current $I_n = 20\text{kA}$ (8/20 μ s) and maximum discharge current $I_{MAX} = 40\text{kA}$ (8/20 μ s), surge arrester from neutral to earth (same arrangement as the example shown above).
- 5.10.2 All the surge arresters must be DIN rail mounted and must comply with IEC 61643-1 (other designations, SANS 61643-1 and SANS IEC 61643-1) and there must be visual indication if the unit is over stressed (i.e. it has failed).
- 5.10.3 The spark gap must be able to withstand surges of 12kA (10/350 μ s) and must specifically bond between neutral and earth.

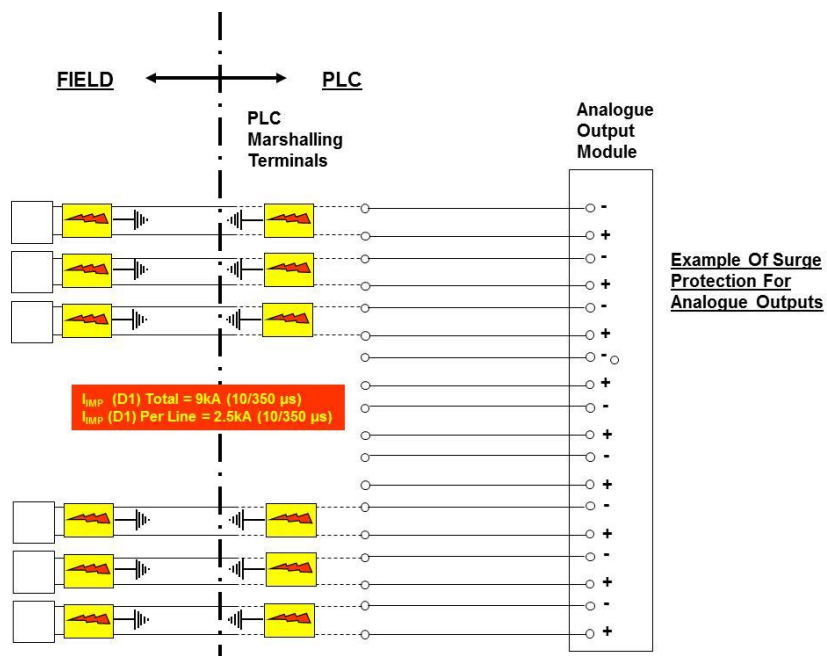
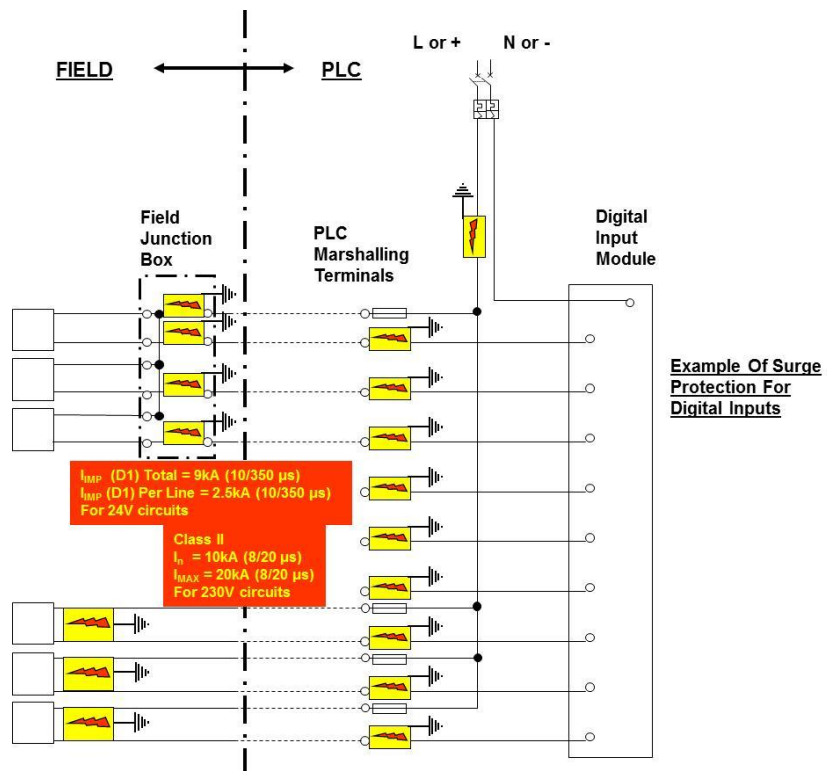


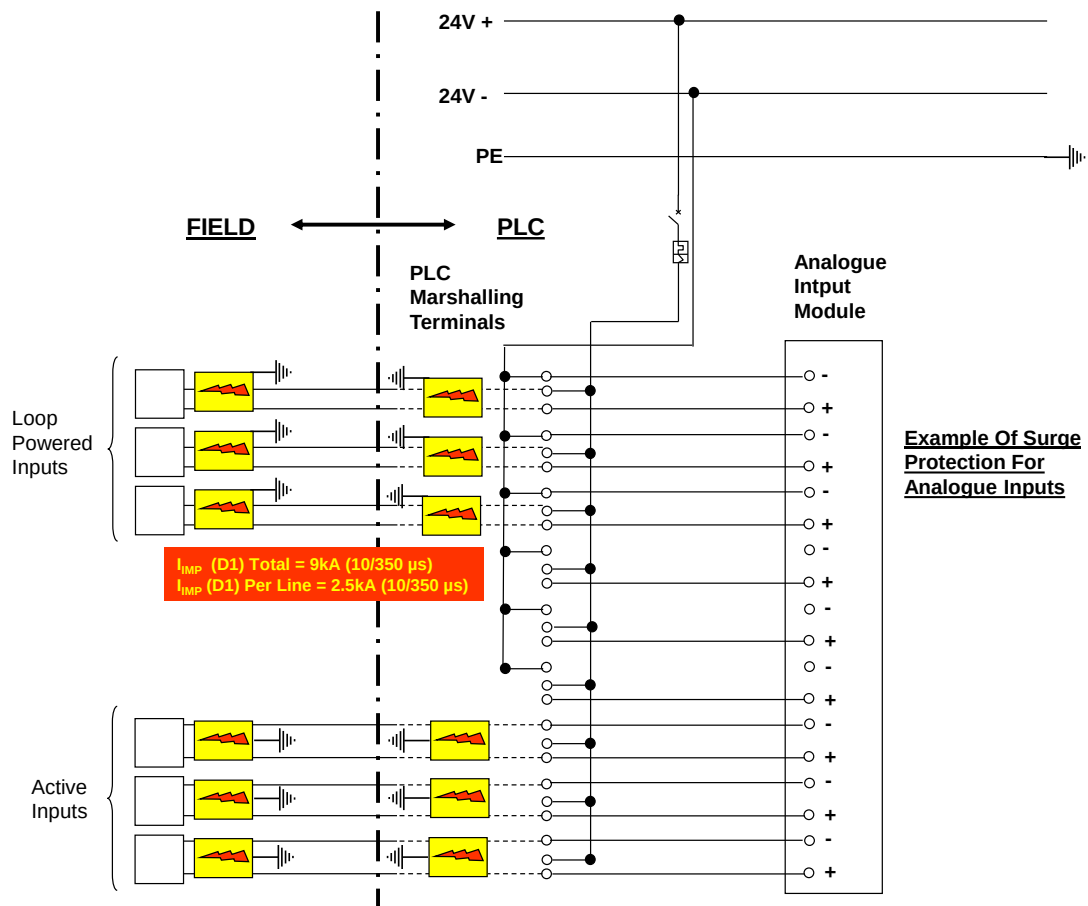
5.11 Surge Protection On Field I/O

- 5.11.1 SPDs used for data protection (i.e. of digital and analogue I/O connected to devices outside the PLC building where induced voltages and currents are possible) must be designed to repeatedly withstand direct lightning currents I_{imp} of 2.5kA (10/350 μ s) per line and nominal (i.e. peak) surges I_{sn} of 20kA (8/20 μ s) for 4-20mA control loops, 24V DC digital and analogue systems and 24V AC systems. SPDs used for 230V AC digital I/O connected to devices outside the PLC building where induced voltages and currents are possible, must be designed to repeatedly withstand nominal discharge currents I_n of 10kA (8/20 μ s) and maximum discharge currents I_{max} of 20kA (8/20 μ s). These 230V AC SPDs must be rated at least Class II according to IEC 61643-1 or Type 2 according to IEC 61643-11.
- 5.11.2 SPDs must be installed at both ends of each cable (i.e. at the PLC and at the field instrument, MCC, control panel, junction box, etc).
- 5.11.3 The LPZ in which the instrument, instrument distribution board or instrument junction box is, must be used to determine the ratings of the SPD. The ratings on digital and analogue I/O protection must just never be lower than the ratings mentioned in item 5.11.1 above.
- 5.11.4 The rated operating current for SPDs used for protection of I/O systems must not be less than 0.75Amp.
- 5.11.5 All SPDs must consist of a base and a pluggable top which can be disconnected without interrupting the signals.









5.12 Surge Protection Data Sheets

5.12.1 The tenderer must complete the relevant data sheets below with his tender:

Technical Data Sheet: Mains Surge Protection

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Order No./Part No./Reference No.	
Class (E.g. Class I, Class II, combined Class I/Class II, etc.)	
Surge current rating at the relevant waveform (E.g. 20kA, 10/350µs, phase-to-neutral)	
Rated operating voltage	
Rated operating current	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

Technical Data Sheet: Surge Protection 230V Digital I/O

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Order No./Part No./Reference No.	
Class (E.g. Class I, Class II, combined Class I/Class II, etc.)	
Discharge current rating at the relevant waveform (E.g. 20kA, 10/350µs, phase-to-neutral)	
Rated operating voltage	
Rated operating current	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

Technical Data Sheet: Surge Protection 24V DC Digital I/O

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Order No./Part No./Reference No.	
Lightning Impulse Current and pulse form (E.g. 9kA - 10/350µs – total, 2.5kA - 10/350µs – per line, etc.)	
Rated operating voltage	
Rated operating current	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

Technical Data Sheet: Surge Protection Analogue I/O

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Order No./Part No./Reference No.	
Lightning Impulse Current and pulse form (E.g. 9kA - 10/350µs – total, 2.5kA - 10/350µs – per line, etc.)	
Rated operating voltage	
Rated operating current	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

PARTICULAR SPECIFICATION
VOLUME 6 : CABLING

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DOCUMENT CONTROL SHEET

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6 CABLING

6.1 Scope

6.1.1 This specification covers the selection, installation, testing, marking and termination of electrical cables used for low voltage power and control installations as well as fibre-optic and copper cables for data transmission, used in process monitoring and control applications at Johannesburg Water wastewater sites.

6.2 Abbreviations

6.2.1 In this specification the following abbreviations will apply :-

SANS	: South African National Standards
IEC	: International Electrotechnical Commission
EN	: Standards from the European Committee for Standardization
PLC	: Programmable Logic Controller
UV	: Ultra Violet
PVC	: Poly Vinyl Chloride
OTDR	: Optical Time Domain Reflectometer
OLTS	: Optical Loss Test Set
SFP	: Small Form Pluggable
MRM Ref. No.	: The nominal mass in kg/m ² multiplied by 100, used for steel wire mesh reinforcing.

6.3 Standards

6.3.1 All design standards for cabling shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 10142-1	: National Standards for the wiring of premises
SANS 1507	: Electric Cables (300/500V to 900/3300V)
SANS 1574	: Electric Cables Flexible cords and flexible cables
SANS 1411-1 to 7	: Material of insulated electric cables and flexible cords
SANS 1507-1 to 3	: Electric cables with extruded solid dielectric insulation for fixed installations (300/500V to 1900/3300V)
SANS 1803-1	: Lugs and ferrules for insulated cables
SANS 60793	: Optical fibres
SANS 1024:2006	: Steel wire mesh
IEC 60793	: Optical fibres
SANS 60794	: Optical fibre cables
IEC 60794	: Optical fibre cables

ISO/IEC 14763-3	:	Fibre optic testing
TIA/EIA 568-B.2-10	:	Copper data cable testing
EN 50288	:	Multi-element metallic cables used in analogue and digital communications and control
ISO/IEC SANS 11801:2002	:	Information Technology – Generic cabling for customer premises
IEC 60332-1	:	Flammability of a single vertical cable

6.4 General

- 6.4.1 All cables and wiring supplied must be supplied complete with fittings, accessories, etc.
- 6.4.2 The installation of all wires and cables must comply with SANS 10142-1:2003 and SANS 1507-1 to 3, all as amended.
- 6.4.3 The installation of flexible cords must comply with SANS 1574:2004 as amended.
- 6.4.4 All power, control and instrumentation cables (i.e. excluding fibre-optic cabling for data transmission) and wires must have untinned, annealed, multi-strand copper conductors and must comply with, SANS 1507-2 and SANS 1507-3: 2002 as amended.
- 6.4.5 All power, control and instrumentation cables (i.e. excluding fibre-optic cabling for data transmission) and wires must comply with the latest edition of SANS 1411-1 to 7 in terms of material of construction. The sheath of these cables must be an impermeable, halogen-free, reduced smoke emission, flame retardant, UV stabilised compound in accordance with the latest edition of SANS 1411.
- 6.4.6 All fibre-optic cables must comply with SANS 60793-1 for measurement and test methods, SANS 60793-2 for product specifications and SANS 60794 for generic, sectional and family specifications.
- 6.4.7 All blown fibre-optic installations must comply with the requirements of SANS 60794-5 which specifies the requirements of microduct optical fibre cables, microduct fibre units, microducts and protected microducts for installation by blowing for outdoor and/or indoor use.
- 6.4.8 All fibre-optic micro cables must comply with the requirements of SANS 60794-5-10 and all blown fibre-optic bundles must comply with the requirements of SANS 60794-5-20.
- 6.4.9 All blown fibre installations must be done by people who can provide proof of certified training by a recognized supplier/installer such as Lonspeare SA (Pty) Ltd. or equivalent.
- 6.4.10 Where fibre-optic data communication is employed, blown fibre installations will be the preferred method. Only where the use of fibre-optic cabling is unavoidable, will such cabling, instead of blown fibre assemblies be accepted.
- 6.4.11 All wires and cables must be from fresh stock, with the manufacturer's original wrappings, labels and seals intact when delivered to site.
- 6.4.12 All cables must be inspected for visible defects or signs of damage before installation. A

checklist of cables checked for visible defects/damage must be available on request.

- 6.4.13 All cable ends must be sealed or capped immediately after cutting to prevent ingress of moisture, dirt, impurities, etc. This applies to cables to be installed as well as cable remaining on the drum.
- 6.4.14 Where cables or wires of different voltages run in the same trunking, cable trays, cable racks or cable supports, all insulation must be rated for the highest voltage being conducted.
- 6.4.15 For PLC panel wiring, this specification must be read in conjunction with the PLC Panels Specification (Volume 3 of the Automation And Control Standards).
- 6.4.16 All electrical and instrumentation cables must be tested, and the results recorded, for insulation resistance and conductivity in accordance with SANS 1507-3:2002 as amended, before installation and again before final termination. Rectification of faults in cables before final termination will be for the contractor's account.
- 6.4.17 For PLC I/O wiring, the minimum conductor size shall be 0.5mm² but contractors must ensure that all cables and wiring are capable of carrying the full system currents, inclusive of de-rating factors as specified in SANS 10142-1:2003 as amended.
- 6.4.18 All wiring for PLC panels, junction boxes, control panels, etc. shall be flexible, untinned, annealed, multi-strand copper wire of not less than:-
 - 6.4.18.1 6mm² for 230V AC power between the main incoming circuit breaker of the PLC panel and the distribution AC circuit breakers.
 - 6.4.18.2 4mm² for 24V DC power between the main DC circuit breaker of the PLC panel and the distribution DC circuit breakers.
 - 6.4.18.3 1,5mm² for 230V AC or 110V AC power from below the distribution circuit breakers.
 - 6.4.18.4 1,0mm² for 24V DC or AC power from below the distribution circuit breakers.
 - 6.4.18.5 0,5mm² for all PLC I/O wiring between modules and marshalling terminals.
 - 6.4.18.6 4,0mm² for earth drain.
- 6.4.19 Irrespective of the minimum wire sizes allowed in this specification, contractors must ensure that all cables and wiring are capable of carrying the full system currents, inclusive of de-rating factors as specified in SANS 10142-1:2003 as amended. If wiring of greater cross-sectional area than the sizes indicated in item 6.4.17 and 6.4.18 above are indicated on project design drawings, the larger wiring sizes will take precedence.
- 6.4.20 All wires and cable cores must be fitted with suitable lugs at the end of each wire or core. The fitting of lugs and ferrules must comply with SANS 1803-1:2002 as amended. No more than one wire may be crimped into a single lug. Where pin lugs are crimped onto the ends of wires, correctly sized pin lugs must be used, which fit into the terminals properly and such that the tightening of the terminal does not result in the loosening of the pin lug.
- 6.4.21 The use of lugs and ferrules must comply with SANS 1803-1:2002 as amended.
- 6.4.22 The outer sheath of all power cabling must be black and the outer sheath of all instrumentation and control cabling must be orange. The power supply to instruments

and transmitters are regarded as part of the instrumentation cabling and must therefore have an orange outer sheath. The outer sheaths of all blown fibre microduct assemblies must also be orange. Where blown fibre microduct assemblies have an outer sheath of a specific material (such as UV protection) which is not available in orange, the contractor can apply to the Engineer for a concession to use the assembly as is and only attach an orange heat-shrink (for identification purposes) at the ends where terminations are made.

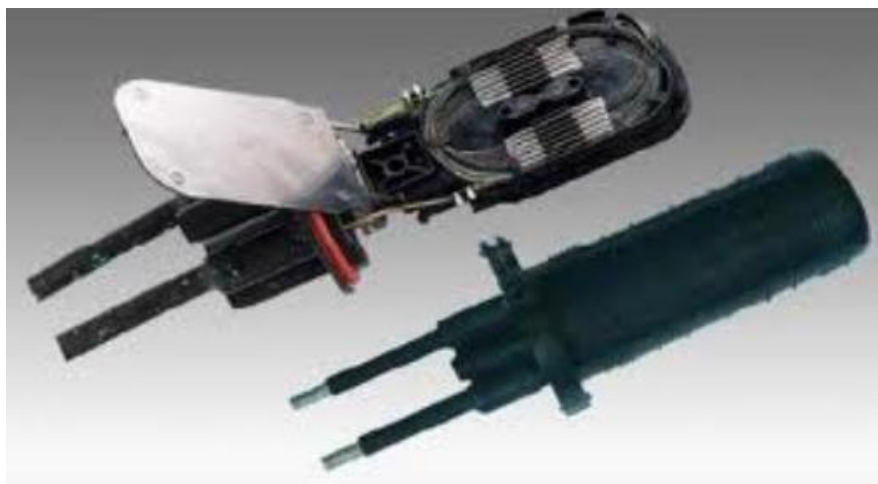
- 6.4.23 The jacket or buffer tubes of fibre cores in fibre-optic cables must be colour coded and terminated in the following sequence:

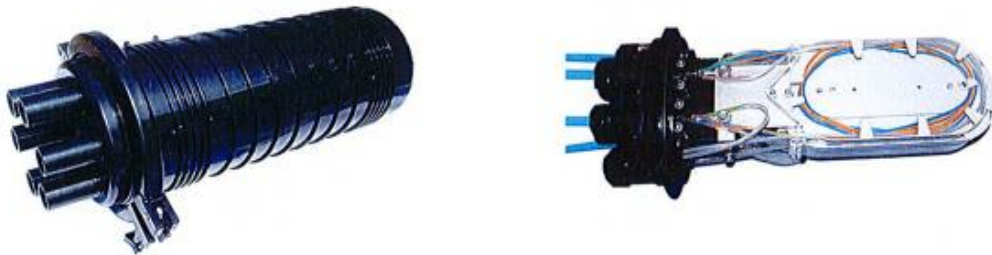
Fibre/Tube	Colour
1	Blue
2	Orange
3	Green
4	Brown
5	Grey (Slate)
6	White
7	Red
8	Black
9	Yellow
10	Violet
11	Pink (Rose)
12	Aqua (Turquoise)

- 6.4.24 All fibre-optic cable will be CST (corrugated steel tape) or steel wire armoured, rodent-proof, UV protected, loose-tube, water blocking, suitable for use in direct burial and manufactured with an orange PVC sheath. The conductive steel armour of installed fibre cables shall be properly grounded to the protective earth at all termination points.
- 6.4.25 All blown fibre microduct assemblies installed in trenches must be suitable for direct burial in terms of strength and mechanical protection.
- 6.4.26 All blown fibre microduct assemblies installed on cable racks or supports above ground must have suitable mechanical protection. Suitable mechanical protection includes, blown fibre microduct assemblies on racks that are covered with metal covers, blown fibre microduct assemblies installed in metal tubing and blown fibre microduct assemblies with steel wire armouring or steel tape armouring.
- 6.4.27 Where blown fibre microduct assemblies are installed in buildings or in cable tunnels, such microduct assemblies must have an inner and outer sheath of fire retardant material. The outer sheath must also be low-smoke and halogen-free.
- 6.4.28 Where blown fibre microduct assemblies are exposed to direct sunlight, such microduct assemblies must have an outer sheath that is UV protected.
- 6.4.29 The contractor must take very careful note of the requirements for blown fibre microduct assemblies as outlined in items 6.4.25 to 6.4.28 above. These requirements imply that where the installation conditions change, suitable blown fibre microduct assemblies must be installed to suit the requirements of each section of the installation. The table below gives an example of the blown fibre microduct assembly requirements for various sections of an installation:

Installation Condition	Blown Fibre Microduct Assembly Requirement
In ceiling of a building	Rodent-proof, low-smoke, fire retardant, halogen-free.
On a cable support against the side of the building	Steel wire or steel tape armoured, UV protected.
Buried in a trench	Suitable for direct burial.
On a rack in the open above ground	Mechanical protection, UV protection (if mechanical protection is not steel covers or metal tubing).
On a rack inside a building	Mechanical protection, low-smoke, halogen-free, retardant.

