TENDER COVER PAGE

MBD 1

YOU ARE HEREBY INVITED TO BID FOR REQUIREMENTS OF JOHANNESBURG WATER

BID NUMBER: JW 13504 **CLOSING DATE: 31 JANUARY 2025** **CLOSING TIME: 10:30 AM**

DESCRIPTION: JW 13504 RECTIFICATION OF CONTRACT JW13504 – CONSTRUCTION OF A BALANCING TANK THROUGH MIXERS (15 MIXERS) REDESIGN AND REINSTALLATION, AND REINSTATEMENT OF ASSOCIATED ANCILLARIES

CIDB REQUIREMENTS: TENDERERS SHOULD HAVE A CONTRACTOR CIDB GRADING OF 6ME OR HIGHER

BRIEFING SESSION	COMPLUSORY: YES
BRIEFING DETAILS	DATE AND TIME : 28 NOVEMBER 2024 AT 13:00 ADDRESS : Cnr Golden Highway and Stockwell Ave, Eldorado Estate. VENUE : Administration Building at the Bushkoppie Wastewater Treatment Works, Cnr Golden Highway and Stockwell Ave, Eldorado Estate. ***Note:*** ***For offsite briefing attendees to ensure that transport used is capable to access the gravel road for site viewing.***
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	SYDNEY MANGANYI	CONTACT PERSON	GCINA NDELA
TELEPHONE NUMBER	011 688 1948	TELEPHONE NUMBER	011 688 1796
E-MAIL ADDRESS	sydney.manganyi@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.

TENDER COVER PAGE

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: ……...

1. TENDER NOTICE AND INVITATION TO TENDER

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

CONTRACT NO. **JW 13504 RECTIFICATION OF CONTRACT JW13504 – CONSTRUCTION OF A BALANCING TANK THROUGH MIXERS (15 MIXERS) REDESIGN AND REINSTALLATION, AND REINSTATEMENT OF 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

All tenders and supporting documents must be submitted in a sealed envelope and be placed in the Tender box on the ground floor of the Johannesburg Water by no later than 10:30 am on 31January 2025.

Address is as follows:

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

Johannesburg Water (SOC) Ltd is not obliged to accept the lowest or any tender and Johannesburg Water reserves 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 Johannesburg Water has awarded the contract. Johannesburg Water (SOC) Ltd and the successful tenderer/s will sign the contract agreement forms.

Johannesburg Water SOC Ltd

CONTRACT NO: JW13504

RECTIFICATION OF CONTRACT JW13504 – CONSTRUCTION OF A BALANCING TANK THROUGH MIXERS (15 MIXERS) REDESIGN AND REINSTALLATION, AND REINSTATEMENT OF ASSOCIATED ANCILLARIES

VOLUME 1

TENDER AND CONTRACT

Prepared by
PMU
PO Box 61542
Marshalltown
2107

V2.0
August 2023

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, minimum required CIDB grading for the tender and Active Status – if applicable	•			
	COIDA Registration Number			•	
	Tax SARS PIN No.	•	•		
	MAAA No. for Tax Compliant Status		•		
	Mandatory Documents at Particular Stage:				
	Registration with CIDB for 6ME or higher grading	•			
	Form of Offer Completed and Signed	•			
	Attendance of Compulsory Briefing Session	•			
T2.1	Signed Certificate of Authority to Sign	•			
	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	•	•		

	~~included) Completed and signed.~~				
	MBD 6.1 - Preference Points Schedule – Specific Goals and Price Points - Completed and signed.	•			
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 Tenderer - 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 documents.	•	•		
	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 accounts documents.	•	•		
	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 Required for Criteria 1 – Contactable Reference Letter	•			
	Documentary Evidence Required for Criteria 2 – Contactable Reference Letter	•			
	Documentary Evidence Required for Criteria 3 – CV and Qualifications	•			
	Documentary Evidence Required for Criteria 4 – CV and Qualifications	•			
	Documentary Evidence Required for Criteria 5 – CV and Qualifications	•			
5.	**Specific Goals:**				
	Business owned by 51% or more -Black **People**: • Valid Construction BBBEE Certificate issued by SANAS accredited verification agency or a Construction Sworn Affidavit.	•			
	Business owned by 51% or more- **Women:** • Valid Construction BBBEE Certificate issued by SANAS accredited verification agency or a Construction Sworn Affidavit. • CIPC registration document showing percentage of ownership and share certificate where applicable	•			
6.	**Scope of Work**				
	Scope of Work and or Specifications	•			
7.	**Pricing Schedule:**				
	Alterations authenticated – Refer to Acknowledgment of Tender Conditions	•			
	Bill of Quantities	•			
8.	**Terms and Conditions:**				
	CIDB related document	•			
	Special Conditions of Contract	•			
9.	**Other Documents**				
	Form of Acceptance .. do not complete Form of Acceptance it will be completed by JW official.			•	
	Public Liability Insurance			•	
	Professional Indemnity			•	
	Valid Registration with Compensation for Occupation Injuries and Diseases Act			•	
	Performance Security – where applicable for industrial related services			•	
	Resolution Letter for the Subcontractor (a letter authorizing the person		•		

	~~completing the tender to sign on behalf~~ of the company) – if applicable				
	Comprehensive Health and Safety Plan (compliance with OHSE Specification - if applicable			•	

Tenderers will be notified of such 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), authority to sign 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_____

Volumes	Contents	
Number	**Number**	**Heading**
Volume 1	**Part 1: Tender Procedures**	
	T1.1	Tender Data
	Part 2: Returnable Documents	
	T2.1	List of Returnable Documents
	T2.2	Returnable Schedules
	Part 1: Agreement and Contract Data	
	C1.1	Form of Offer and Acceptance
	C1.2	Contract Data
	C1.3	Forms of Securities
	Part 2: Pricing Data	
	C2.1	Pricing Instructions
	C2.2	Bill of Quantities
Volume 2A	**Part 3: Scope of Work**	
	C3	Scope of Work
Volume 2B		Particular Specifications
Volume 2A	**Part 4: Site Information**	
	C4	Site Information
Volume 3		Occupational Health and Safety Specification and Environmental Management Plan
Volume 4		Tender Drawings (If applicable)

Only Volume 1 and Volume 2A must be returned.

Johannesburg Water (SOC) Ltd

CONTRACT NO. JW13504

BUSHKOPPIE WASTEWATER TREATMENT WORKS

RECTIFICATION OF CONTRACT JW13504 – CONSTRUCTION OF A BALANCING TANK THROUGH MIXERS (15 MIXERS) REDESIGN AND REINSTALLATION, AND REINSTATEMENT OF ASSOCIATED ANCILLARIES

VOLUME 1

TENDERING PROCEDURES

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T1.1.2 Tender Data..... 3

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:** **Part 1: Tendering Procedures** T1.1 Tender Notice and Invitation to Tender T1.2 Tender Data **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 **Volume 1:** **Part 1: Agreement and Contract Data** C1.1 Form of Offer and Acceptance C1.2 Contract Data C1.3 Forms of Securities **Part 2: Pricing Data** C2.1 Pricing Instructions C2.2 Schedule of Rates **Volume 2A** **Part 3: Scope of Work** C3.1 Scope of Work C3.2 Particular Specifications **Part 4: Site Information** C4 Site Information **Volumes 2B:** Generic Specifications **Volume 3:** Occupational Health, Safety and Environmental Specification and Environmental Management Plan **Volume 4:** Tender Drawings

Clause number	Tender Data
C.1.4	The Employer's representative is: Contact Person: Sydney Manganyi Telephone: 011 688 3909 E-mail address: sydney.manganyi@jwater.co.za The SCM representative is: Contact Person: Mr 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 **6ME** 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 **6ME** class of construction work. Failure to meet to Eligibility criteria and requirements will result in disqualification.
C.2.7	Acceptable or Responsive Bid: a bid that meets the following requirements complies in all respects with the specification and conditions of the bid: a. All the prescribed bid forms have been completed and signed to enable evaluation thereof; b. The bidder complies with all requirements as prescribed by the CSD; the bidder has the necessary capacity and ability to execute the contract.
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 working days before the closing time stated in the foregoing notice and clause C.2.15.1"
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."

Clause number	Tender Data
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."
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 on 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. Corrections may not be made using correction fluid, correction tape or the like, bid received contrary to this will be disqualified.
C.2.12.1	Replace Contents Alternative offers will not be permitted.
C.2.12.2	Failure to complete bid amount on the form of offer and sign 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

Clause number	Tender Data
	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: (i) Check the amount in words against the amount in figures on the *Form of Offer*, (ii) Check the Form of Offer against the Summary Schedule Total, (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 bidder 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 is 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.

Clause number	Tender Data
	This is not an opportunity for Tenderers to change the bid offer. A bidder that does not agree to the above will be disqualified. 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, *as well as the Tenderer's name, their Authorised Representative's name, postal address and telephonic contact numbers*.
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.
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:

Clause number	Tender Data
	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. 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 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. 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:

Clause number	Tender Data
	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; ii) a member of the board of directors of any municipal entity; iii) an official of any municipality or municipal entity; iv) an employee of any national or provincial department; v) provincial public entity or constitutional institution within the meaning of the Public Finance Management Act, 1999 (Act No.1 of 1999); vi) a member of the accounting authority of any national or provincial public entity; or vii) an employee of Parliament or a provincial legislature." In order 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.
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. In order 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) and other documents that require completion and signatures that do not have a bearing on functionality, specific goals and price. Bidders that are received contrary to the above requirements will be disqualified after three (3) days period has lapsed. In cases where locality

Clause number	Tender Data
	is a specific goal and the bidder did not submit the required documentation, the tenderer upon submitting the municipal statement, lease agreement or letter from ward councillor 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. The tenderer will not be offered an opportunity to complete and sign certificate of authority.
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	Tenderer to complete, sign and return MBD6.1 with the tender submission. Tenderer to claim the points in the space provided and submit documentary evidence to support the points claimed for specific goals.