- 6.4.30 All cables on racks, in trenches, in tunnels, in wire ways, on cable supports, etc. must be vermin-proof. I.e. such cables must be equipped with suitable armouring to prevent rodents or other vermin from chewing through core conductors or their insulation.
- 6.4.31 Bending of all cables and microduct assemblies for blown fibres must be limited to the safe criteria specified by the manufacturers.
- 6.4.32 Holes for cables or blown fibre microduct assemblies passing through walls, floors, partitions, ceilings, etc. must be done neatly and must be sealed off with plaster or filler as appropriate.
- 6.4.33 Splices in cables are prohibited, unless the route lengths exceed the maximum length of a drum or if the Engineer agrees to a splice. In such cases splices are to be made by using approved proprietary types of junction boxes, installed in an appropriate manner. For fibre-optic cables, dome splicing kits with a protection rating of at least IP68, installed in a manhole must be used. The dome splicing kit must be mounted vertically inside the manhole. The manhole must be big enough to create a 3m service loop in the each cable without exceeding the minimum bending radius of the cable and big enough to mount the enclosure appropriately in the manhole. Only fusion splices will be acceptable and ease of access to the splice must be ensured. Examples of such dome splicing kits are shown below. Alternatively the splice can be made in a junction box that complies with all the requirements of the specification "Field Junction Boxes And Panels" (Volume 19 of the Automation And Control Standards), mounted on a proper support, above ground level. Once a splice is completed, all the testing requirements of items 6.8.8 and 6.8.9 below must be complied with.





- 6.4.34 For blown fibre microduct assemblies, in-line splicing kits, installed in a manhole, can be used if a splice is approved by the Engineer. These kits must also have a protection rating of at least IP68. Only fusion splices will be acceptable and ease of access to the splice must be ensured. An example of such an in-line splicing kit is shown below. Alternatively the splice can be made in a junction box that complies with all the requirements of the specification “Field Junction Boxes And Panels” (Volume 19 of the Automation And Control Standards), mounted on a proper support, above ground level. Once a splice is completed, all the testing requirements of items 6.8.8 and 6.8.9 below must be complied with.



- 6.4.35 Splices in copper cables can be done with the aid of proprietary, resin-encapsulated splices that are completely water-proof (such as Scotch Cast or similar). Alternatively the splice can be made in a junction box that complies with all the requirements of the specification “Field Junction Boxes And Panels” (Volume 19 of the Automation And Control Standards), mounted on a proper support, above ground level.
- 6.4.36 Manholes used for splicing can be constructed using bricks or concrete. The manhole must allow for adequate drainage of water. All sleeves entering the manhole must be sealed with an appropriate sealer that will prevent moisture, dirt, rodents, etc. from getting into the sleeves, but the sealant must be of such material that it can easily be removed if required in future. The area around the sleeve where it enters the manhole must also be sealed to prevent moisture, mud, rodents, etc. from getting into the manhole. The manhole must not have any sharp edges that can damage cables or microduct assemblies.
- 6.4.37 Cables or conductors passing through holes must be fully protected against damage by

correctly fitted grommets, bushes, etc.

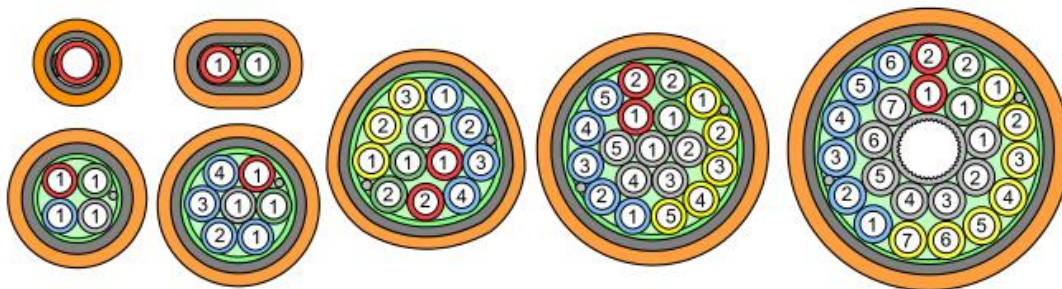
6.4.38 All cable routes, including trenches, cable racks, tunnels, cable supports, etc. must be clearly marked on drawings and submitted for approval by the Engineer. The project will not be regarded as complete until such cable route drawings have been submitted and approved.

6.4.39 The jacket or buffer tubes of fibre bundles used in blown fibre installations must be colour coded and terminated in the following sequence:

Fibre/Tube	Colour
1	Blue
2	Orange
3	Green
4	Brown
5	Grey (Slate)
6	White
7	Red
8	Black
9	Yellow
10	Violet
11	Pink (Rose)
12	Aqua (Turquoise)

6.4.40 The microducts (or inner tubes) of microduct assemblies used for blown fibre installations must be constructed from low-friction Poly Ethylene (PE). These microducts must be 5/3.5 in size (i.e. 5mm OD and 3.5mm ID). Surrounding the group of microducts, must be a layer of waterswell tape. Where steel wire armour or steel tape armour is not used, the microduct assembly must be metal-free.

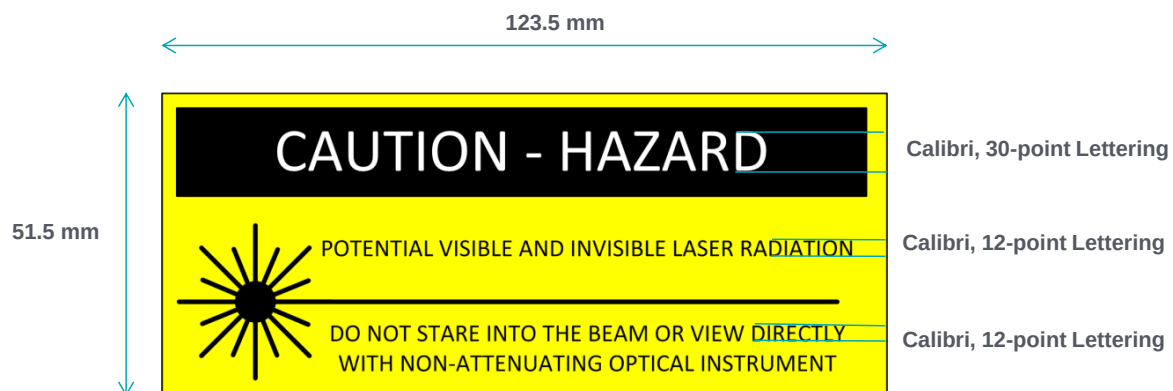
6.4.41 Microducts in microduct assemblies must be available in 1, 2, 4, 7, 12, 19 and 24 microduct assemblies and must be numbered and colour-coded as indicated in the sketch below.



6.4.42 The routes (i.e. source and destination) of microducts installed at each splice and/or termination must be noted down in detail during installation. This record must indicate for each fibre bundle that is blown into a microduct: Source – microduct colour – microduct number and Destination – microduct colour – microduct number. This detailed record must be submitted to the Engineer for approval before the blowing in of fibre bundles commences. Once it is approved, installation must be done according to this record. If a change is made, such a change must be recorded and a final “as-built” record of the installation must be produced for record purposes. The project will not be

regarded as complete until such microduct route records have been submitted and approved.

- 6.4.43 Wherever fibre-optic ends exist, such as at patch panels, splices, switches, transmitters, receivers, etc. and where it would be possible for a person to look into such fibre-optic ends, a danger warning as shown by the image below (or equivalent approved by the engineer), must be affixed to the panel, enclosure, etc. This label must comply with all the requirements stipulated in the JW Labelling Specification (Volume 25 of the Automation And Control Standards).



6.5 Cabling On Racks And Supports

- 6.5.1 Cable ladders shall, unless otherwise specified, be heavy-duty cable ladder standard pattern.
- 6.5.2 Cable ladders used inside Elutriation Terrace pump stations or in areas within 10m or less of Ferric Chloride, Sodium Hypochlorite or Chlorine shall be manufactured from corrosion resistant GRP (Glass Reinforced Polyester). All GRP cable ladders shall consist of a 75 mm high side rail. The minimum thickness of the material that the cable rack is to be manufactured from, shall at least be 4mm. Cross rungs shall be spaced at maximum intervals of 300 mm (centre-to-centre). All screws, bolts and nuts shall be hexagonal to ISO Metric commercial standards. All bolts, nuts, spring washers, etc. shall be 316 grade stainless steel for all these corrosive applications, and all exposed metal shall be painted with a 2-component auto-motive or industrial paint (2K poly urethane paint). Racks for instrumentation and control cabling shall contain pigmentation to produce an electric orange rack. A sample of the rack material must be approved by the engineer before manufacturing commences. Sections of rack, bends, t-pieces etc. shall be joined together with the correct dowels and resins as specified by the supplier. Wherever racking is drilled or cut, the exposed areas of GRP must be sealed with the same resin and painted with 2K paint to ensure that the material does not fray. Channels or other sections used for securing of cable ladders should also be made from GRP. All cable glands must be totally encapsulated glands (envirogland type) as shown in the example below.

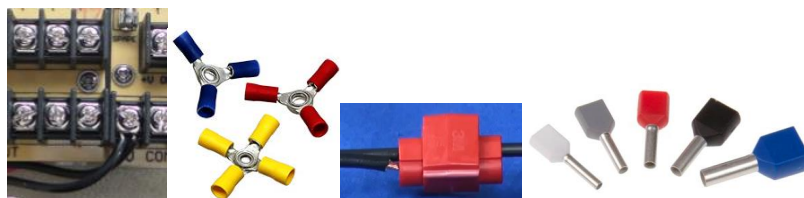


- 6.5.3 The GRP profile (cable rack or equipment support) shall consist of pultruded (i.e. a continuous process of pulling material, such as **glass fiber** and resin, through a shaped die for manufacturing of composite materials with constant cross-section), e-glass roving and e-glass multi-axial fabric strength mat, sandwiched between polyester synthetic veil or tissue of minimum 35 gram/ m², all of which is encased in an isophthalic vinyl-ester resin. The resin must contain UV stabiliser. It must also contain pigment to provide colour and additional environmental protection. The rack or support must be cleaned and de-greased before it is painted with a 2K automotive or industrial poly urethane paint.
- 6.5.4 Cable ladders used inside de-watering buildings shall be metal cable ladders, manufactured from corrosion resistant, powder coated, 3CR12 grade stainless steel. All cable ladders shall consist of at least 75 mm high side rail. The minimum sheet thickness of the material that the cable rack is to be manufactured from shall at least be 2mm. Cross rungs shall be spaced at maximum intervals of 300 mm (centre-to-centre). All screws, bolts and nuts shall be hexagonal to ISO Metric commercial standards. All bolts, nuts, spring washers, etc. shall be 316 grade stainless steel. Metal racks for instrumentation and control cabling shall be powder coated electric orange.
- 6.5.5 Cable ladders used for all applications other than those mentioned in items 6.5.2 to 6.5.4 above shall be heavy-duty metal cable ladders, manufactured from corrosion resistant hot-dipped galvanised, powder coated, mild steel. All metal cable ladders shall consist of at least 75 mm high side rail. The minimum sheet thickness of the material that the cable rack is to be manufactured from shall at least be 3mm. Cross rungs shall be spaced at maximum intervals of 300 mm (centre-to-centre). All screws, bolts and nuts shall be hexagonal to ISO Metric commercial standards. All bolts, nuts, spring washers, etc. shall be 316 grade stainless steel. Racks for instrumentation and control cabling shall be powder coated electric orange.
- 6.5.6 Power and control cabling must always be separated by no less than 500mm. Where it is unavoidable to cross power and control cabling, such cross-overs must be done at right angles.
- 6.5.7 Only single layers of cable will be allowed on a rack, to reduce de-rating and for ease of replacement and/or repairs.
- 6.5.8 Bends in cable racks and supports shall have radii which will ensure that cables are not bent more than the safe criteria specified by the cable manufacturers. For this reason all racking, whether horizontal or vertical must include 90 degree bends where there are 90 degree direction changes in cable runs. I.e. cabling cannot be run from one straight cable rack onto another straight cable rack at 90 degrees, without a 90 degree cable rack bend.
- 6.5.9 Angle iron cable supports may be used. All such angle iron supports must be hot-dipped galvanised, 3CR12 grade stainless steel, 304 grade stainless steel or 316 grade stainless steel and electric orange powder coated as for the cable racks. The material will depend on the application area as specified in items 6.5.2 to 6.5.5 above.
- 6.5.10 No more than two cables may be run on a single angle iron support.
- 6.5.11 The size of angle iron supports must be such that no part of a cable projects beyond the support.
- 6.5.12 The minimum size of angle iron cable supports is 25mm x 25mm x 5mm.
- 6.5.13 Wherever possible cable racks must be mounted in the vertical plane to avoid accumulation of dirt and debris.

- 6.5.14 UV stabilised PVC straps may be used for cables up to 4core x 25mm². For cables of larger diameter than this (i.e. 30mm diameter and larger), stainless steel strapping must be used.
- 6.5.15 Cables must be marked at both ends with stainless steel cable markers strapped to the cable with stainless steel or UV resistant straps in a position where this number is visible without the need to move cables or equipment to view the number. Cable numbering must comply with all the requirements of the Labelling Specification (Volume 25 of the Automation And Control Standards).

6.6 Electric Cable Terminations

- 6.6.1 All cable terminations must be made in a professional manner and cables shall be made off by using appropriate cable glands and UV treated shrouds. Glands similar or equal to the “Enviro” glands supplied by some manufacturers must be used. All cable glands must be:
- environmentally sealed to IP68 against the ingress of water from either end of the cable gland
 - constructed from brass and black nylon plastic encapsulation
 - supplied complete with brass locknut
 - have a loose cone bush and cone ring
 - suitable for use in an Ex e application and must therefore have an Ex identification band
- 6.6.2 Proprietary type wire strippers shall be used and no stranded conductor shall be terminated if one or more strands have been damaged.
- 6.6.3 Not more than one wire shall be connected to any terminal unless the terminal can accept pin lugs on either side of a screw or unless proper connecting material is used (see examples below).



Every wire shall be marked at both ends with a numbering system as specified in the Labelling Specification (Volume 25 of the Automation And Control Design Standards), or if approved by the Engineer, and all terminating wires shall also be suitably crimped to a terminal lug. Not more than one wire shall be crimped into a single lug. Bare wire terminations will not be accepted.

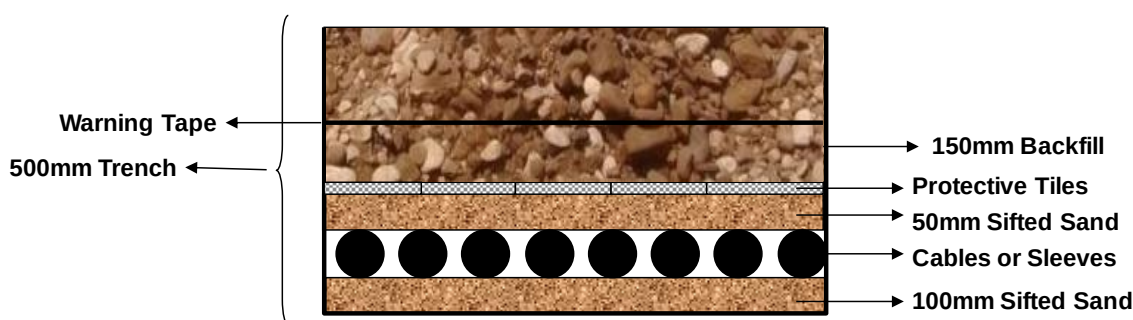
- 6.6.4 Where lugs are bolted onto studs, suitably sized lugs must be used. Enlarged holes in lugs will not be accepted.
- 6.6.5 Where pin lugs are crimped onto the ends of wires, correctly sized pin lugs must be used, which fit into the terminals properly and such that the tightening of the terminal

does not result in the loosening of the pin lug.

- 6.6.6 Where cable cores are terminated, sufficient slack must be allowed for wiring changes, re-terminations, etc.
- 6.6.7 Where cable junction boxes, terminal boxes or terminations in instruments or any other panels in the field take place it must be ensured that such a junction box, termination box, instrument, etc. is not exposed to fire hazards from burning grass or other vegetation. If such a termination point is out in the open field (e.g. where grass grows below and/or around it), a clear area of at least 2.5m radius around this termination point must be provided. This must be a permanent clearing, such as a cement or concrete surface. A mere clearing of vegetation which can grow back again will not be accepted.

6.7 Cables, Sleeves Or Microduct Assemblies In Trenches

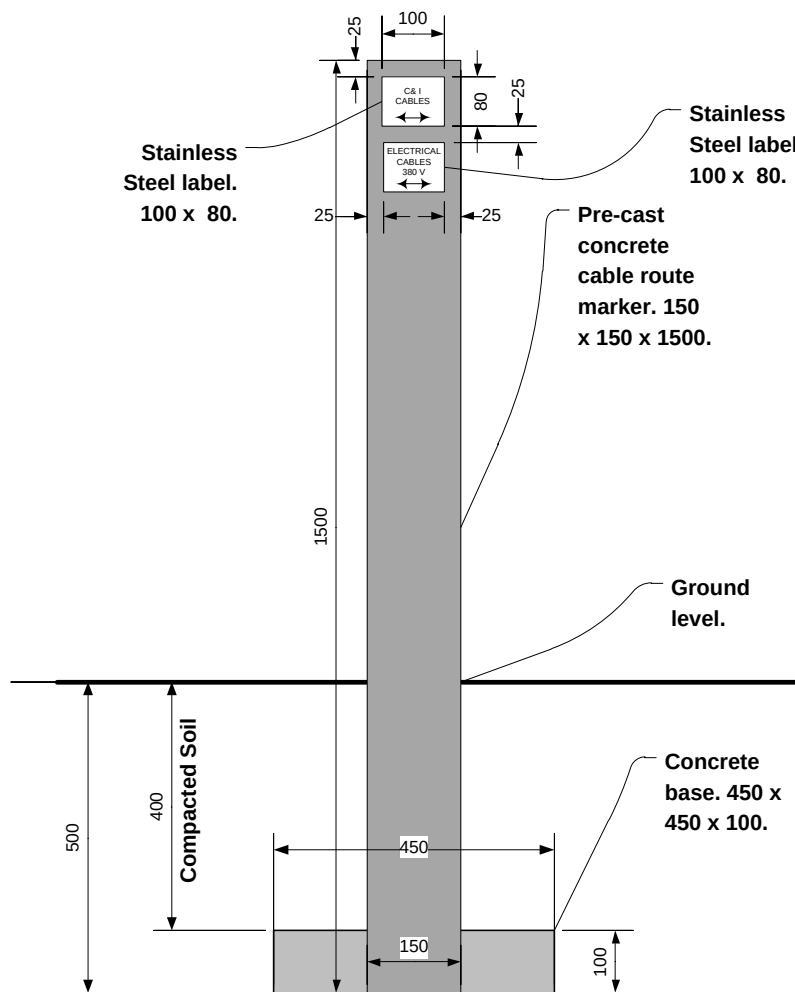
- 6.7.1 All cabling in trenches must be armoured cables to ensure sufficient mechanical protection.
- 6.7.2 Where cabling (electrical or fibre-optic) has to be done between points where cabling will not run along cable racks, in cable ducts or in cable tunnels, these cables or microduct assemblies for blown fibre must be run in trenches. Overhead cabling will not be acceptable. Blown fibre microduct assemblies buried in trenches must be suitable for direct burial.
- 6.7.3 Cable trenches must be at least 500 mm deep. There must be a 100mm layer of selective backfill (soft sifted sand), free of sharp and hard objects, at the bottom of the trench and another 50mm layer of selective backfill (soft sifted sand) directly above the cable, sleeves or microduct assemblies. Thereafter a single layer of protective pre-cast concrete tiles must be placed, without spaces between tiles, so that it forms one continuous protective layer. On top of the concrete tiles a layer of approximately 150mm backfill must be placed before placing plastic cable warning tape. The warning tape must consist of a strip of polyethylene of thickness 0,04 mm and of nominal width 230 mm, completely impregnated with a pigment such that the colour of the tape is yellow, colour No B49 of SANS 1091, and having printed at intervals not exceeding 1 metre along its length, a black-triangle and an electric flash symbol and the words "Danger, Gevaar, Ingozi". Thereafter the trench must be filled with sand (see the sketch below).



- 6.7.4 Protective concrete tiles in trenches are there to provide protection against hand digging and warning of cables below. These tiles therefore can be paving blocks, precast wall slabs, etc. Requirements are that the tiles are not less than 38mm thick and will not break under their own weight (i.e. when the longest span of the tile or slab is supported on its ends) or when laid in the trenches by commonly accepted means.

The tiles must also not break when the soil is compacted. The tiles must cover the entire width and length of the trench. Before purchasing any protective tiles, the contractor must submit details of the proposed tiles to the engineer for approval.

- 6.7.5 Where trenches pass under roads, railway lines, buildings, structures, etc., the cable trench must be at least 800 mm deep and at least 110mm HDPE (High-density polyethylene) double wall, corrugated pipes must be used as sleeving.
- 6.7.6 Protective concrete tiles in trenches under roads must comply with all the requirements listed in item 6.7.4 above plus the concrete tiles must not break if subjected to the heavy vehicle traffic on that road. The requirements mentioned in items 6.7.5 and 6.7.6 must be extended for 2 meters beyond the edge of roads to ensure that cables and cable sleeves will suffer no damage from heavy vehicles driving beyond the edge of the road.
- 6.7.7 Cable route markers, in the form of concrete pre-cast posts, which stand 1.0m above ground level, secured in the ground, must be installed every 50m on straight runs and at every change in direction of the trench. Movable route markers will not be acceptable. The post must be equipped with a stainless steel plate engraved with "C&I CABLES" and/or "DATA CABLES" as applicable and the direction indicated in which the cables run. If there are electrical cables in the same trench, there must be a separate label engraved with "ELECTRICAL CABLES", the voltage and the direction indicated in which the cables run. If there are data communication cables in the same trench, there must be a separate label engraved with "DATA CABLES" and the direction indicated in which the cables run. These labels must be cast into the concrete post so that they cannot be pried off.
- 6.7.8 At the bottom of the post a 450 x 450 x 100mm concrete base must be cast to ensure that the route marker can only be removed if it is deliberately dug out of the ground. Steel reinforcing mesh of MRM reference 156, in accordance with SANS 1024:2006 is required in the concrete and the concrete compressive strength of the base must not be less than 15 MPa. (Note: Reinforcing mesh to MRM 156 consists of 3.55mm diameter wire used to create 100 x 100 mm squares).
- 6.7.9 These route markers must be installed right next to the trench and not over the cables, so that the trench can be re-opened without affecting the route marker. The labels on the route marker must be on the trench side of the route marker.
- 6.7.10 All route markers for C&I and data cables must be painted with two coats synthetic polymer base emulsion paint for exterior use, complying with SANS 1586 Grade 1. The first coat may be thinned with no more than 10% water to aid penetration. Thereafter reflective yellow paint, suitable for use on concrete, must be applied.
- 6.7.11 The diagram below provides the required detail of these cable route markers.



- 6.7.12 Power and control cables must remain separated by at least 500mm as stated earlier. This means that power and control cables are not to be installed in the same cable sleeve.
- 6.7.13 Where sleeves are used for cables, an accessible manhole must be installed on every 50m straight run of sleeve and at every change of direction. This manhole can be built from bricks or concrete or it can be polyethylene Stakboxes as shown in the example below. Lids used on Stakboxes must not be made of material that is prone to theft for scrap metal (such as mild, steel, cast iron, etc).



- 6.7.14 The manhole must be large enough to allow proper access for cable installation. For example a manhole on a straight length of sleeving must in any event also not be smaller than 300mm x 300mm. Manholes installed at a change of direction must be large enough so that the bending radius of any cable running through it is not smaller than the manufacturer's recommended bending radius. The manhole must also not be smaller than 300mm x 300mm. If the manhole is required to make cable splices (fibre or copper) it must comply with all the requirements of item 6.4.36 above and there must be enough space so that cable loops can be comfortably left in the manhole without exceeding manufacturer's recommended minimum bending radii. Such a manhole must in any event also not be smaller than 600mm x 600mm.
- 6.7.15 The larger the number of cables running through the manhole, the larger the manhole must be to ensure ease of cable installation.
- 6.7.16 The depth below ground level at which the cables run through the manhole must not be less than the required cable burial depth as specified in item 6.7.3 above.
- 6.7.17 All sleeves entering the manhole must be sealed with an appropriate sealer that will prevent moisture, dirt, rodents, etc. from getting into the sleeves, but the sealant must be of such material that it can easily be removed if required in future. The area around the sleeve where it enters the manhole must also be sealed to prevent moisture, mud, rodents, etc. from getting into the manhole. The manhole must not have any sharp edges that can damage cables or microduct assemblies.
- 6.7.18 Where manholes are installed in roads, paving or paths where vehicles can travel, the lids and lid support structure must be strong enough so that heavy vehicle traffic from that area will have no detrimental effect on the lid or manhole. Such manhole covers must not be manufactured from material such as cast iron which is prone to theft. Metal covers filled with concrete will be acceptable.
- 6.7.19 The manhole covers shall either have a latch that requires a special tool to unlock and remove, or be heavy enough that lifting equipment is required to remove them (see the picture below).



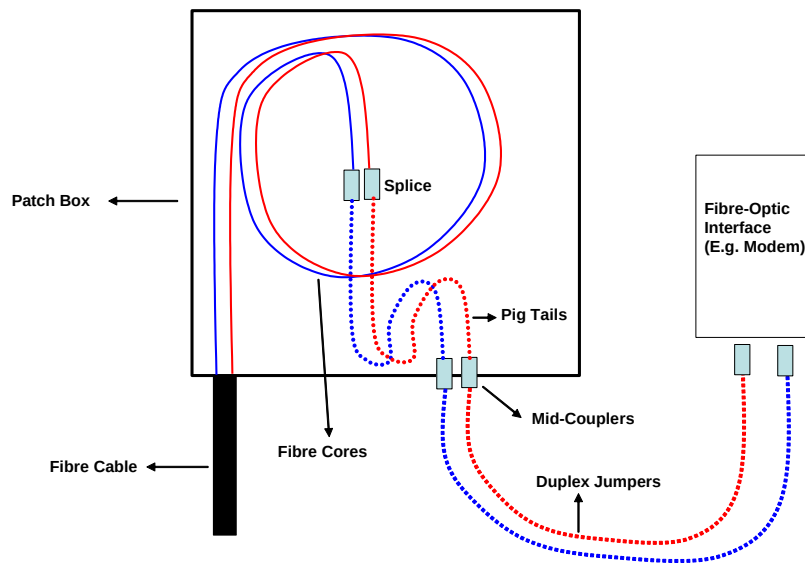
6.7.20 The base of the chamber must be made up of a dry mix of stone and cement so that it forms a hard but porous surface which is free draining for any water which enters the chamber.

6.7.21 All installed sleeves must be equipped with draw wires (or equivalent, such as nylon rope) to allow pulling in of cables. These draw wires must be non-corrosive and must be strong enough to pull the cables intended for that sleeve.

6.8 Fibre-Optic Data Cable Terminations

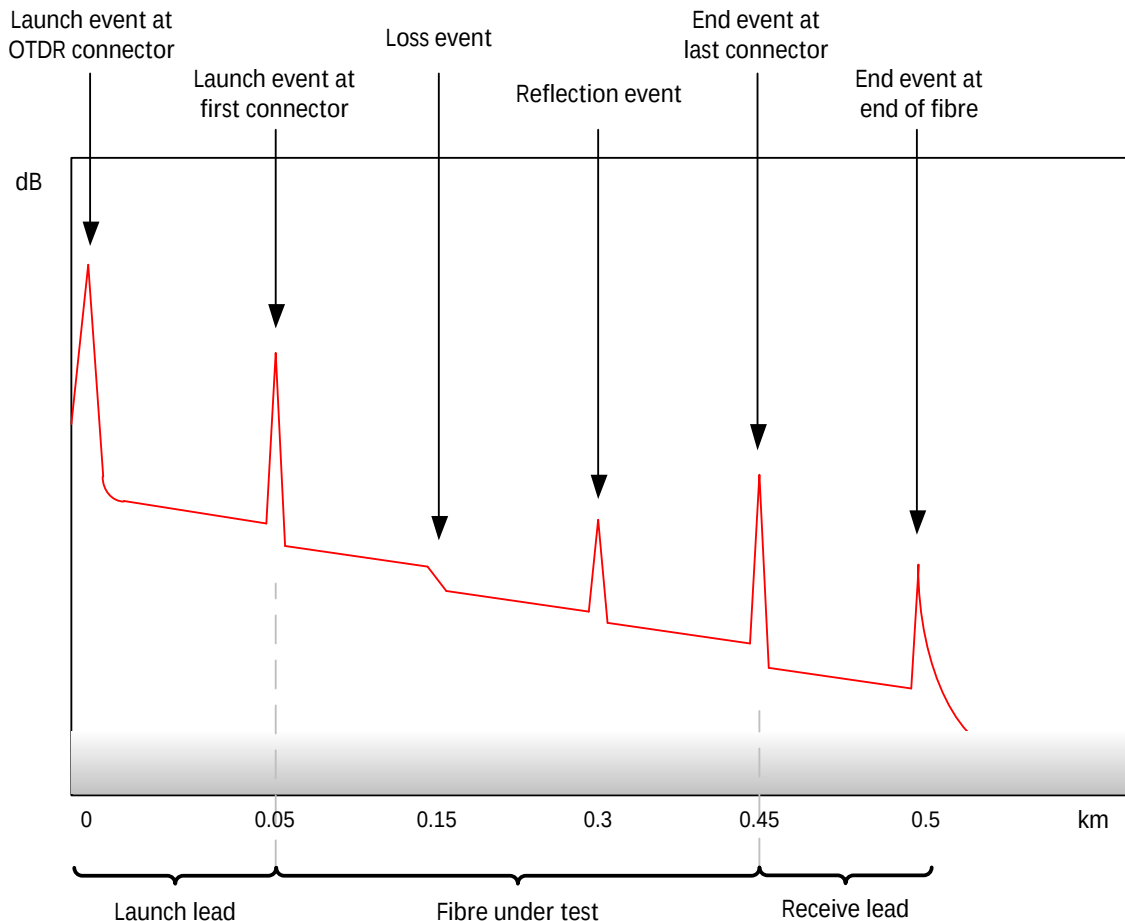
6.8.1 All terminations must be done by fusion splicing cores of the fibre-optic cable onto pre-fabricated "pig tails", inside a "patch box". The optical fibres will be terminated in the sequence specified in item 6.4.23 and 6.4.39 above.

6.8.2 The "patch box" must be equipped with mid-couplers, to accept the "pig tails" from inside the "patch box". The other end of these mid-couplers must accept the ends of the duplex jumpers fitted with LC connectors at both ends, which in turn are connected to the fibre-optic interface (modem, switch, hub, etc.). This arrangement is to ensure that disconnecting for testing or maintenance purposes does not involve working where the splices were made (see the sketch below).



- 6.8.3 The “patch box” must be hardened and robust, with a minimum environmental rating of IP65 and suitable for use in industrial applications.
- 6.8.4 All splices must be fusion splices, and not mechanical splices.
- 6.8.5 All fibre-optic cables must be at least 12-core cables to ensure sufficient spare cores in the event of faults and for future modifications, additions, etc.
- 6.8.6 All fibre-optic data communication cables must be single mode.
- 6.8.7 All fibre-optic cables supplied must comply with the relevant parts of SANS 60793/ IEC 60793 and SANS 60794/ IEC 60794 in terms of construction, installation and testing.
- 6.8.8 All the fibres and splices must be tested by an experienced fibre-optic network specialist and the results saved for analysis. The following tests have to be completed and test certificates have to be produced:
 - 6.8.8.1 OTDR (optical time domain reflectometer) tests for all fibres at both 1310nm and 1550nm wavelengths, in both directions, must be completed when the cable is delivered to the site and again after the installation has been completed.
 - 6.8.8.2 When performing OTDR tests, adequate launch and receiving leads must be used so that the splicing on both ends of the cable is clearly visible on the OTDR trace. The pulse width must be set to the minimum possible width for the distance under test and the time duration of the test must not be less than sixty (60) seconds. The scale of the trace should be set to 1.5x to 2x the length of the cable under test. The measured loss of each event must be captured in MS Excel and the original OTDR results must be saved in its native format. The results must be supplied to the engineer for approval. A typical OTDR trace is shown below.

Typical OTDR trace

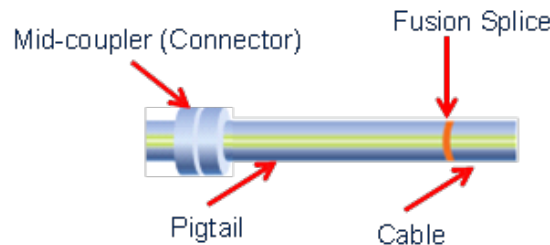


6.8.8.3 OLTS (optical loss test set) analysis with a power source and power meter must be done for all fibres after the installation has been completed. These tests must be done in both directions and the results have to be captured in MS Excel. A typical test report for one fibre is shown below. (P/Loss = Power Loss; ORL = Optical Reflection Loss).

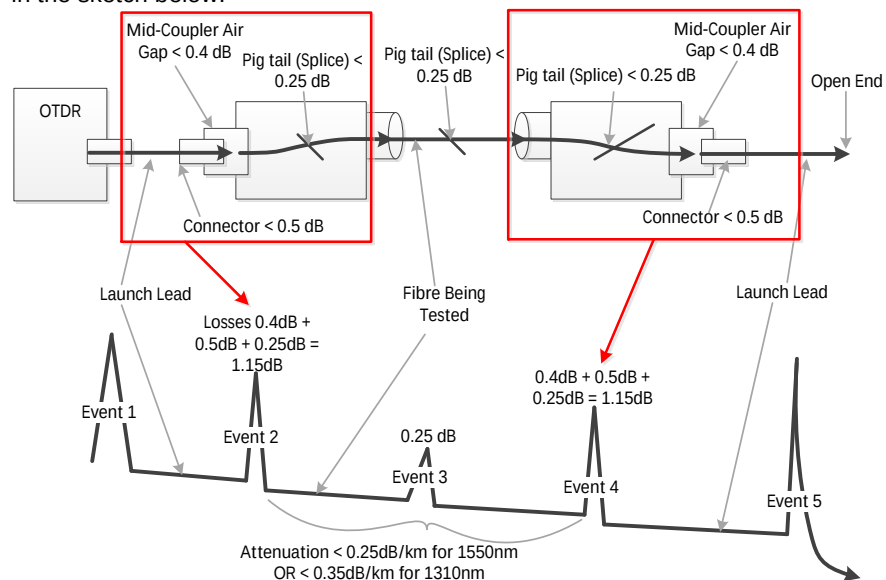
Fibre ID	Wavelength	P/Loss	P/Loss	Average	ORL A	ORL B	Length
		A->B	B->A				
	(nm)	(dB)	(dB)	(dB)	(dB)	(dB)	(km)

6.8.9 Losses in any fibre-optic core measured end-to-end at wavelengths of 1310nm and 1550nm, must not exceed **0.25dB per fusion splice**. The attenuation over the length of the fibre must not exceed 0.35dB/km at 1310nm and 0.25dB/km at 1550nm.

- 6.8.10 Losses over any connection (i.e. including mid-couplers) must not exceed 0.5dB.



- 6.8.11 The figure above shows a typical patch box situation (see item 6.8.2) where a pigtail is spliced onto the cable at one end and onto a connector (the mid-coupler) at the other end. These two events are too close together to be identified as separate events by an OTDR test. The overall maximum acceptable loss (at 1310 nm or 1550nm) for this combination will thus be **0.5 (connection) + 0.25 (fusion splice) = 0.75 dB**. This requirement is illustrated in the sketch below.



- 6.8.12 SFP's should be used so that the length of a fibre measured from one end to the other is greater than 5% of the rated maximum distance specified by the manufacturer of the SFP.

6.9 Copper Data Cables

- 6.9.1 All copper data cable shall be a high performance, 4-pair, Category 6, 23 AWG, unshielded, twisted pair (U/UTP) with solid copper conductors, polyolefin insulated PVC or low-flammability sheath and colour-coded pairs.

- 6.9.2 All copper data cable shall be tested after installation using an instrument with the capability of certifying the cable as Category 6 as specified in the TIA/EIA 568-B.2-10 industry standard.

6.10 Data Cabling General

- 6.10.1 All data cabling systems must be designed and installed in accordance with ISO/IEC SANS 11801:2002.
- 6.10.2 The cables must comply with EN 50288-5/6.
- 6.10.3 In terms of flammability, the cables or blown fibre microduct assemblies inside buildings (whether on racks, in ceilings, under floor panels, etc.) must comply with IEC 60332-1.

6.11 Cable Theft Prevention Measures

- 6.11.1 Cable theft prevention methods must be discussed with each site manager and implemented to suit the unique requirements in each area on each site.
- 6.11.2 Trenches in high risk areas (as defined by the relevant site manager) will have a 100mm thick layer of 20/20 concrete (i.e. 20MPA strength and 20mm aggregate size) supplied in the place of the concrete tiles.
- 6.11.3 Where inverted culverts with cable racking inside the culverts and concrete covers over the culverts are used the concrete covers must be constructed of reinforced concrete. The slabs must be sized to suit the width of the culvert. Each slab must weigh at least 100kg and must be provided with only two lifting holes.
- 6.11.4 Where cables are laid in trenches, the contractor must ensure that cable de-rating factors are strictly applied in accordance with SANS 10142-1:2003 to prevent cables from overheating. This clause is especially important to adhere to when existing inverted culverts with existing installed cables are to be filled with soil.
- 6.11.5 No bare copper conductors are to be used for earth conductors, earth strapping, earth bonding, etc. If possible a 5-core cable should be used to allow the 5th core to be used as an earth conductor. If this is not a viable option, a 2-core PVC, SWA cable must be installed as an earth cable.
- 6.11.6 For short runs of earth cable (such as bonding of earth bars or earthing conductors of buildings), other cable (i.e. not copper), approved by the Engineer, must be used.
- 6.11.7 For high risk areas where cable racking is used, such cable racks must be covered with solid covers of the same material and complying with the same paint specification as the racking itself. Such covers must be bolted onto the rack in such a way that either special tools or a disk grinder would be required to remove these covers.
- 6.11.8 If any additional cable theft prevention methods are required, such requirements will be made clear to the contractor at the time of tender.

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

PARTICULAR SPECIFICATION
VOLUME 7 : NETWORKING

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DOCUMENT CONTROL SHEET

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7 NETWORKING

7.1 Scope

- 7.1.1 This specification covers the supply and installation of equipment, the network topologies, the communication methods and the security for data communication systems, typically between Programmable Logic Controllers and Supervisory systems, used in process monitoring and control applications at Johannesburg Water wastewater sites.

7.2 Abbreviations

- 7.2.1 In this specification the following abbreviations will apply :-

CD	:	Compact Disk
CLI	:	Command Line Interface
DiffServ	:	Differentiated Services
EMC	:	Electro-Magnetic Compatibility
GARP	:	Generic Attribute Registration Protocol
GMRP	:	GARP Multicast Registration Protocol
GUI	:	Graphical User Interface
GVRP	:	GARP VLAN Registration Protocol
HTTPS	:	Hyper Text Transfer Protocol Secure switches
IEC	:	International Electrotechnical Commission
IEEE	:	Institute of Electrical and Electronic Engineers
IGMP	:	Internet Group Management Protocol
LACP	:	Link Aggregation Control Protocol
LAN	:	Local Area Network
LED	:	Light Emitting Diode
MAC	:	Media Access Control
Mbit	:	Mega bits
Mbps	:	Mega bits per second
MDI/MDI-X	:	Medium Dependent Interface/ Medium Dependent Interface (crossed)
OS	:	Operating system
PC	:	Personal Computer
PLC	:	Programmable Logic Controller
QoS	:	Quality Of Service
RD	:	Read
RSTP	:	Rapid Spanning Tree Protocol
SANS	:	South African National Standards
SCADA	:	Supervisory Control And Data Acquisition

SNMP	:	Simple Network Management Protocol
SSH	:	Secure Shell
SSL	:	Secure Sockets Layer
TCP/IP	:	Transmission Collision Protocol/Internet Protocol
TOS	:	Type Of Service
TX	:	Transmit
USB	:	Universal Serial Bus
VLAN	:	Virtual Local Area Network

7.3 Standards

7.3.1 All design standards shall be subject to the latest amendments and editions of the following standard specifications:-

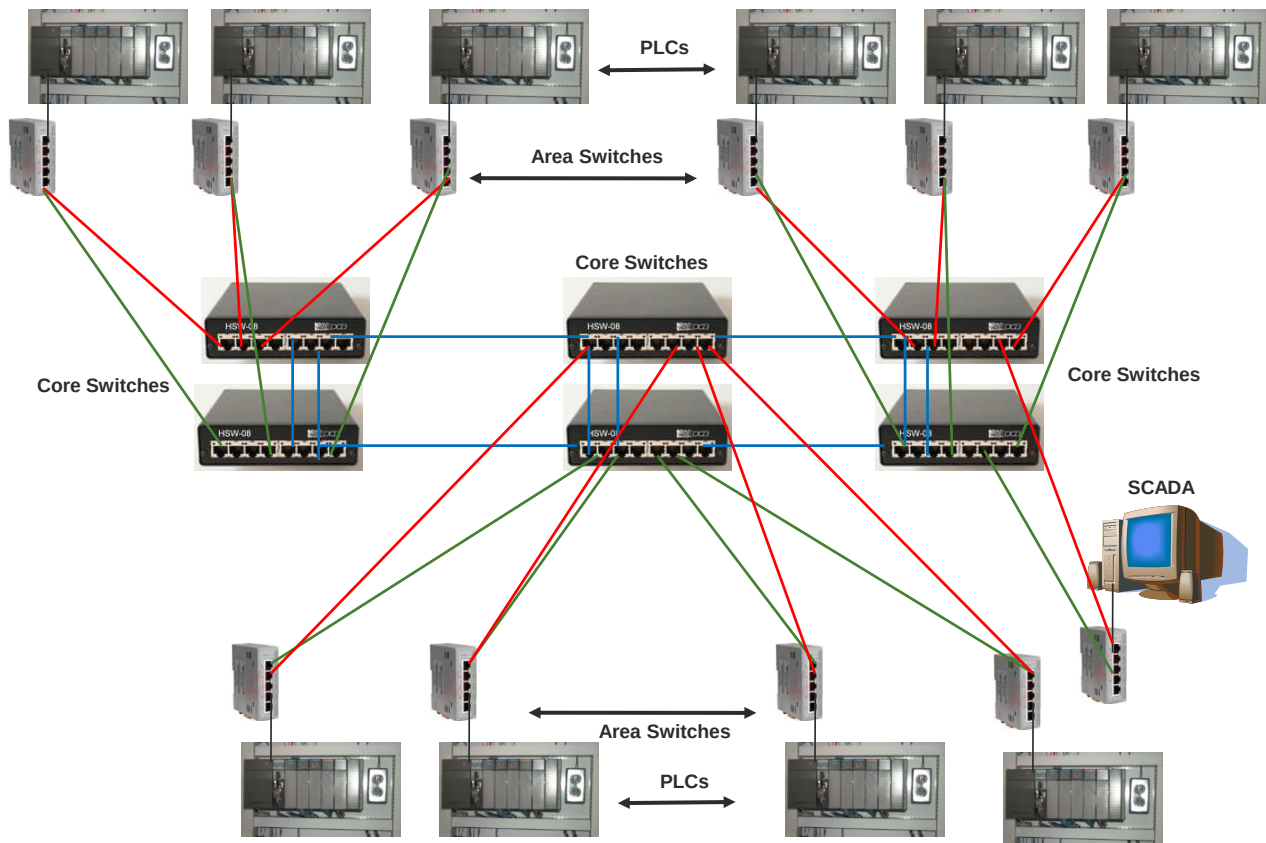
SANS 10142-1	:	National Standards for the wiring of premises
IEEE 802.3-2005	:	Carrier Sense Multiple Access with Collision Detection (CSMA/CD) access method and physical layer specifications
IEEE 802.3ad (Now IEEE 802.1AX):	:	Link Aggregation
IEEE 802.1d	:	MAC Bridges
IEEE 802.1p	:	Quality of service
IEEE 802.1Q	:	VLAN Tagging
IEEE 802.1w	:	Rapid Spanning Tree Protocol
IEEE 802.1X	:	Port Based Network Access Control
IEC 60068-2-6	:	Environmental Testing - Vibration
IEC 60068-2-27	:	Environmental Testing – Test Ea and guidance: Shock
SANS 61000-4/IEC 61000-4	:	Electromagnetic compatibility – testing and measurement techniques

7.4 Communication Protocol

7.4.1 The preferred method of communication between PLC's or between PLC's and SCADA systems is Ethernet TCP/IP.

7.4.2 Systems must be designed and equipment selected with the view of communicating via TCP/IP over Ethernet.

7.5 Network Topology



- 7.5.1 The preferred topology is an Ethernet star/mesh topology as indicated in the diagram above.
- 7.5.2 Where existing installations make the use of a star/mesh topology impractical, contractors must link into the existing system in such a way that future conversion to a star/mesh topology will not be hampered by the current installation.
- 7.5.3 All systems must be designed and equipment selected with the view of converting to a star/mesh topology when possible.
- 7.5.4 Network redundancy must be such that if one core switch fails, there must be a second one that can maintain communication (as shown in the diagram above).
- 7.5.5 Data communication between core switches and from core switches to the area switch patch panels must be done via 9/125µm, single mode, PVC, CST (Corrugated Steel Tape) cable or single mode blown fibre microduct assemblies (see the Cabling Specification (Volume 6 of the Automation And Control Standards)). The number of cores must be as specified in the project scope of work and the tender bill of quantities.

- 7.5.6 Each core switch pair (i.e. the two core switches which form a dual redundant system at a particular location) must be equipped with two UPSs (Uninterruptable Power Supplies) as specified in the "Automation And Control Design Standards, Volume 5, Clean Power And Surge Protection". The two power supplies must be connected to both switches (i.e. each UPS supplies both core switches) to provide redundancy. These supplies must also be equipped with proper surge protection as detailed in the same specification - "Automation And Control Design Standards, Volume 5, Clean Power And Surge Protection".

7.6 Switches

7.6.1 Minimum Requirements For Area Switches

- 7.6.1.1 Only industrial type switches will be accepted. No standard "commercial" or "Office" switches will be accepted. These switches must have at least an IP 20 rating, must have a rugged high-strength metal case and must have DIN-rail or panel mounting ability. They must have an operating temperature of at least 0 to 55°C, without the use of cooling fans and must be able to work in relative humidity up to 95% without condensation.
- 7.6.1.2 Redundancy and fault recovery:
- Must comply with IEEE 802.1w for Rapid Spanning Tree Protocol
- 7.6.1.3 Remote management and monitoring:
- Must support SNMP V1/V2/V3 for different levels of network management security
- 7.6.1.4 Area switches must have at least two SFP uplink ports which are 1000Base-LX Gigabit Ethernet standard compatible. These ports must be compatible with Duplex LC-type connectors for single-mode fibre.
- 7.6.1.5 Area switches must have the number of copper ports as specified in the project scope of work and the tender bill of quantities. The copper ports must be 10BASE-T/100BASE-TX compatible in order to communicate with the PLCs. These ports must be capable of accepting RJ45 connectors on CAT-6 cable.
- 7.6.1.6 In terms of configuration, maintenance, management and monitoring features required, all area switches must:
- Have support for loading or saving configurations to a remote host
 - Have port monitoring for debugging
 - Have line-swap fast recovery to normal operation (within milliseconds) after devices are unplugged and then re-plugged into different ports
 - Be configurable by Operating System (OS) independent web browser, using secure HTTPS

7.6.2 Minimum Requirements For Core Switches

- 7.6.2.1 Only industrial type switches will be accepted. No standard "commercial" or "Office" switches will be accepted. These switches

must have redundant, dual DC power units, must have at least an IP 30 rating, must have a rugged high-strength metal case and must be 19" rack-mounted switches. They must have an operating temperature of at least 0 to 55°C, without the use of cooling fans and must be able to work in relative humidity up to 95% without condensation.

- 7.6.2.2 Redundancy and fault recovery:
- Must comply with IEEE 802.1w for Rapid Spanning Tree Protocol
 - Must comply with IEEE 802.3ad (now 802.1AX) for link aggregation or port trunking and must have at least 4 trunks.
- 7.6.2.3 Broadcast isolation and network segmentation:
- Must comply with IEEE 802.1Q in terms of support for VLAN Registration Protocol (GVRP) to ease network planning
- 7.6.2.4 Quality of service:
- Must comply with IEEE 802.1p/1Q in terms of support for TOS/DiffServ in order to increase determinism
- 7.6.2.5 Multicasting:
- Must have IGMP Snooping and GMRP for filtering multicast traffic from industrial Ethernet protocols
- 7.6.2.6 Security and authentication:
- Must comply with IEEE 802.1X in terms of support for SSL to enhance network security
- 7.6.2.7 Remote management and monitoring:
- Must support SNMP V1/V2/V3 for different levels of network management security
- 7.6.2.8 Core switches must be managed, Layer 3 switches with the number of ports as specified in the project scope of work and the tender bill of quantities.
- 7.6.2.9 Core switches must provide support for a minimum of four trunked Gigabit SFP ports with 1000Base-LC, LC connectors.
- 7.6.2.10 Core switches must provide support for a minimum of eight SFP ports that will support a combination of Fast Ethernet ports (10/100Base-TX,) and Gigabit Ethernet ports (1000Base-T, 1000Base-LX).
- 7.6.2.11 In terms of configuration, maintenance, management and monitoring features required, all core switches must:
- Have support for loading or saving configurations to a remote host
 - Have port monitoring for debugging
 - Have line-swap fast recovery to normal operation (within milliseconds) after devices are unplugged and then re-plugged into different ports
 - Be configurable by Operating System (OS) independent web browser, using secure HTTPS
 - Be configurable by CLI by Local Serial console and remote SSH network connection
 - Support ping commands to identify network segment integrity

7.7 Compliance With Standards

- 7.7.1 It is important that all equipment is selected and installations are done to industrial standards. These are usually harsh environments in terms of dirt, industrial activities such as welding, grinding, etc. and electrical interference such as lightning, capacitor switching, large drives starting and stopping, etc.
- 7.7.2 The complete installation and networking system must comply with IEEE 802.3-2005.
- 7.7.3 The equipment installed must comply with SANS 61000-4/IEC 61000-4 for EMC.
- 7.7.4 The equipment installed must comply with IEC 60068-2-6 for vibration (10 to 57 Hz – amplitude 0.15mm, 57 to 150 Hz – acceleration 2g).
- 7.7.5 The equipment installed must comply with IEC 60068-2-27 for shock (12 shocks semi-sinusoidal, 15g, 11ms).
- 7.7.6 All installations must comply with the requirements of SANS 10142-1.

7.8 Network Switch Data Sheets

- 7.8.1 For network switches supplied, the tenderer must supply the data sheets shown in Appendix A with his tender.
- 7.8.2 All installations must comply with the requirements of SANS 10142-1.

7.9 Redundancy Testing

- 7.9.1 All the core network switches and area switches that have been installed in a redundant configuration must to be tested by a network specialist and the results documented. The contractor must make the following equipment available to complete these tests:
- Two portable area switches as specified in 7.6.1
 - Two portable computers, running from a CD ROM-booted operating system (e.g. Linux LiveCD)
- 7.9.2 The following ping test procedures must be followed using ICMP (Internet Control Message Protocol).
- Continuous ping messages will be sent from a portable test computer located at the core switch to a remote portable test computer that will be moved around all the network points (i.e. the area switches) to confirm the data throughput, latency (ping time) and network failover time.
 - Confirm that the round-trip ping times with a packet size of 10kb does not exceed 2 milliseconds.
 - Confirm that the continuous ping messages recovers within 3 seconds after either one of the redundant core switches has been powered down or powered up and after either one of the fly leads to the area switch has been disconnected from a core switch.
 - Capture the result as indicated in the following example:

Port No	PING Time	SW0-A Switch Down	SW0-B Switch Down	SW0-A Link Down	SW0-B Link Down	Comments
1	<1ms	✓	✓	✓	✓	Location L2

7.10 Labelling

7.10.1 All labelling must comply with the requirements as specified in the Labelling Specification (Volume 25 of the Automation And Control Standards).

APPENDIX 1

DATA SHEET - FIBRE "CORE" GIGABIT ETHERNET SWITCHES

DESCRIPTION	DATA
Manufacturer	
Model or Type	
Part or Order Number	
19" Rack-mount switch?	☐ Yes ☐ No
Comply with IEEE 802.1w for Rapid Spanning Tree Protocol?	☐ Yes ☐ No
Comply with IEEE 802.3ad (now 802.1AX) for link aggregation or port trunking?	☐ Yes ☐ No
Switch has at least 4 trunks?	☐ Yes ☐ No
Comply with IEEE 802.1Q i.t.o. support for VLAN Registration Protocol (GVRP)?	☐ Yes ☐ No
Comply with IEEE 802.1p/1Q i.t.o. support for TOS/DiffServ?	☐ Yes ☐ No
Comply with IEEE 802.1X i.t.o. support for SSL?	☐ Yes ☐ No
Support SNMP V1/V2/V3 for different levels of network management security?	☐ Yes ☐ No
Is it a managed, Layer 3 switch?	☐ Yes ☐ No
At least 8 SFP ports that will support a combination of Fast Ethernet ports (10/100Base-TX) and Gigabit Ethernet ports (1000Base-T, 1000Base-LX)?	☐ Yes ☐ No
Support for loading or saving configuration to a remote host?	☐ Yes ☐ No
Port monitoring for debugging?	☐ Yes ☐ No
Has line-swap fast recovery to normal operation (within milliseconds) after swapping devices?	☐ Yes ☐ No
Configurable by Operating System (OS) independent web browser, using secure HTTPS?	☐ Yes ☐ No
Configurable by CLI by Local Serial console and remote SSH?	☐ Yes ☐ No
Support ping commands to identify network segment integrity?	☐ Yes ☐ No

Local Agent?	☐ Yes ☐ No
Local agent contact details	
Guarantee period	

DATA SHEET – “AREA” ETHERNET SWITCHES

DESCRIPTION	DATA
Manufacturer	
Model or Type	
Part or Order Number	
Comply with IEEE 802.1w for Rapid Spanning Tree Protocol?	☐ Yes ☐ No
SFP Uplink ports which are 1000BASE-LX Gigabit Ethernet standard compatible?	☐ Yes ☐ No
Uplink ports compatible with Duplex LC-type connectors for single-mode fibre?	☐ Yes ☐ No
Support for loading or saving configuration to a remote host?	☐ Yes ☐ No
Port monitoring for debugging?	☐ Yes ☐ No
Has line-swap fast recovery to normal operation (within milliseconds) after swapping devices?	☐ Yes ☐ No
Configurable by Operating System (OS) independent web browser, using secure HTTPS?	☐ Yes ☐ No
Local Agent?	☐ Yes ☐ No
Local agent contact details	
Guarantee period	

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

PARTICULAR SPECIFICATION
VOLUME 8 : FLOW MEASUREMENT

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DOCUMENT CONTROL SHEET

Document Title: Particular Specification – VOLUME 8 : Flow Measurement

JW Reference: BWV523C

Document Ref. No: VOLUME 8

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Approved	Manager	T. Thabeng		

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2009-08-18	7	C. Du Toit	New logos and transmitter position requirements added and mag flow pulse output requirements altered.
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2007-11-07	4	C. Du Toit	Flow meters for distributing/flow diversion added.
2007-09-10	3	C. Du Toit	Gas flow measurement added and "Minimum" 500 ohm load changed to "Maximum".
2007-06-05	2	C. Du Toit	Revision block updated and "Joburg" logo added
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8 FLOW MEASUREMENT

8.1 Scope

8.1.1 This specification covers the supply and installation of Flow meters, complete with sensors, transmitters, indicators, panels, etc. used for process monitoring and control applications at Johannesburg Water wastewater sites.

8.2 Abbreviations

8.2.1 In this specification the following abbreviations will apply :-

BS	: British Standards
PLC	: Programmable Logic Controller
I/O	: Input/Output
CPU	: Central Processing Unit
UPS	: Uninterruptible Power Supply
MCC	: Motor Control Centre
MCB	: Miniature Circuit Breaker
SPD	: Surge Protection Device
FJB	: Field Junction Box
SSO	: Switched Socket Outlet
SPDT	: Single Pole Double Throw (refers to relay or switch contact arrangements).
LCD	: Liquid Crystal Display
LED	: Light Emitting Diode
PTFE	: Polytetrafluoroethylene
O&M	: Operating And Maintenance

NPT	: National Pipe Thread
DP	: Differential Pressure
LP	: Low Pressure
HP	: High Pressure
RH	: Relative Humidity
IS	: Intrinsically Safe

8.3 Standards

8.3.1 The supply and installation of all Flow meters and associated cabling, panels and any other equipment shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 10142-1	: National Standards for the wiring of premises.
SANS 1091:2004	: National Colour Standard.
SANS 1274-2005	: Coatings applied by the powder-coating process.
BS 381C:1980	: Paint colour chart.
BS 3680	: Measurement of liquid flow in open channels.
SANS10108:2005	: The classification of hazardous locations and the selection of apparatus for use in such locations.
SANS60079-10:2005	: Electrical apparatus for explosive gas atmospheres. Part 10: Classification of hazardous areas.
SANS60079-11:2005	: Electrical apparatus for explosive gas atmospheres. Part 10: Intrinsic safety "i".
SANS10086-1	: The installation, inspection and maintenance of equipment used in explosive atmospheres Part 1: Installations including surface installations on mines

8.4 General Requirements

8.4.1 This specification must be read in conjunction with the following specifications:-

8.4.1.1	PLC Panels Specification (Volume 3 of the Automation And Control Standards).
8.4.1.2	Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).
8.4.1.3	Cabling Specification (Volume 6 of the Automation And Control Standards).
8.4.1.4	Field Junction Boxes And Panels (Volume 19 of the Automation And Control Standards).

8.4.1.5 Labelling (Volume 25 of the Automation And Control Standards).

- 8.4.2 Where cables are exposed to physical damage (including damage from rodents) armoured cables must be used or un-armoured cables must be run in steel conduit.
- 8.4.3 All power supply cables to instruments must have a black outer sheath, while all control cables (such as digital and analogue signals to PLC's) must have an orange outer sheath as specified in the Cabling Specification (Volume 6 of the Automation And Control Standards).
- 8.4.4 FJB's and as far as practically possible all instrument sensors and transmitters, must be mounted such that all equipment, wiring, numbers, terminations, etc. are readily accessible and can be viewed clearly. No equipment may be mounted such that it becomes a hazard or dangerous to view or gain access to such equipment.
- 8.4.5 Where sensors and/or transmitters cannot be mounted where they are readily accessible, the installation must be done in such a way that the sensor or transmitter can easily be moved to a safe and convenient position for testing, maintenance, replacement, etc. (e.g. by using hinged brackets, telescopic brackets, etc.).
- 8.4.6 Where transmitters can be exposed to the elements (wind, rain, ultra violet, etc.) such transmitters must be installed inside the FJB. LCD displays must always be protected from direct sunlight, either by facing them away from the sun or by installing it inside the FJB, in the shade of the FJB canopy. Where transmitters are protected from the elements (i.e. inside buildings) but they are exposed to potentially harmful conditions like moisture from splashing or equipment being hosed down, or the sensor is in such a position that the transmitter display is not clearly visible from floor level, without the need to climb onto ladders or structures to access it, the transmitter must also be installed inside the FJB. Only where transmitters are not exposed to the elements or any other harsh or potentially harmful conditions and where the displays on such transmitters are clearly legible by an average person standing on the ground or the normal walking surface (e.g. grating above ground level), can the transmitter be mounted outside the FJB.
- 8.4.7 FJB's must be mounted against a wall or structure or on a sturdy pedestal such that the top of the FJB enclosure is no higher than 1.8 m from the floor and easily accessible from the front.
- 8.4.8 All instrument installations must be done in accordance with the manufacturer's requirements and recommendations for proper operation. It is the tenderer's responsibility to ensure that he/she is familiar with both the requirements of the manufacturer as well as the installation requirements, in terms of location, site conditions, materials, equipment or substances to be measured (e.g. hot liquids, acids, abrasive material, etc.) and to ensure that if there are potential problems, they can be pointed out and rectified before orders for equipment are placed.
- 8.4.9 Costs incurred for alterations required to ensure proper operation of instruments, after orders have been placed, will be for the tenderer's account. For example, if instruments have been ordered and it is found there is insufficient space to install the instrument, or the instrument is not flooded with liquid all the time as it is required for proper operation, or the instrument transmitter is sometimes flooded in its installed position, or the sensing head is sometimes outside the medium it is supposed to measure, or the instrument linings are damaged by abrasive liquids, or the sensor is does not have a suitable range of measurement, etc. alterations or

replacements required to rectify such problems will be for the tenderer's account if the Engineer finds that the tenderer was negligent in his/her assessment of the installation.

- 8.4.10 Each instrument must be equipped with a circuit breaker connected to the power supply of the instrument, to enable local isolation in case of repairs or replacement.
- 8.4.11 The supplier of the instrument must be present for the installation, testing and commissioning of the instrument on site. Due allowance must be made for this in the tender sum.
- 8.4.12 The tenderer must supply a complete and detailed set of documentation for the installation, connections, terminations, power supply, technical details, setting up, calibration (if applicable), testing, etc. of the instrument for inclusion in a final O&M manual.
- 8.4.13 If a flow meter (for any application) is offered, which has the facility to store calibration and set-up data electronically, so that it can be downloaded when an instrument is replaced, the contractor must include the supply of all the necessary equipment (special cables, memory cards, etc.) to enable the use of this facility.
- 8.4.14 Completed data sheets are required as part of the returnable documents of each tender. Failure to complete these data sheets, supplied at the end of this specification, will lead to disqualification of the tender.

8.5 Surge Protection

- 8.5.1 Each instrument and its associated equipment must be suitably protected against surges from induced voltages, switching of equipment, lightning strikes, etc. as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).
- 8.5.2 The power supply to the instrument must be equipped with suitable surge protection, both at the instrument and at the source of the power supply (i.e. at the distribution board, MCC, PLC panel, etc.), as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).
- 8.5.3 Both the digital and analogue signals between the instrument and other remote devices (such as the PLC), must be equipped with suitable surge protection, both at the instrument and at the remote device as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

8.6 Open Channel Flow Measurement – Controller/Transmitter

- 8.6.1 Flow calculations for all open channel flow measurement must be done in accordance with BS 3680.
- 8.6.2 All flow measurements in open channels must be done by using ultra-sonic distance measurement, which is converted into a flow value at weirs or venturi flumes. Where there are no weirs or venturi flumes, area/velocity flow meters must be used (see requirements later in this specification).
- 8.6.3 All instrument transmitter enclosures must have at least an IP 65 or higher rating.

- 8.6.4 The instrument must be equipped with an isolated, active, 4 – 20mA output which will be connected to a maximum 500 ohm load. This output must be user-programmable.
- 8.6.5 The instrument must be equipped with at least one SPDT relay, rated for at least 230V AC, 500mA, for totalised flow pulses. This output must be user-programmable for the units-per-pulse.
- 8.6.6 The transmitter must be suitable for use with a 230V AC, 50/60 Hz power supply.
- 8.6.7 The transmitter must have an accuracy of at least 0.25% or 6mm, whichever is greater.
- 8.6.8 The transmitter must have a resolution of at least 0.1% or 2mm, whichever is greater.
- 8.6.9 The transmitter must have an LCD or LED display showing instantaneous flow and totalised flow.

8.7 Open Channel Flow Measurement – Sensor/Transducer

- 8.7.1 The range of the sensor must be suitable for the application (see items 8.4.8 and 8.4.9 of this specification).
- 8.7.2 The sensor must be suitable for an operating temperature range of -10°C to +50°C.
- 8.7.3 The sensor must be equipped with automatic temperature compensation.
- 8.7.4 The sensor must have a protection rating of at least IP 67 or higher.
- 8.7.5 Brackets used for the mounting of ultra-sonic sensor heads and velocity sensor heads (if external velocity sensors are used) must be made of at least 3CR12 grade stainless steel.

8.8 Full Pipeline Flow Measurement – Controller/Transmitter

- 8.8.1 All flow measurements in full pipelines must be done by using electro-magnetic flow (mag-flow) measurement, which is converted into a flow value where accuracy of measurement is required for dosing and/or custody transfer of flow. Where measurement for flow distribution or flow diversion is required or for pump protection (i.e. where high accuracy is not essential), non-intrusive flow measurement using external sensors can be applied. These systems must incorporate either ultrasonic time of flight or Doppler principles. Ultrasonic time of flight systems can be used on clean water with low contents of air bubbles or other entrained gasses and suspended solids of less than 10,000 milligrams/litre. Doppler systems can be used on liquids with entrained particles or gasses of 100 microns or larger and suspended solids in excess of 75 milligrams/litre.
- 8.8.2 All instrument transmitter enclosures must have at least an IP 65 or higher rating.
- 8.8.3 The instrument must be equipped with an isolated, active, 4 – 20mA output which will be connected to a maximum 500 ohm load. This output must be user-programmable.

- 8.8.4 The instrument must be equipped with at least one SPDT relay, or an output that can be used to drive a relay, for totalised flow pulses. This output must be user-programmable for the units-per-pulse.
- 8.8.5 The transmitter must be suitable for use with a 230V AC, 50/60 Hz power supply.
- 8.8.6 The transmitter for electro-magnetic flow meters must have an accuracy of at least 0.5%, or better, of the measured value for flow velocities which are greater than 0.5 meters/second. Transmitters of flow meters for flow distribution/diversion can have an accuracy of less than 0.5% but they must not be less accurate than $\pm 2\%$ of the full scale for Doppler meters and not less than $\pm 2\%$ of the measured value for time of flight meters. For both Doppler and time of flight meters these accuracy requirements apply to flow velocities of 0.5 meters/second or greater. Repeatability must not be less than 1% of the measured value.
- 8.8.7 The transmitter must have an LCD or LED display showing instantaneous flow and totalised flow.

8.9 Full Pipeline Flow Measurement – Sensor/Transducer

- 8.9.1 The range of the sensor must be suitable for the application (see items 8.4.8 and 8.4.9 of this specification).
- 8.9.2 The sensor lining for electro-magnetic flow meters used in sludge or non-corrosive liquids must be Neoprene or Rubber, suitable for operating in temperatures ranging from -10°C to +80°C.
- 8.9.3 The sensor lining for electro-magnetic flow meters used in corrosive or heated liquids must be PTFE, suitable for operating in temperatures ranging from -20°C to +150°C.
- 8.9.4 The sensor must have a protection rating of at least IP 68 or higher.
- 8.9.5 The sensor tube material for electro-magnetic flow meters must be at least 304, 316 or 3CR12 grade stainless steel.
- 8.9.6 The sensor electrode material for electromagnetic flow meters must be at least 304, 316 or Hastelloy C grade stainless steel.
- 8.9.7 The sensor for electromagnetic flow meters must have either a grounding electrode or earth rings fitted.
- 8.9.8 Where process flow in the pipeline cannot be stopped or isolated by any other means, isolation hand valves must be fitted on either side of electro-magnetic flow meters for removal/replacement of the flow meter.
- 8.9.9 The sensor material for flow meters used for flow distribution/diversion must be stainless steel.
- 8.9.10 Magnetic flow meters must be equipped with an "Empty Pipe" detection which is configurable to stop the 4-20mA flow indication and/or operate a potential free contact, or an output that can be used to drive a relay, for PLC interfacing.
- 8.9.11 Electro-magnetic flow meters must not be a wafer-type. I.e. the sensor tube or wafer must be housed in a flanged stainless steel spool piece which can readily be bolted onto flanges in the pipe where it must be installed.

8.10 Partially Filled Pipeline Or Channel Flow Measurement – Controller/Transmitter

- 8.10.1 Where electro-magnetic flow meters (e.g. for full pipes) or conventional ultrasonic flow meters (e.g. at weirs or venturi flumes) cannot be used, such as in partially filled pipes or open channels without a weir or venturi, area-velocity flow meters must be used. A liquid velocity measurement as well as a liquid depth measurement, together with the dimension of the pipe or channel which is programmed into the controller/transmitter, must then be used to produce a proportional flow measurement.
- 8.10.2 The flow measurement must be done by using ultrasonic, microwave or radar signals to measure both velocity and depth of liquid.
- 8.10.3 The controller/transmitter must have at least an IP66 rating or higher.
- 8.10.4 The controller/transmitter must have a backlit LCD display to display flow rate and total flow.
- 8.10.5 The error of the level measurement must not be more than 0.25% of the range and the error of the velocity must not exceed 2% of the velocity reading.
- 8.10.6 The repeatability and linearity must be 0.1% or better.
- 8.10.7 The unit must be suitable for use with a 230V AC supply.
- 8.10.8 The unit must have 3 x 4-20mA outputs, one for flow, one for level and one for velocity.
- 8.10.9 The unit must have at least 2 x SPDT relays, rated at no less than 2A at 230V AC. One of the relays must be programmable for flow pulses and the other must be programmable for flow and/or level alarm.
- 8.10.10 The unit must have at least 3 x 4-20mA outputs, one for velocity, one for level/depth and one for flow. These outputs will be connected to a maximum 500 ohm load.
- 8.10.11 The unit must be suitable for operating in temperatures ranging from minus 15°C to +60°C.

8.11 Partially Filled Pipeline Flow Measurement – Sensors/Transducers For Velocity Measurement

- 8.11.1 If the velocity sensor is installed below the water, the velocity sensor must be shaped and installed in such a manner that the cabling to it is protected from any debris that might flow in that pipe or channel.
- 8.11.2 The velocity sensor must be able to measure in a range of 0.03 to 6.2 m/sec and reverse flow of -1.5m/sec if a submerged sensor is used. If a non-submerged sensor is used, it must be able to measure in a range of 0.2 to 6 m/sec.
- 8.11.3 The velocity sensor must be suitable for operating in temperatures ranging from minus 15°C to +65°C.

8.11.4 The velocity sensor must be equipped with continuous, automatic temperature compensation.

8.12 Partially Filled Pipeline Flow Measurement – Sensors/Transducers For Level Measurement

8.12.1 The level sensor must have a low profile, in order to provide the maximum measuring distance in enclosed pipes.

8.12.2 The level sensor must have a measuring range of at least 3.66m and a minimum range (deadband) of not more than 203.2mm.

8.12.3 The level sensor must be suitable for operating in temperatures ranging from minus 15°C to +65°C.

8.12.4 The level sensor must be equipped with continuous, automatic temperature compensation.

8.13 Partially Filled Pipeline Flow Measurement – General

8.13.1 The submerged velocity sensor must not be installed in locations where sediment builds up.

8.13.2 The sensors must not be installed in locations where there is high water turbulence (the lower the turbulence, the higher the accuracy).

8.13.3 The sensors must be installed in locations where the velocity and level are equally distributed across the channel or pipe.

8.13.4 The channel or pipe where the sensors are installed must not have drops or direction changes immediately upstream of the sensors.

8.13.5 The slope of the pipe or channel where the sensors are installed must not exceed 3%.

8.13.6 Under no circumstances must sensors be installed in a manner or in a location which makes it impossible for site maintenance staff to access it for repairs or replacement later.

8.14 Gas Flow

8.14.1 The flow measurement must be done by using thermal dispersion technology, with a guaranteed drift-free operation and a turn down ratio up to 100:1 to measure volumetric gas flow. With thermal dispersion, two temperature probes are used. The first probe generates a temperature and the second one measures the dispersed temperature. Thermal dispersion measurement must be unaffected by changes in gas pressure or gas temperature. The sensor must also maintain a minimum accuracy of 2% of the reading $\pm 0.2\%$ of full scale for changes in gas composition as high as $\pm 2.5\%$ of CH₄.

8.14.2 The instrument must be equipped with a remote transmitter which can be mounted in an IJB located in an easily accessible location in a non-hazardous area for viewing, maintenance and repairs. The transmitter shall have a 10-digit LED display for indication of flow rate and totalised flow. Where compensating leads for Pt100s are used, the contractor must ensure that the cable between the sensor

and transmitter is installed as supplied by the supplier. I.e. cables must not be cut. Excess cable must be coiled up neatly at the IJB.

- 8.14.3 The instrument must be equipped with integrated compensation for humidity. The average biogas composition which will be used must be 60% Methane and 40% Carbon Dioxide.
- 8.14.4 All instrument transmitter enclosures must have at least an IP 67 or higher rating.
- 8.14.5 The instrument must be equipped with a 4 – 20mA output which will be connected to a maximum 500 ohm load, for instantaneous volumetric flow in m³/hr. It must also be equipped with a pulsed output for flow totalization.
- 8.14.6 The instrument must be suitable for use with a 24V DC power supply and it must have an EEx [i, e or d] rating, suitable for use in a Zone 1 area with Methane gas.
- 8.14.7 The sensor shall be of the insertion type with full stainless steel design. The housing shall be a compression-proof, dual compartment, stainless steel housing of material type DIN 1.4571 (316Ti). All sealing on the housing shall be done with Viton "O" rings.
- 8.14.8 The sensor must be equipped with a hot tapping unit for ease of insertion removal during normal digester operation. The compression fitting on the hot tapping unit must be with a metal-Viton elastomer design, resistant to pipe vibration and with a robust, threaded process connection for frequent mounting/dismounting of the sensor for inspection.
- 8.14.9 The sensor must be installed strictly in accordance with the supplier's recommendations and requirements. The sensor must be equipped with locating pins to ensure that the sensor cannot be replaced incorrectly after removal.
- 8.14.10 The range of the instrument must be suitable for the application (see items 8.4.8 and 8.4.9 of this specification)
- 8.14.11 The instrument must be suitable for an ambient operating temperature range of minus 20°C to +70°C and a process temperature operating range of minus 20°C to +120°C.
- 8.14.12 The instrument must be suitable for operating in a humidity range of 0 to 100% RH.

8.15 Spares

- 8.15.1 The tenderer will be required to provide a recommended spares list for three years maintenance. This item must be completed so that spares may be ordered as part of the capital contract. Tenderers ignoring this condition may be disqualified.

8.16 Hazardous Areas

- 8.16.1 If the flow meter is going to be used for any combustible gas flow measurement, the tenderer must ensure that there is a hazardous area classification for the area in which the instrument will be installed.
- 8.16.2 If no hazardous area classification exists, the tenderer must allow a suitable cost for the classification of all relevant areas and must clearly indicate this cost in either the Bill Of Quantities or in a covering letter.

- 8.16.3 The flow meter and associated equipment supplied must all be suitable for use in the hazardous area concerned.

8.17 Intrinsically Safe Installations

- 8.17.1 Where intrinsically safe (IS) installations are required the tenderer must allow a cost to have the IS design from the Engineer certified as safe and compliant with the relevant legal requirements. This certification can only be done by a suitably accredited organization or company.
- 8.17.2 Once the certified IS design has been installed, the installation must be certified as correct and in accordance with the certified design. The tenderer must allow a cost for the certification. This certification can only be done by a suitably accredited organization or company.
- 8.17.3 All instruments supplied for use in a hazardous area must have the hazardous area rating and classification (E.g. Ex ia IIC T5) and suitable marking as specified in SANS 10108, ARP 0108:2007, Annex B, indicated on the instrument and the instrument must be certified by an approved testing/certification body as listed in SANS 0108, ARP 0108:2007.

8.18 Data Sheets

- 8.18.1 All data sheets in the attached Appendix 1 must be completed.

APPENDIX 1

DATA SHEET – OPEN CHANNEL FLOW METER

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Power Supply (Voltage)	
Analogue Output Type & Programmable (Y/N)?	
Digital Output Type & Rating (E.g. SPDT, 230V AC, 5A) & Programmable (Y/N)?	
Controller/Transmitter Enclosure Rating	
Accuracy	
Resolution	
Programmable Totaliser (Y/N)?	
Display Data & Type (E.g. instantaneous & total LCD)	
Transducer/Sensor range	
Transducer/Sensor temperature operating range	
Transducer/Sensor temperature compensation (Y/N)?	
Transducer/Sensor enclosure rating	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

DATA SHEET – FULL PIPELINE FLOW METER (MAGNETIC)

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Power Supply (Voltage)	
Analogue Output Type & Programmable (Y/N)?	
Digital Output Type & Rating (E.g. SPDT, 230V AC, 5A or 24V DC output) & Programmable (Y/N)?	
Controller/Transmitter Enclosure Rating	
Accuracy	
Repeatability	
Programmable Totaliser (Y/N)?	
Display Data & Type (E.g. instantaneous & total LCD)	
Transducer/Sensor range	
Transducer/Sensor wafer-type or flange-type?	
Transducer/Sensor temperature operating range	
Transducer/Sensor temperature compensation (Y/N)?	
Transducer/Sensor enclosure rating	
Transducer/Sensor lining material	
Transducer/Sensor tube material	
Transducer/Sensor grounding details	
Transducer/Sensor equipped with "Empty Pipe" detection as specified (Y/N)?	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

DATA SHEET – FULL PIPELINE FLOW METER FOR DISTRIBUTION/DIVERSION

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Power Supply (Voltage)	
Analogue Output Type & Programmable (Y/N)?	
Digital Output Type & Rating (E.g. SPDT, 230V AC, 5A) & Programmable (Y/N)?	
Controller/Transmitter Enclosure Rating	
Accuracy	
Repeatability	
Programmable Totaliser (Y/N)?	
Display Data & Type (E.g. instantaneous & total LCD)	
Transducer/Sensor range	
Transducer/Sensor temperature operating range	
Transducer/Sensor material	
Transducer/Sensor rating	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

DATA SHEET – GAS FLOW METER

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Power Supply (Voltage)	
Analogue Output	
Hazardous area rating (E.G. Ex ia IIC T5)	
Hazardous classification certification body (E.G. CSA, CESI, DEMKO, DMT, LCIE, etc.) as approved by SANS 10108, ARP 0108:2007.	
Controller/Transmitter Enclosure Rating	
Accuracy	
Range	
Display Data & Type (E.g. instantaneous m ³ /hr LCD)	
Ambient temperature operating range	
Process temperature operating range	
Humidity range	
Sensor material	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

DATA SHEET – AREA-VELOCITY FLOW METER

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Power Supply (Voltage)	
Analogue Output Type & Programmable (Y/N)?	
No. Of Analogue Outputs	
Digital Output Type & Rating (E.g. SPDT, 230V AC, 2A) & Programmable (Y/N)?	
No. Of Relay Outputs	
Controller/Transmitter Enclosure Rating	
Velocity Accuracy	
Level Accuracy	
Repeatability & Linearity	
Programmable Totaliser (Y/N)?	
Display Data & Type (E.g. instantaneous & total LCD)	
Velocity Transducer/Sensor range	
Level Transducer/Sensor range	
Velocity Transducer/Sensor temperature operating range	
Level Transducer/Sensor temperature operating range	
Velocity Transducer/Sensor temperature compensation (Y/N)?	
Velocity Transducer/Sensor temperature compensation (Y/N)?	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

PARTICULAR SPECIFICATION
VOLUME 9 : LEVEL MEASUREMENT

Johannesburg Water (SOC) Ltd.
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DOCUMENT CONTROL SHEET

Document Title: Particular Specification – VOLUME 9 : Level Measurement

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DOCUMENT APPROVAL

ACTION	FUNCTION	NAME	DATE	SIGNATURE
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Reviewed	Engineer	L. Gobinca	2019-08-26	
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9 LEVEL MEASUREMENT

9.1 Scope

9.1.1 This specification covers the supply and installation of Level meters, complete with sensors, transmitters, indicators, panels, etc. used for process monitoring and control applications at Johannesburg Water wastewater sites.

9.2 Abbreviations

9.2.1 In this specification the following abbreviations will apply :-

BS	: British Standards
PLC	: Programmable Logic Controller
I/O	: Input/Output
CPU	: Central Processing Unit
UPS	: Uninterruptible Power Supply
MCC	: Motor Control Centre
MCB	: Miniature Circuit Breaker
SPD	: Surge Protection Device
FJB	: Field Junction Box
SSO	: Switched Socket Outlet
SPDT	: Single Pole Double Throw (refers to relay or switch contact arrangements).
LCD	: Liquid Crystal Display
LED	: Light Emitting Diode
O&M	: Operating And Maintenance

9.3 Standards

9.3.1 The supply and installation of all Level meters and associated cabling, panels and any other equipment shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 10142-1	: National Standards for the wiring of premises.
SANS 1091:2004	: National Colour Standard.
SANS 1274-2005	: Coatings applied by the powder-coating process.
BS 381C:1980	: Paint colour chart.

9.4 General Requirements

9.4.1 This specification must be read in conjunction with the following specifications:-

- 9.4.1.1 PLC Panels Specification (Volume 3 of the Automation And Control Standards).
- 9.4.1.2 Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).
- 9.4.1.3 Cabling Specification (Volume 6 of the Automation And Control Standards).
- 9.4.1.4 Load Cells And Their Installation
- 9.4.1.5 Labelling (Volume 25 of the Automation And Control Standards).
- 9.4.2 Where cables are exposed to physical damage (including damage from rodents) armoured cables must be used or un-armoured cables must be run in steel conduit.
- 9.4.3 All power supply cables to instruments must have a black outer sheath, while all control cables (such as digital and analogue signals to PLC's) must have an orange outer sheath as specified in the Cabling Specification (Volume 6 of the Automation And Control Standards).
- 9.4.4 FJB's and as far as practically possible all instrument sensors and transmitters, must be mounted such that all equipment, wiring, numbers, terminations, etc. are readily accessible and can be viewed clearly. No equipment may be mounted such that it becomes a hazard or dangerous to view or gain access to such equipment.
- 9.4.5 Where sensors and/or transmitters cannot be mounted where they are readily accessible, the installation must be done in such a way that the sensor or transmitter can easily be moved to a safe and convenient position for testing, maintenance, replacement, etc. (e.g. by using hinged brackets, telescopic brackets, etc.).
- 9.4.6 Where transmitters can be exposed to the elements (wind, rain, ultra violet, etc.) such transmitters must be installed inside the FJB. Where transmitters are protected from the elements (i.e. inside buildings) but they are exposed to potentially harmful conditions like moisture from splashing or equipment being hosed down, or the sensor is in such a position that the transmitter display is not clearly visible from floor level, without the need to climb onto ladders or structures to access it, the transmitter must also be installed inside the FJB. Only where transmitters are not exposed to the elements or any other harsh or potentially harmful conditions and where the displays on such transmitters are clearly legible by an average person standing on the ground or the normal walking surface (e.g. grating above ground level), can the transmitter be mounted outside the FJB.
- 9.4.7 FJB's must be mounted against a wall or structure or on a sturdy pedestal such that the top of the FJB enclosure is no higher than 1.8 m from the floor and easily accessible from the front.
- 9.4.8 All instrument installations must be done in accordance with the manufacturer's requirements and recommendations for proper operation. It is the tenderer's responsibility to ensure that he/she is familiar with both the requirements of the manufacturer as well as the installation requirements, in terms of location, site conditions, materials, equipment or substances to be measured (e.g. hot liquids, acids, abrasive material, etc.) and to ensure that if there are potential problems, they can be pointed out and rectified before orders for equipment are placed.
- 9.4.9 Costs incurred for alterations required to ensure proper operation of instruments, after orders have been placed, will be for the tenderer's account. For example, if

instruments have been ordered and it is found there is insufficient space to install the instrument, or the instrument is not flooded with liquid all the time as it is required for proper operation, or the instrument transmitter is sometimes flooded in its installed position, or the sensing head is sometimes outside the medium it is supposed to measure, or the instrument linings are damaged by abrasive liquids, or the sensor does not have a suitable range of measurement, etc. alterations or replacements required to rectify such problems will be for the tenderer's account if the Engineer finds that the tenderer was negligent in his/her assessment of the installation.

- 9.4.10 Each instrument must be equipped with a circuit breaker connected to the power supply of the instrument, to enable local isolation in case of repairs or replacement.
- 9.4.11 The supplier of the instrument must be present for the installation, testing and commissioning of the instrument on site. Due allowance must be made for this in the tender sum.
- 9.4.12 The tenderer must supply a complete and detailed set of documentation for the installation, connections, terminations, power supply, technical details, setting up, calibration (if applicable), testing, etc. of the instrument for inclusion in a final O&M manual.
- 9.4.13 Completed data sheets are required as part of the returnable documents of each tender. Failure to complete these data sheets, supplied at the end of this specification, will lead to disqualification of the tender.

9.5 Surge Protection

- 9.5.1 Each instrument and its associated equipment must be suitably protected against surges from induced voltages, switching of equipment, lightning strikes, etc. as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).
- 9.5.2 The power supply to the instrument must be equipped with suitable surge protection, both at the instrument and at the source of the power supply (i.e. at the distribution board, MCC, PLC panel, etc.), as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).
- 9.5.3 Both the digital and analogue signals between the instrument and other remote devices (such as the PLC), must be equipped with suitable surge protection, both at the instrument and at the remote device as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

9.6 Level Measurement – Controller/Transmitter

- 9.6.1 All level measurements must be done by using ultra-sonic distance measurement, which is converted into a level value.
- 9.6.2 All instrument transmitter enclosures must have at least an IP 65 or higher rating.
- 9.6.3 The instrument must be equipped with an isolated, active, 4 – 20mA output which will be connected to a maximum 500 ohm load. This output must be user-programmable.

- 9.6.4 The instrument must be equipped with at least three to five SPDT relays, rated for at least 230V AC, 2A, for preset level outputs. These outputs must be user-programmable for various levels.
- 9.6.5 The transmitter must be suitable for use with a 230V AC, 50/60 Hz power supply.
- 9.6.6 The transmitter must have an accuracy of at least 0.25% or 6mm, whichever is greater.
- 9.6.7 The transmitter must have a resolution of at least 0.1% or 2mm, whichever is greater.
- 9.6.8 The transmitter must have an LCD or LED display showing instantaneous level and relay status.

9.7 Level Measurement – Sensor/Transducer

- 9.7.1 The range of the sensor must be suitable for the application (see items 9.4.8 and 9.4.9 of this specification).
- 9.7.2 The sensor must be suitable for an operating temperature range of -10°C to +50°C.
- 9.7.3 The sensor must be equipped with automatic temperature compensation.
- 9.7.4 The sensor must have a protection rating of at least IP 67 or higher.
- 9.7.5 Brackets used for the mounting of ultra-sonic sensor heads must be made of at least 3CR12 grade stainless steel.

9.8 Spares

- 9.8.1 The tenderer will be required to provide a recommended spares list for three years maintenance. This item must be completed so that spares may be ordered as part of the capital contract. Tenderers ignoring this condition may be disqualified.

9.9 Labelling

- 9.9.1 All labelling must comply with the requirements as specified in the Labelling Specification (Volume 25 of the Automation And Control Standards).

9.10 Data Sheets

- 9.10.1 All data sheets in the attached Appendix 1 must be completed.

APPENDIX 1

DATA SHEET – LEVEL METER

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Power Supply (Voltage)	
Analogue Output Type & Programmable (Y/N)?	
Digital Output Quantity, Type & Rating (E.g. 5 x SPDT, 230V AC, 5A) & Programmable (Y/N)?	
Controller/Transmitter Enclosure Rating	
Accuracy	
Resolution	
Display Data & Type (E.g. instantaneous level & relay status LCD)	
Transducer/Sensor range	
Transducer/Sensor temperature operating range	
Transducer/Sensor temperature compensation (Y/N)?	
Transducer/Sensor enclosure rating	
Local agent (Y/N)?	
Local agent contact details.	
Guarantee period	

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

PARTICULAR SPECIFICATION
VOLUME 14 : TURBIDITY/SUSPENDED SOLIDS
MEASUREMENT

Johannesburg Water (SOC) Ltd.
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DOCUMENT CONTROL SHEET

Document Title: Particular Specification – VOLUME 14 : Turbidity/Suspended Solids Measurement

JW Reference: BW523C

Document Ref. No: VOLUME 14

DOCUMENT APPROVAL

ACTION	FUNCTION	NAME	DATE	SIGNATURE
Prepared	HOD	C. Du Toit	2019-08-26	
Reviewed	Engineer	L. Gobinca	2019-08-26	
Approved	Manager	A. Nkomo		

RECORD OF REVISIONS

Date	Revision	Author	Comments
2019-08-26	14	C. Du Toit	Cover page updated
2019-06-15	13	C. Du Toit	Revision approved by JW.
2018-11-30	12	C. Du Toit	Added reference to Labelling specification & included suspended solids measurement.
2014-04-17	11	C. Du Toit	Added reference to FJB specification and sensor flow
2013-10-07	10	C. Du Toit	Updated footer
2012-07-27	9	C. Du Toit	Updated headers & footers.
2012-03-08	8	C. Du Toit	Changed (Pty) to (SOC) and corrected range
2011-07-11	7	C. Du Toit	Removed 2010 logo.
2010-07-27	6	C. Du Toit	Transmitter relay rating altered.
2009-08-18	5	C. Du Toit	New logos and transmitter requirements added.
2009-03-25	4	C. Du Toit	JW Wastewater Partnership deleted & logos altered as per client's requirements.
2007-10-09	3	C. Du Toit	"Minimum" 500 ohm load changed to "Maximum"
2007-06-05	2	C. Du Toit	Revision block updated and "Joburg" logo added
2007-03-28	1	C. Du Toit	Final copy issued for approval and sign-off

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14 TURBIDITY /SUSPENDED SOLIDS MEASUREMENT

14.1 Scope

14.1.1 This specification covers the supply and installation of Turbidity meters, complete with sensors, transmitters, indicators, panels, etc. used for process monitoring and control applications at Johannesburg Water wastewater sites.

14.2 Abbreviations

14.2.1 In this specification the following abbreviations will apply :-

BS	: British Standards
PLC	: Programmable Logic Controller
I/O	: Input/Output
CPU	: Central Processing Unit
UPS	: Uninterruptible Power Supply
MCC	: Motor Control Centre
MCB	: Miniature Circuit Breaker
SPD	: Surge Protection Device
FJB	: Field Junction Box
SSO	: Switched Socket Outlet
SPDT	: Single Pole Double Throw (refers to relay or switch contact arrangements).
LCD	: Liquid Crystal Display
LED	: Light Emitting Diode
NTU	: Nephelometric Turbidity Unit (A measure of the cloudiness of water)
mg/l	: Milligram per litre
O&M	: Operating And Maintenance

14.3 Standards

14.3.1 The supply and installation of all Turbidity/Suspended Solids (other than mixed liquor suspended solids measurement in a bioreactor) meters and associated cabling, panels and any other equipment shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 10142-1	: National Standards for the wiring of premises.
SANS 1091:2004	: National Colour Standard.
SANS 1274-2005	: Coatings applied by the powder-coating process.
BS 381C:1980	: Paint colour chart.

14.4 General Requirements

- 14.4.1 This specification must be read in conjunction with the following specifications:-
- 14.4.1.1 PLC Panels Specification (Volume 3 of the Automation And Control Standards).
 - 14.4.1.2 Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).
 - 14.4.1.3 Cabling Specification (Volume 6 of the Automation And Control Standards).
 - 14.4.1.4 Field Junction Boxes And Panels (Volume 19 of the Automation And Control Standards).
 - 14.4.1.5 Labelling (Volume 25 of the Automation And Control Standards).
- 14.4.2 Where cables are exposed to physical damage (including damage from rodents) armoured cables must be used or un-armoured cables must be run in steel conduit.
- 14.4.3 All power supply cables to instruments must have a black outer sheath, while all control cables (such as digital and analogue signals to PLC's) must have an orange outer sheath as specified in the Cabling Specification (Volume 6 of the Automation And Control Standards).
- 14.4.4 FJB's and as far as practically possible all instrument sensors and transmitters, must be mounted such that all equipment, wiring, numbers, terminations, etc. are readily accessible and can be viewed clearly. No equipment may be mounted such that it becomes a hazard or dangerous to view or gain access to such equipment.
- 14.4.5 Where sensors and/or transmitters cannot be mounted where they are readily accessible, the installation must be done in such a way that the sensor or transmitter can easily be moved to a safe and convenient position for testing, maintenance, replacement, etc. (e.g. by using hinged brackets, telescopic brackets, etc.).
- 14.4.6 Where transmitters can be exposed to the elements (wind, rain, ultra violet, etc.) such transmitters must be installed inside the FJB. Where transmitters are protected from the elements (i.e. inside buildings) but they are exposed to potentially harmful conditions like moisture from splashing or equipment being hosed down, or the sensor is in such a position that the transmitter display is not clearly visible from floor level, without the need to climb onto ladders or structures to access it, the transmitter must also be installed inside the FJB. Only where transmitters are not exposed to the elements or any other harsh or potentially harmful conditions and where the displays on such transmitters are clearly legible by an average person standing on the ground or the normal walking surface (e.g. grating above ground level), can the transmitter be mounted outside the FJB.
- 14.4.7 FJB's must be mounted against a wall or structure or on a sturdy pedestal such that the top of the FJB enclosure is no higher than 1.8 m from the floor and easily accessible from the front.
- 14.4.8 All instrument installations must be done in accordance with the manufacturer's requirements and recommendations for proper operation. It is the tenderer's responsibility to ensure that he/she is familiar with both the requirements of the

manufacturer as well as the installation requirements, in terms of location, site conditions, materials, equipment or substances to be measured (e.g. hot liquids, acids, abrasive material, etc.) and to ensure that if there are potential problems, they can be pointed out and rectified before orders for equipment are placed.

- 14.4.9 Costs incurred for alterations required to ensure proper operation of instruments, after orders have been placed, will be for the tenderer's account. For example, if instruments have been ordered and it is found there is insufficient space to install the instrument, or the instrument is not flooded with liquid all the time as it is required for proper operation, or the instrument transmitter is sometimes flooded in its installed position, or the sensing head is sometimes outside the medium it is supposed to measure, or the instrument linings are damaged by abrasive liquids, or the sensor is does not have a suitable range of measurement, etc. alterations or replacements required to rectify such problems will be for the tenderer's account if the Engineer finds that the tenderer was negligent in his/her assessment of the installation.
- 14.4.10 Each instrument must be equipped with a circuit breaker connected to the power supply of the instrument, to enable local isolation in case of repairs or replacement.
- 14.4.11 The supplier of the instrument must be present for the installation, testing and commissioning of the instrument on site. Due allowance must be made for this in the tender sum.
- 14.4.12 The tenderer must supply a complete and detailed set of documentation for the installation, connections, terminations, power supply, technical details, setting up, calibration (if applicable), testing, etc. of the instrument for inclusion in a final O&M manual.
- 14.4.13 Completed data sheets are required as part of the returnable documents of each tender. Failure to complete these data sheets, supplied at the end of this specification, will lead to disqualification of the tender.

14.5 Surge Protection

- 14.5.1 Each instrument and its associated equipment must be suitably protected against surges from induced voltages, switching of equipment, lightning strikes, etc. as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).
- 14.5.2 The power supply to the instrument must be equipped with suitable surge protection, both at the instrument and at the source of the power supply (i.e. at the distribution board, MCC, PLC panel, etc.), as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).
- 14.5.3 Both the digital and analogue signals between the instrument and other remote devices (such as the PLC), must be equipped with suitable surge protection, both at the instrument and at the remote device as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

14.6 Turbidity/Suspended Solids Measurement – Controller/Transmitter

- 14.6.1 All turbidity/suspended solids measurements must be done by using a light scatter

operating principle.

- 14.6.2 All instrument transmitter enclosures must have at least an IP 65 or higher rating.
- 14.6.3 The instrument must be equipped with an isolated, active, 4 – 20mA output which will be connected to a maximum 500 ohm load. This output must be user-programmable for turbidity or suspended solids.
- 14.6.4 The instrument must be equipped with at least one to three SPDT relays, rated for at least 230V AC, 2A. Two relays for preset turbidity or suspended solids outputs and one relay for alarm status (i.e. transmitter failure, out of range measurement, etc.). The preset outputs must be user-programmable for various turbidity or suspended solids values.
- 14.6.5 The transmitter must be suitable for use with a 230V AC, 50/60 Hz power supply.
- 14.6.6 The transmitter must have an accuracy of at least 5% or 0.02 NTU, whichever is greater for turbidity. For suspended solids the accuracy must also be at least 5% of full scale.
- 14.6.7 The transmitter must have a resolution of at least 1% of full scale.
- 14.6.8 The transmitter must have an LCD or LED display, which will show instantaneous turbidity and relay status.

14.7 Turbidity/Suspended Solids Measurement – Transducer/Sensor

- 14.7.1 The range of the sensor must be from 0.00 to 99.9 mg/l for suspended solids and from 0 to 400 NTU for turbidity and must be suitable for the application (see items 14.4.8 and 14.4.9 of this specification). The low ranges are because these instruments will usually be used for measurement in final effluent. If not, it will be specified as such in the tender documentation or another document which will supersede the requirements in this specification.
- 14.7.2 The sensor must be suitable for an operating temperature range of 0°C to +50°C.
- 14.7.3 The sensor must have a protection rating of at least IP 67 or higher.
- 14.7.4 Brackets used for the mounting of the sensor must be made of at least 3CR12 grade stainless steel if the sensor is not used within a flow cell.
- 14.7.5 The sensor must be supplied, complete with a cleaning unit (air or water), equipped with a user-programmable cleaning cycle if the sensor is not used within a flow cell.

14.8 Spares

- 14.8.1 The tenderer will be required to provide a recommended spares list for three years maintenance. This item must be completed so that spares may be ordered as part of the capital contract. Tenderers ignoring this condition may be disqualified.

14.9 Data Sheets

- 14.9.1 All data sheets in the attached Appendix 1 must be completed.

APPENDIX 1

DATA SHEET – TURBIDITY METER

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Operating principle	
Power Supply (Voltage)	
Analogue Output Type & Programmable (Y/N)?	
Digital Output Quantity, Type & Rating (E.g. 3 x SPDT, 230V AC, 5A) & Programmable (Y/N)?	
Controller/Transmitter Enclosure Rating	
Accuracy	
Resolution	
Display Data & Type (E.g. instantaneous Turbidity & relay status LCD).	
Transducer/Sensor Turbidity/Suspended Solids range (Show range applicable to this application)	
Transducer/Sensor temperature operating range	
Transducer/Sensor enclosure rating	
Transducer/Sensor cleaning system type & programmable (Y/N)?	
Local agent (Y/N)?	
Local agent contact details	
Guarantee period	

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

PARTICULAR SPECIFICATION
VOLUME 19 : FIELD JUNCTION BOXES AND
PANELS

Johannesburg Water (SOC) Ltd.
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DOCUMENT CONTROL SHEET

Document Title: Particular Specification – VOLUME 19 : Field Junction Boxes And Panels

JW Reference: BW523C

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DOCUMENT APPROVAL

ACTION	FUNCTION	NAME	DATE	SIGNATURE
Prepared	HOD	C. Du Toit	2019-08-26	
Reviewed	Engineer	L. Gobinca	2019-08-26	
Approved	Manager	T. Thabeng		

RECORD OF REVISIONS

Date	Revision	Author	Comments
2019-08-26	19	C. Du Toit	Cover page updated
2019-08-14	18	C. Du Toit	Use of materials in corrosive areas updated (GRP)
2019-06-25	17	C. Du Toit	Stopper plugs used updated.
2019-06-15	16	C. Du Toit	Cable terminations plus wiring and terminations updated to correspond with that in PLC Panels and
2019-01-28	15	C. Du Toit	Included Cydna requirement for no direct sunlight on display units.
2018-11-30	14	C. Du Toit	Updated reference to Labelling specification, IJBs should not cause obstruction, clearing to be created
2014-04-17	13	C. Du Toit	Updated FJB stands and labelling
2013-10-07	12	C. Du Toit	Updated footer and racking on IJB stands
2012-07-27	11	C. Du Toit	Updated headers & footers.
2012-03-08	10	C. Du Toit	Added Polycarbonate boxes and updated labelling requirements.

2012-03-08	9	C. Du Toit	Changed required paint thickness for IJBs, added requirements for supports/brackets and changed (Pty)
2011-07-11	8	C. Du Toit	Removed 2010 logo.
2010-07-27	7	C. Du Toit	Altered minimum panel powder coating thickness & hinges material.
2010-03-12	6	C. Du Toit	Altered submission time of FJB panel drawings.
2009-08-18	5	C. Du Toit	New logos and data display viewing requirements
2009-03-25	4	C. Du Toit	JW Wastewater Partnership deleted & logos altered as per client's requirements.
2008-10-08	3	C. Du Toit	"Joburg" & "JW" Logos added to top & partnership logos removed.
2007-06-05	2	C. Du Toit	Revision block updated and "Joburg" logo added
2007-03-28	1	C. Du Toit	Final copy issued for approval and sign-off

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19 **FIELD JUNCTION BOXES AND PANELS**

19.1 **Scope**

19.1.1 This specification covers the manufacturing, supply and installation of Field Junction Boxes, Field Equipment Panels and any other panels used for housing terminals, surge protection devices, instruments, control switchgear (such as pushbuttons, selector switches, indicating lamps, potentiometers, etc.) for process monitoring and control applications at Johannesburg Water wastewater sites.

19.2 **Abbreviations**

19.2.1 In this specification the following abbreviations will apply :-

BS	: British Standards
PLC	: Programmable Logic Controller
I/O	: Input/Output
MCB	: Miniature Circuit Breaker
LPZ	: Lightning Protection Zone
SPD	: Surge Protection Device

19.3 **Standards**

19.3.1 All design standards for cabling shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 10142-1	: National Standards for the wiring of premises.
SANS 1091:2004	: National Colour Standard.
SANS 1274-2005	: Coatings applied by the powder-coating process.
BS 381C:1980	: Paint colour chart.

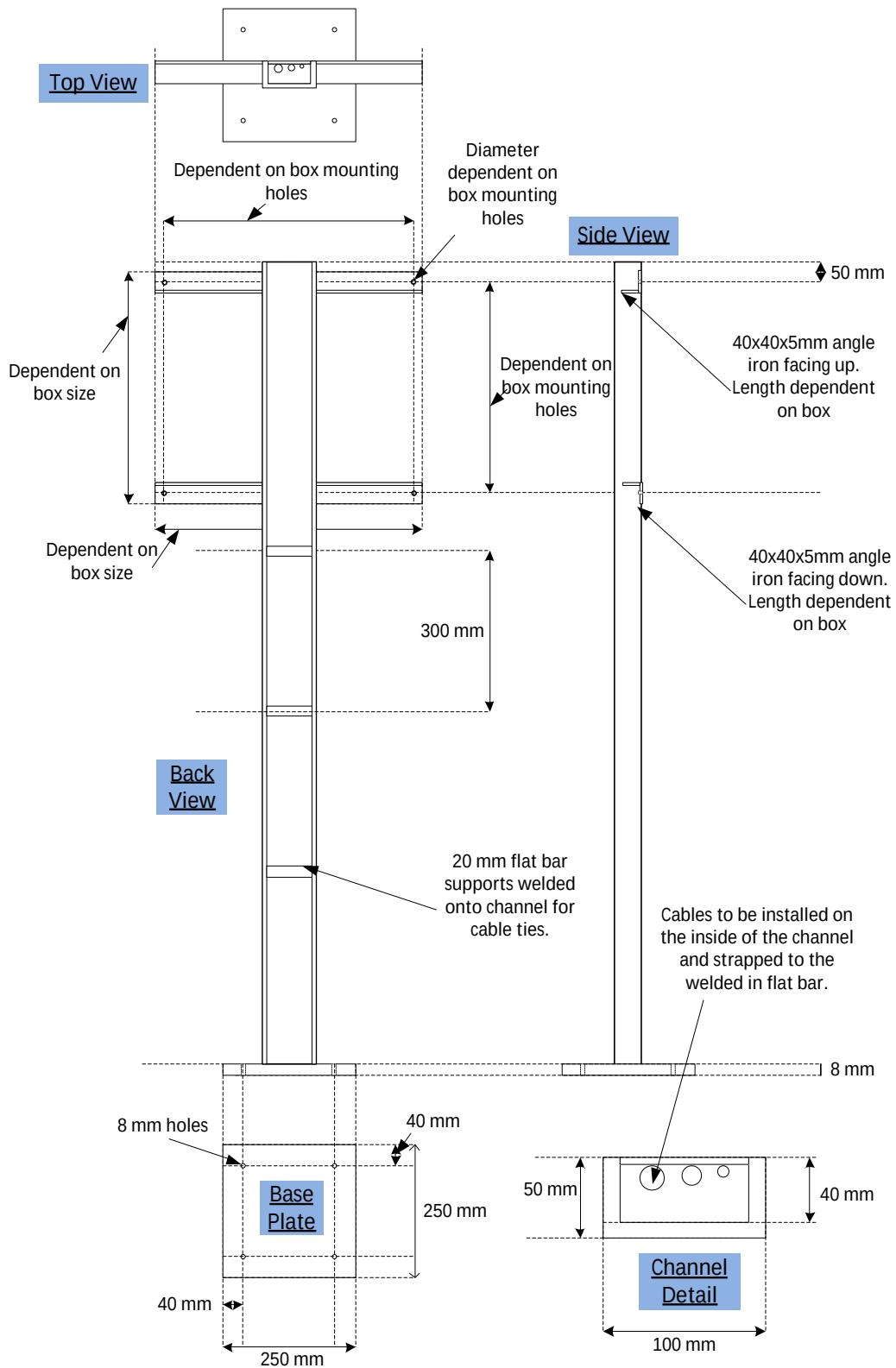
19.4 **General Requirements**

19.4.1 The Field Panel will typically house the following items:-

- 19.4.1.1 Terminals, fuses, MCB's, trunking, surge protection, relays, etc.
- 19.4.1.2 Pushbuttons, selector switches, potentiometers, indicating lamps, etc.
- 19.4.1.3 Power supplies, indicating instruments, etc.
- 19.4.1.4 Instruments such as transmitters.

19.4.2 The supply and installation shall in general comply with the relevant clauses in all specifications attached to the tender documentation.

- 19.4.3 The panels shall be free standing units with bottom cable entry (via a glanding plate) and have front door access (hinged and lockable).
- 19.4.4 For areas other than those mentioned in item 19.4.12 below, the panel should be manufactured from at least 3CR12 grade stainless steel typically not less than 1,5 mm thick. All hinges, locking devices, bolts, nuts and washers must also be at least 3CR12 stainless steel. The panel will have a door on the front which opens to the full width and height of the panel. The panel shall be free standing and the top edge of the panel shall not be more than 1,8m above floor level and it should be sized to accommodate all the associated equipment comfortably.
- 19.4.5 Once the door is open there should be no obstruction to prevent full access to every point inside the panel.
- 19.4.6 The panel shall be epoxy powder coated electric orange (Shade B26) finish. Interior chassis mounting plates will be finished in appliance white.
- 19.4.7 All IJBs should be clearly labelled with labels as specified in the Labelling Specification (Volume 25 of the Automation And Control Standards).
- 19.4.8 The panel must be vermin-proof and must have a protection rating of no less than IP 65.
- 19.4.9 Where equipment such as pushbuttons, selector switches, potentiometers, etc. are required on the panel exterior, a double door system must be used. The equipment must be mounted on a hinged door, which in turn is located inside a second hinged door fitted with a transparent panel so that all relevant equipment can be viewed without the need to open this external door. This external door with the glass panel must ensure that the IP 65 protection rating is not compromised by the fitting of equipment such as pushbuttons, switches, etc.
- 19.4.10 Where outer doors are equipped with transparent panels, such a panel must consist of a material that will not deteriorate significantly due to its exposure to the elements such as ultra-violet radiation, heat, wind, rain, etc. Glass panels will be preferred.
- 19.4.11 Where there are no existing structures against which the panel can be mounted, a sturdy stand (see the picture below), or mounting bracket must be manufactured of the same material as the panel (i.e. at least 3CR12 grade stainless steel), painted to the same specification and in the same colour as the panel. A ladder type cable rack of suitable width to accommodate all the cabling, plus at least 10% spare space must be fitted to the stand or structure to enable proper securing of the cables, if the cables cannot comfortably be run inside the channel used for the stand or if there is no stand (i.e. where brackets or wall-mounting is used). The cable racking must comply with all the requirements in the Cabling Specification (Volume 6 of the Automation And Control Standards).



- 19.4.12 Field junction boxes used inside Elutriation Terrace pump stations or in areas within 10m or less of Ferric Chloride, Sodium Hypochlorite or Chlorine shall be manufactured from Polycarbonate. All bolts, nuts, spring washers, etc. shall be 316 grade stainless steel, painted with 2K poly urethane paint, for all these applications. A sample of the panel must be approved by the engineer before manufacturing or purchasing commences. Channels or other sections used for securing of these junction boxes should be made from GRP (Glass Reinforced Polyester). Where transparent covers are used, they must be high visibility Polycarbonate with UV filtration. Since these Polycarbonate panels are used in highly corrosive atmospheres, they must contain as little metal as possible. Hinges, locking devices, etc. wherever possible, should also be Polycarbonate. All cable glands must be totally encapsulated glands (envirogland type) as shown in the example below.



- 19.4.13 The GRP profile (cable rack or equipment support) shall consist of pultruded (i.e. a continuous process of pulling material, such as **glass fiber** and resin, through a shaped die for manufacturing of composite materials with constant cross-section), e-glass roving and e-glass multi-axial fabric strength mat, sandwiched between polyester synthetic veil or tissue of minimum 35 gram/ m², all of which is encased in an isophthalic vinyl-ester resin. The resin must contain UV stabiliser. It must also contain pigment to provide colour and additional environmental protection. The rack or support must be cleaned and de-greased before it is painted with a 2K automotive or industrial poly urethane paint.
- 19.4.14 IJB's shall not be installed such that they obstruct passageways or are close to the road where moving objects such as vehicles, forklifts etc. can damage the IJB.
- 19.4.15 Where cable junction boxes, terminal boxes or terminations in instruments or any other panels in the field take place it must be ensured that such a junction box, termination box, instrument, etc. is not exposed to fire hazards from burning grass or other vegetation. If such a termination point is out in the open field (e.g. where grass grows below and/or around it), a clear area of at least 2.5m radius around this termination point must be provided. This must be a permanent clearing, such as a cement or concrete surface. A mere clearing of vegetation which can grow back again will not be accepted.

19.5 Standard Features

- 19.5.1 Each panel shall have the following features as standard:-
- 19.5.1.1 No ventilation fans shall be mounted in the panel and thereby compromise the protection rating.
 - 19.5.1.2 No holes may be drilled for tapping, riveting, bolts & nuts, etc. in any section of the panel where it will compromise the protection rating of the panel. I.e. only in the first (i.e. inner) door of a 2-door panel, in the backing plate or in the glanding plate may holes be drilled. Where drilling is unavoidable, e.g. to affix labels, the holes must be sealed so that the protection rating of the

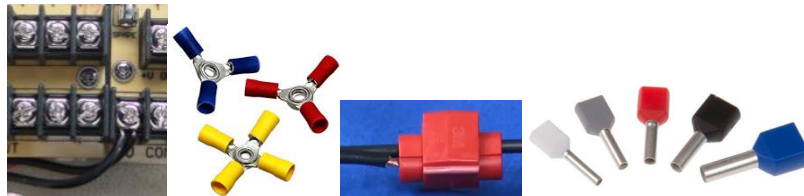
panel is not compromised.

- 19.5.1.3 Bolts with nuts shall not be used to attach equipment to any mounting plate at any point. On mounting plates only bolts in tapped holes will be acceptable. Bolts with nuts will be allowed on enclosure doors however, where the bolts and nuts are easily accessible.
- 19.5.1.4 Where bolts are used on the door or any outside panels of the enclosure, a sealing method (e.g. rubber washers) must be used to ensure that the IP protection rating of the enclosure is not compromised.
- 19.5.1.5 Wherever bolts are used, the bolts must be as short as practically possible so that there are no long protrusions that can injure people or snag clothing, wiring, other equipment, etc. If bolts are cut to the correct length, the ends of the bolts must be neatly de-burred and smoothed so that there are no sharp edges that can cause injuries and so that the nuts can be easily screwed on and off. No more than four threads of the bolt end must be visible beyond the nut. It is however preferred that the correct length of bolts are used so that shortening is not required.
- 19.5.1.6 A copper earth bar running the width of the panel at the bottom with solid electrical connection to the panel doors and to the steel of the panel at two or more places and provided with terminals for connection of equipment and screen earth wires.
- 19.5.1.7 Terminals and equipment of the same voltage must be grouped together, while terminals and equipment of different voltages must be clearly marked and separated by at least 50mm or by suitable insulated barriers to ensure that inadvertent contact or accidental terminations in the wrong place are avoided. Where such barriers are used between terminals of different voltages, these barriers must be larger than the terminals (i.e. standard terminal end barriers will not be acceptable) to ensure that there is a clear separation and to avoid accidental incorrect terminations.
- 19.5.1.8 Where the panel will be installed out in the open (i.e. not in an area where it is in the shade), the panel must be equipped with a cover which will provide shade for the panel while allowing air flow between the panel and the cover. Such panels should as far as practically possible be installed to face South and the cover should ensure that all transmitters, analysers, pushbuttons, lamps, etc. are protected from direct sunlight. It must be ensured that transmitter LED/LCD displays are **never** exposed to direct sunlight.
- 19.5.1.9 Where stopper plugs are used to seal holes that are not used, no plastic stopper plugs will be acceptable. All stopper plugs must be threaded, non-corrodible, metal plugs with rubber washers on both sides of the panel to ensure at least an IP65 seal (see examples below).



19.6 Wiring and Terminals

- 19.6.1 All terminals shall be screw type terminals and shall be mounted on raised DIN terminal rail, secured to the chassis plate at the back of the panel.
- 19.6.2 Proprietary type wire strippers shall be used and no stranded conductor shall be terminated if one or more strands have been damaged.
- 19.6.3 Not more than one wire shall be connected to any terminal unless the terminal can accept pin lugs on either side of a screw or unless proper connecting material is used (see examples below).



Every wire shall be marked at both ends with a numbering system as specified in the Labelling Specification (Volume 25 of the Automation And Control Design Standards), or if approved by the Engineer, and all terminating wires shall also be suitably crimped to a terminal lug. Not more than one wire shall be crimped into a single lug. Bare wire terminations will not be accepted.

- 19.6.4 All wiring shall be flexible, tinned, annealed, multi-strand copper wire not less than:-
- 19.6.4.1 1,5mm² for 230V AC or 110V AC power
 - 19.6.4.2 1,0mm² for 24V DC or AC power
 - 19.6.4.3 0,5mm² for all PLC I/O wiring between modules and marshalling terminals
 - 19.6.4.4 4,0mm² for earth drain
- 19.6.5 Irrespective of the minimum wire sizes allowed in this specification, contractors must ensure that all cables and wiring are capable of carrying the full system currents, inclusive of de-rating factors as specified in SANS 10142-1:2003 as amended.
- 19.6.6 All wire terminations must be done by using suitable lugs. Where pin lugs are crimped onto the ends of wires, correctly sized pin lugs must be used, which fit into the terminals properly and such that the tightening of the terminal does not result in the loosening of the pin lug.
- 19.6.7 All panel wiring shall run in suitable sized slotted trunking for as much of their course as possible, thereafter in spiral band or similar conduit to its destination if the exposed run would exceed 100mm.
- 19.6.8 The distance between the terminals and the trunking or between equipment (such as relays, surge protection, circuit breakers, etc.) and trunking shall not be less than 50mm.
- 19.6.9 Control wiring should not run with power wiring and all cross-overs shall be at ninety degrees.
- 19.6.10 Each analogue and digital input and output to and from the PLC shall have surge protection units as specified in the Clean Power And Surge Protection Specification

(Volume 5 of the Automation And Control Standards).

19.6.11 Internal wiring shall be colour coded as follows:-

19.6.11.1	<u>230V AC Power</u>	
	Live	Brown
	Neutral	Blue
	Earth	Green and Yellow
19.6.11.2	<u>24V DC Power</u>	
	Positive	Red
	Negative	Black
19.6.11.3	<u>Digital Inputs</u>	
	230V AC	Yellow
	24V DC	Red
19.6.11.4	<u>Digital Outputs</u>	
	230V AC	Grey
	24V DC	Red
19.6.11.5	<u>Relay Outputs</u>	
	230V AC	Grey
	24V DC	Red
19.6.11.6	<u>Analogue Signals</u>	
	Positive	Orange
	Negative	Purple

19.6.12 A terminal section for AC and DC power distribution shall be included in the panel where both voltages are used for equipment power supplies. The terminal groups shall be clearly identified to indicate the various voltages.

19.6.13 All wiring must be continuous from one termination (in a terminal strip or device such as a relay, contactor, surge arrester, etc.) to the next. No spliced wiring will be accepted.

19.7 Existing Panels

19.7.1 All modifications and wiring changes to existing panels must comply with the specifications as laid down for new panels.

19.8 Factory Acceptance

19.8.1 Before delivery of the panels, a comprehensive system factory acceptance test must take place. The Engineer must be notified one week in advance of the proposed test.

19.8.2 The test shall comprise of at least, but not be limited to:

- 19.8.2.1 Checking the panel manufacturing and assembly for compliance with this specification.
- 19.8.2.2 Layout, numbering and labelling of equipment.

- 19.8.2.3 Wiring – sizes, numbering, colours, termination, etc.
- 19.8.2.4 Wiring as per drawings, I/O schedules, etc. (i.e. loop checks).

19.9 Over-Voltage/Lightning Protection

- 19.9.1 The function of the over-voltage/lightning protection units is to prevent damage from occurring to the electrical and electronic devices due to destructive voltages, by resistive coupling, capacitive coupling or inductive coupling, arising from extraneous events such as lightning discharges, switching surges etc. All lightning and surge protection must be in accordance with the requirements in the Clean Power And Surge Protection specification (Volume 5 of the Automation And Control Design Standards).
- 19.9.2 The SPD's on all incoming power supplies to the panel shall be in accordance with the LPZ in which the panel is and must comply with the requirements of SANS 10142-1:2003 Annex L. Even if the LPZ dictates that class III surge protection is required, at least class II surge protection must be installed.
- 19.9.3 All analogue and digital input and output circuits shall be in accordance with the LPZ in which the panel is and must comply with the requirements of SANS 10142-1:2003 Annex L. and even if the LPZ dictates that class III surge protection is required, at least class II surge protection must be installed. for protection of these circuits.

19.10 Spares

- 19.10.1 The tenderer will be required to provide at least 10% spare fuses and other consumable items which may be required during commissioning. In addition to commissioning spares, a recommended spare list for three years maintenance, should be submitted. This item must be completed so that spares may be ordered as part of the capital contract. Tenderers ignoring this condition may be disqualified.

19.11 Painting (Powder Coating Method)

19.11.1 General

Switchboards and panels shall be epoxy powder coated in accordance with Type 1 coatings to SANS 1274-2005.
Unless specified otherwise, a high gloss finish in the following colour shall be provided:
Colour - Light Orange, Colour No. B26, Munsell Ref. 2,5 YR C/14 to SANS 1091 : 2004 and Colour No. 381C-557 to BS 381C : 1980.
Paintwork must be guaranteed against blistering, peeling, cracking and general deterioration which can lead to rusting, corrosion, etc. for a period of no less than three years. If the tenderer cannot comply with this requirement, it must be clearly stated as such in the tender.

19.11.2 Specifications

The following specifications in accordance with SANS 1274-2005 shall be provided:-

<u>Property</u>	<u>Requirement</u>	<u>Test Method</u>
Thickness, minimum	50 micron	6,7
Marking Resistance (400g)	No marking	6.20
Impact Resistance, J, minimum	6,78	6.10

Water Resistance, h, minimum	720	6.13
Humidity resistance, h, minimum	1000	6.14
Resistance to salt fog, h, minimum	1000	6.16

19.11.3 **Surface Preparation**

Surface preparation of sheet steel components shall be carried out by means of the multi-bath zinc phosphate/chromate passivation treatment.

All fabricated sheet steel components are to be degreased and de-rusted ready for treatment.

A steel surface is considered ready for treatment when all dirt, grease, rust, mill scale, moisture or other contaminants have been removed in an alkaline degreaser to give a dry, clean, bright, metallic surface.

Steel plate less than 4mm thick - black steel sheet shall be pickled to white metal condition while pre-pickled, bright, cold rolled sheet steel shall be solvent cleaned.

These surfaces shall be treated within eight hours in all cases while still uncontaminated and rust-free.

The prepared steel surface shall be treated by means of immersion in a heated zinc phosphate solution bath, rinsing and thereafter chromate passivated by means of immersion in the final treatment bath.

19.11.4 **Powder Coating**

A thermosetting powder consisting of epoxy/polyester resin shall be applied by means of an electrostatic spray gun to give a uniform coating thickness of 50 to 60 micron. Less than 50 micron will not be acceptable.

The powder coating shall be baked at a metal temperature of 185°C so as to melt the powders to form a continuous film over the metal substrate.

19.12 **Drawings And Diagrams**

19.12.1 The tenderer must submit layout drawings, showing the panel size, cable entry, location of equipment, details of equipment (such as trunking size, circuit breakers, fuses, terminals, etc.), panel colour, material of construction (e.g. 2mm 3CR12 SS), etc. for approval by the Engineer before any manufacturing commences.

19.12.2 The drawings must be accompanied with data lists of the proposed equipment. These data sheets must show the type, supplier, make, model, size, etc. of equipment where applicable. For example:

Terminals	- Phoenix SK12, 4mm, white.
MCB's	- Merlin Gerin, 5A, 10kA, single-pole.
Etc.	

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

PARTICULAR SPECIFICATION
VOLUME 23 : PRESSURE MEASUREMENT

Johannesburg Water (SOC) Ltd.
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DOCUMENT CONTROL SHEET

Document Title: Particular Specification – VOLUME 23 : Pressure Measurement

JW Reference: BWW523C

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Approved	Manager	T. Thabeng		

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23 PRESSURE MEASUREMENT

23.1 Scope

23.1.1 This specification covers the supply and installation of Pressure meters, complete with sensors, transmitters, indicators, panels, etc. used for process monitoring and control applications at Johannesburg Water wastewater sites.

23.2 Abbreviations

23.2.1 In this specification the following abbreviations will apply :-

BS	: British Standards
PLC	: Programmable Logic Controller
I/O	: Input/Output
CPU	: Central Processing Unit
UPS	: Uninterruptible Power Supply
MCC	: Motor Control Centre
MCB	: Miniature Circuit Breaker
SPD	: Surge Protection Device
FJB	: Field Junction Box
SSO	: Switched Socket Outlet
SPDT	: Single Pole Double Throw (refers to relay or switch contact arrangements).
LCD	: Liquid Crystal Display
LED	: Light Emitting Diode
O&M	: Operating And Maintenance

23.3 Standards

23.3.1 The supply and installation of all Pressure meters and associated cabling, panels and any other equipment shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 10142-1	: National Standards for the wiring of premises.
SANS 1091:2004	: National Colour Standard.
SANS 1274-2005	: Coatings applied by the powder-coating process.
BS 381C:1980	: Paint colour chart.

23.4 General Requirements

23.4.1 This specification must be read in conjunction with the following specifications:-

- 23.4.1.1 PLC Panels Specification (Volume 3 of the Automation And Control Standards).
- 23.4.1.2 Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).
- 23.4.1.3 Cabling Specification (Volume 6 of the Automation And Control Standards).
- 23.4.1.4 Field Junction Boxes And Panels (Volume 19 of the Automation And Control Standards).
- 23.4.1.5 Labelling (Volume 25 of the Automation And Control Standards).
- 23.4.2 Where cables are exposed to physical damage (including damage from rodents) armoured cables must be used or un-armoured cables must be run in steel conduit.
- 23.4.3 All power supply cables to instruments must have a black outer sheath, while all control cables (such as digital and analogue signals to PLC's) must have an orange outer sheath as specified in the Cabling Specification (Volume 6 of the Automation And Control Standards).
- 23.4.4 FJBs and as far as practically possible all instrument sensors and transmitters, must be mounted such that all equipment, wiring, numbers, terminations, etc. are readily accessible and can be viewed clearly. No equipment may be mounted such that it becomes a hazard or dangerous to view or gain access to such equipment.
- 23.4.5 Where sensors and/or transmitters cannot be mounted where they are readily accessible, the installation must be done in such a way that the sensor or transmitter can easily be moved to a safe and convenient position for testing, maintenance, replacement, etc. (e.g. by using hinged brackets, telescopic brackets, etc.).
- 23.4.6 Where transmitters can be exposed to the elements (wind, rain, ultra violet, etc.) such transmitters must be installed inside the FJB. Where transmitters are protected from the elements (i.e. inside buildings) but they are exposed to potentially harmful conditions like moisture from splashing or equipment being hosed down, or the sensor is in such a position that the transmitter display is not clearly visible from floor level, without the need to climb onto ladders or structures to access it, the transmitter must also be installed inside the FJB. Only where transmitters are not exposed to the elements or any other harsh or potentially harmful conditions and where the displays on such transmitters are clearly legible by an average person standing on the ground or the normal walking surface (e.g. grating above ground level), or where it is not practically possible (for example where a transmitter is screwed directly into a socket in a pipe or vessel), can the transmitter be mounted outside the FJB.
- 23.4.7 FJBs must be mounted against a wall or structure or on a sturdy pedestal such that the top of the FJB enclosure is no higher than 1.8 m from the floor and easily accessible from the front.
- 23.4.8 All instrument installations must be done in accordance with the manufacturer's requirements and recommendations for proper operation. It is the tenderer's responsibility to ensure that he/she is familiar with both the requirements of the manufacturer as well as the installation requirements, in terms of location, site conditions, materials, equipment or substances to be measured (e.g. hot liquids, acids, abrasive material, etc.) and to ensure that if there are potential problems, they can be pointed out and rectified before orders for equipment are placed.

- 23.4.9 Costs incurred for alterations required to ensure proper operation of instruments, after orders have been placed, will be for the tenderer's account. For example, if instruments have been ordered and it is found there is insufficient space to install the instrument, or the instrument is not flooded with liquid all the time as it is required for proper operation, or the instrument transmitter is sometimes flooded in its installed position, or the sensing head is sometimes outside the medium it is supposed to measure, or the instrument linings are damaged by abrasive liquids, or the sensor does not have a suitable range of measurement, etc. alterations or replacements required to rectify such problems will be for the tenderer's account if the Engineer finds that the tenderer was negligent in his/her assessment of the installation.
- 23.4.10 Each instrument must be equipped with a circuit breaker connected to the power supply of the instrument, to enable local isolation in case of repairs or replacement.
- 23.4.11 The supplier of the instrument must be present for the installation, testing and commissioning of the instrument on site. Due allowance must be made for this in the tender sum.
- 23.4.12 The tenderer must supply a complete and detailed set of documentation for the installation, connections, terminations, power supply, technical details, setting up, calibration (if applicable), testing, etc. of the instrument for inclusion in a final O&M manual.
- 23.4.13 Completed data sheets are required as part of the returnable documents of each tender. Failure to complete these data sheets, supplied at the end of this specification, will lead to disqualification of the tender.

23.5 Surge Protection

- 23.5.1 Each instrument and its associated equipment must be suitably protected against surges from induced voltages, switching of equipment, lightning strikes, etc. as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).
- 23.5.2 The power supply to the instrument must be equipped with suitable surge protection, both at the instrument and at the source of the power supply (i.e. at the distribution board, MCC, PLC panel, etc.), as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).
- 23.5.3 Both the digital and analogue signals between the instrument and other remote devices (such as the PLC), must be equipped with suitable surge protection, both at the instrument and at the remote device as detailed in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

23.6 Pressure Measurement – Controller/Transmitter

- 23.6.1 All instrument transmitter enclosures must have at least an IP 65 or higher rating.
- 23.6.2 The instrument must be equipped with a 4 – 20mA output which will be connected to a maximum 500 ohm load. If a pressure switch is required, the instrument must be equipped with two digital outputs of which the pressure operating value can be adjusted.

- 23.6.3 The transmitter must be equipped with an LCD or LED display to show the instantaneous pressure (for analogue or digital (pressure switch) instruments).
- 23.6.4 The transmitter must be mounted inside and IJB (Instrument Junction Box) which will be located in a suitable area for viewing, maintenance, etc. I.e. instruments with a transmitter local to the sensor will not be accepted.
- 23.6.5 The transmitter must have an error of not more than 0.2% of the full scale value for analogue instruments. This error must include non-linearity, hysteresis, repeatability plus zero-point and full scale deviations. If the error is defined by the maximum deviation of the transmitter output from a best fit straight line (B.F.S.L) in any one calibration cycle, this error must not be greater than 0.1% of the span (or full scale value). For digital instruments (pressure switch) the combined error (including non-linearity, hysteresis, zero point and full scale error) must not be greater than 1%.
- 23.6.6 The transmitter must be suitable for an ambient operating temperature range of -10°C to +50°C.

23.7 Pressure Measurement – Sensor/Transducer

- 23.7.1 All pressure measurements must be done by using a threaded instrument with a flush diaphragm sensor to ensure that there are no parts protruding into a pipe or vessel and which can lead to snagging of material in the medium being measured.
- 23.7.2 The range of the sensor must be suitable for the application (see items 23.4.8 and 23.4.9 of this specification).
- 23.7.3 The sensor must be suitable for an operating temperature range of -10°C to +100°C.
- 23.7.4 The sensor must be equipped with automatic temperature compensation.
- 23.7.5 The sensor must have an overpressure safety of not less than 1.33 times the measuring range.
- 23.7.6 The sensor diaphragm material must be ceramic.

23.8 Spares

- 23.8.1 The tenderer will be required to provide a recommended spares list for three years maintenance. This item must be completed so that spares may be ordered as part of the capital contract. Tenderers ignoring this condition may be disqualified.

23.9 Data Sheets

- 23.9.1 All data sheets in the attached Appendix 1 must be completed.

APPENDIX 1

DATA SHEET – PRESSURE METER

DESCRIPTION	DATA
Make/Manufacturer	
Type/Model	
Power Supply (Voltage)	
Analogue Output Type	
Digital Output Quantity, Type & Rating (E.g. 2 x PNP, 250mA) & Programmable (Y/N)?	
Controller/Transmitter Enclosure Rating	
Controller/Transmitter Accuracy	
Resolution	
Display Data & Type (E.g. instantaneous pressure & LCD)	
Transmitter ambient temperature range	
Sensor temperature operating range	
Sensor process connection - Flush diaphragm (Y/N)?	
Transducer/Sensor temperature compensation (Y/N)?	
Sensor overpressure safety rating (??? times range)	
Local agent (Y/N)?	
Local agent contact details.	
Guarantee period	

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

PARTICULAR SPECIFICATION
VOLUME 25 : LABELLING

Johannesburg Water (SOC) Ltd.
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2018-11-30	A	C. Du Toit	Initial revision issued for comment/approval

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25 LABELLING

25.1 Scope

25.1.1 The purpose of this document is to cover the requirements for the supply and installation of labels on all C&I equipment, cables, wires, and panels.

25.1.2 If there is a discrepancy between the requirements of this specification and the requirements in the tender Scope of Work, the Scope of Work will take precedence.

25.2 Abbreviations

25.2.1 In this specification the following abbreviations will apply :-

Contractor : The persons/s named as a contractor in the letter of tender accepted by the employer.

Employer : The person/entity named as Employer in the tender, and the legal successors in title to this person.

Engineer : The person appointed by the Employer to act as Engineer for the purposes of this contract.

BS : British Standards

ICP : Instrument Control Panel

IJB : Instrument Junction Box

PLC : Programmable Logic Controller

SPDT : Single Pole Double Throw (refers to relay or switch contact arrangements).

LCD : Liquid Crystal Display

LED : Light Emitting Diode

PTFE : Mixed Liquor Suspended Solids

O&M : Operating And Maintenance

UV : Ultraviolet

25.3 Standards

25.3.1 All design standards shall be subject to the latest amendments and editions of the following standard specifications:

- SANS 10142-1 : National Standards for the wiring of premises.
SANS 1186 : Information and Safety Signs.
SANS 1040 : National Building Regulations

25.4 Performance And Installation Requirements

- 25.4.1 The attachment of labels must not at any time compromise the IP protection rating of any panel or enclosure.
- 25.4.2 Glue-on labels will only be permitted if industrial type glue or industrial type double-sided adhesive tape is used. Normal commercial or household glue or double-sided adhesive tape will not be accepted. This glue or tape must also not be used where environmental conditions such as wind, rain, UV, etc. can lead to the deterioration of the adhesive tape.
- 25.4.3 Any deviations from this specification need to be approved in writing by the engineer.
- 25.4.4 Where glue or adhesive tape is not used, signs and labels shall be affixed using corrosion resistant, mechanical fixings.
- 25.4.5 Not more than one item will be labelled with one label, **i.e. there will not be a continuous strip of labels for multiple items**. Each item shall have a separate, unique label assigned to it.
- 25.4.6 Allowed label materials are as follows:
- 25.4.6.1 Traffolyte or equal, or hard plastic sandwich board. (black lettering on white background) (not applicable to cables).
 - 25.4.6.2 Reverse engraved acrylic material, with filled letters and reverse sprayed. (not applicable to cables).
 - 25.4.6.3 Engraved or embossed stainless steel (for cable labels).
- 25.4.7 Labels that will be outside and frequently exposed to wind, rain and UV radiation must be either Traffolyte or equal, stainless steel, brass or aluminium, with engraved letters filled with black, or embossed lettering.
- 25.4.8 At the engineer's request the contractor shall provide proof that materials used for labels are corrosion proof or UV resistant. The cost of this needs to be allowed for in the tender.
- 25.4.9 The font used for all printed and engraved labels shall be Arial.
- 25.4.10 Specific requirements for labels listed in the tender specification supersede any general requirements listed in this specification.
- 25.4.11 Bolts with nuts shall not be used to attach labels to any mounting plate at any point. On mounting plates only bolts in tapped holes will be acceptable (if glue or double sided tape as mentioned in item 25.4.2 above is not used). Bolts with nuts will be allowed on enclosure doors however, where the bolts and nuts are easily accessible.
- 25.4.12 The use of pop rivets to attach labels will not be allowed.
- 25.4.13 The preferred method of attaching labels is to use corrosion resistant screws in tapped

holes.

25.4.14 Where bolts are used on the door or any outside panels of the enclosure, a sealing method (e.g. rubber washers) must be used to ensure that the IP protection rating of the enclosure is not compromised.

25.4.15 Wherever bolts are used, the bolts must be as short as practically possible so that there are no long protrusions that can injure people or snag clothing, wiring, other equipment, etc. If bolts are cut to the correct length, the ends of the bolts must be neatly de-burred and smoothed so that there are no sharp edges that can cause injuries and so that the nuts can be easily screwed on and off. No more than four threads of the bolt end must be visible beyond the nut. It is however preferred that the correct length of bolts are used so that shortening is not required.

25.5 Safety

25.5.1 Where hazardous or dangerous equipment, conditions or materials are present, safety signs and labels shall be attached in such a way that it is clear what the hazard or danger is.

25.5.2 Any hazard, for which there is not a standard symbol defined in the standards mentioned in item 25.3.1 of this document, will be identified by simple wording and symbols approved or specified by the engineer.

25.5.3 Self-adhesive safety signs on vinyl will be permitted on enclosures if the safety signs are standard or approved by the engineer.

25.5.4 Where approved by the engineer, internally mounted, project specific safety labels and charts may be printed on plastic or laminated thin card, protected behind Perspex.

25.5.5 The contractor will supply safety signs for all hazardous components, including, but not limited to:

25.5.5.1 Busbar covers.

25.5.5.2 Fibre Optic patch panels and switches where laser light could be harmful to one's sight.

25.5.5.3 Power inside a panel that does not originate inside the panel itself i.e. it may not be powered down when the panel is isolated.

25.5.6 The text size for Information/warning labels inside enclosures shall be 6mm high (16pt).

25.5.7 The text size for Information/warning labels outside enclosures shall be 10mm high (26pt).

25.6 Enclosures

25.6.1 Labels with the name of the enclosure shall be attached to the outside of the enclosure, on the front at eye height, or as close to eye height as is practical.

25.6.2 The label will be attached with corrosive resistant bolts or screws either into a tapped hole, or via a corrosion resistant washer and nut at the back. Nuts and bolts can only be used on enclosures where such nuts and bolts are readily accessible (e.g. on the enclosure door).

25.6.3 Every PLC panel, ICP, or IJB, shall have an engraved stainless steel label attached with the following information clearly visible inside the panel, ICP, or IJB:

25.6.3.1 Contractor name.

25.6.3.2 Contractor contact information.

25.6.3.3 Enclosure serial/identification number and manufacture date.

25.6.4 The text size for Enclosure name labels shall be 10mm high (26pt).

25.7 Cables

25.7.1 Identical labels shall be attached at both ends of each cable.

25.7.2 Labels for cables in a PLC panel/MCC panel/IJB/ICP shall be located at the entry to the panel, on the inside and outside of the panel, where the cable numbers inside and outside the panel are not visible from one location (e.g. cables at the PLC panel entry, where cable numbers are either visible inside the PLC panel or inside the cable trench).

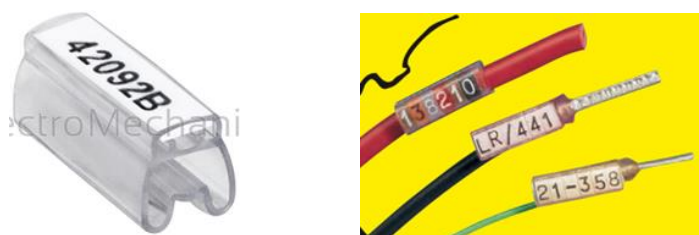
25.7.3 Labels for cables of instrument sensors and other field mounted components shall be located within 100mm of the termination point.

25.7.4 Labels for cables must be attached via either stainless steel straps or cable ties that are certified as UV stabilized.

25.7.5 The text size for cable identification labels shall be at least 6mm (16pt).

25.8 Wires

25.8.1 No separate wire numbers slid onto wires will be accepted. A wire number holder must be attached to the wire and the wire numbers must then be inserted into the wire holder (see the examples below).



These wire number holders must surround the wire completely. I.e. they must slide onto the wire. Clip-on holders will not be accepted.

25.8.2 Wires shall be labelled at both ends with the numbers indicated on construction drawings.

25.9 Components

25.9.1 Each component inside IJBs, ICPs, and PLC panels shall be clearly identified with a

unique label as indicated on the construction drawings.

25.9.2	Labels will not be attached to trunking or any other item that can be removed for maintenance, including the component itself. Removal of trunking or replacement of components must not affect the component labelling.
25.9.3	Pushbuttons and other controls must be labelled with their function on a separate label (E.g. Stop, Start, Open, Close, etc.).
25.9.4	Labels for components are allowed to be inserted in a rail on the mounting plate, if this rail is specifically made for the relevant labels. The rail shall not obscure any part of any lettering.
25.9.5	Labels shall be located directly below, above or adjacent to the relevant equipment, as long as the label is clearly visible and it is clear and unambiguous as to which item of equipment the label refers to.
25.9.6	All terminal strips, and terminals must be labelled with labels that attach to the relevant terminal strip marker or terminal respectively.
25.9.7	The text size for component identification labels shall be 4mm high (10pt).