Mandatory

	Description	Complied	
		Yes	No
1	Registration with CIDB for 6ME or higher		
2	Form of Offer Completed and Signed		
3	Attendance of Compulsory Briefing Session		

Tenderers who **FAIL** to meet the mandatory criteria or requirements of tender will result in disqualification.

Administrative

Description				Complied	
No	**Reference to Tender Document**	**Description**	**Requirement**	**Yes**	**No**
1.	MBD 1	Invitation to Bid Form	Complete and submit complete and signed MBD 1 Form.		
2.	CSD	Central Supplier Database Registration	Provide proof of CSD registration.		
3.	MBD 4	Declaration of Interest	Complete and submit complete and signed MBD 4 Form.		

4.	MBD 5	Declaration of Procurement Above R10m (All Applicable Taxes Included)	Complete and submit complete and signed MBD 5 Form.		
5	MBD 6.1	Preference Points Claim in Terms of The Preferential Procurement Regulations 2022	Complete and submit complete and signed MBD 6.1 Form.		
6.	MBD 8	Declaration of Bidder's Past Supply Chain Management Practices	Complete and submit complete and signed MBD 8 Form.		
7.	MBD 9.	Certificate of Independent Bid Determination	Complete and submit complete and signed MBD 9 Form.		
9.	Annexure – Proof of Specific Goals	Valid BBBEE Certificate or certified copy thereof or a valid sworn affidavit			
10.	Annexure	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).			
11.	Annexure	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).			
12.	Annexure	Joint Venture Agreement signed by all parties (where applicable).			

Refer to clause C.2.28.

Functionality

CRITERIA NO	CRITERIA	EVIDENCE	SUB-CRITERIA/ CLAUSE	MAX SCORE	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 **Note**: *This 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.*	**Experience on 2 Mechanical wastewater or potable water treatment 2 projects.**	Tenderer Has Completed 0-1 Project	**25**	**0**
				Tenderer Has Completed at Least 2 Projects		**17.5**
				Tenderer has completed 3 or more Projects.		**25**
CRITERIA NO	**CRITERIA**	**EVIDENCE**	**SUB-CRITERIA/ CLAUSE**	**MAX SCORE**	**SCORE**	
2	Tenderers experience with respect to specific aspects	Supporting Documents Required include Reference Letters as per T2.1.6 and T2.1.7 (Or on Client Letter	**Experience on Mechanical equipment design**	0 Completed Projects	**25**	**0**

	of the project / comparable projects	Head with all required Information) and Completion / Approval Certificates **(Qualifying projects submitted in criteria (1) above will be counted in this section).** **Note**: The attached contactable 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 functionality 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. **NOTE: Practical Completion Certificates will NOT be considered.**	**where the design approach includes the use of a computational fluid dynamics (CFD) analysis for the new mixing scheme, demonstrating in part the contractor's design competency and qualification for the works prior to implementation. The works must be performance guaranteed on the design basis of the CFD analysis.**	1 Completed Project		**5**	
				2 - 3 Completed Projects		**17.5**	
				4 or More Completed Projects		**25**	
CRITERIA NO	**CRITERIA**	**EVIDENCE**	**SUB-CRITERIA/ CLAUSE**	**MAX SCORE**	**SCORE**		
3	**Post Qualification**		**Number of completed**	0 Completed Projects	**20**	**0**	

	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)	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.	**Mechanical, Electrical or Civil Wastewater or Potable Water Treatment Projects.**	1 - 2 Completed Projects		**5**
				3 - 4 Completed Projects		**14**
				>4 Completed Projects		**20**

	OR PrCPM / PrCM/ PrQS will obtain a score for experience of a Contract Manager. However, the time of registration of Contract Manager will not impact post qualification number of projects					
CRITERIA NO	**CRITERIA**	**EVIDENCE**	**SUB-CRITERIA/ CLAUSE**	**MAX SCORE**	**SCORE**	
4	**Post Qualification**		**Number of completed**	0 Completed Projects	**20**	**0**

	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 the successful bidder and if found to be false punitive measures will be effected.	**Mechanical or Electrical wastewater or potable water treatment projects.**	1 - 2 Completed Projects		**5**
				3 - 4 Completed Projects		**14**
				>4 Completed Projects		**20**
CRITERIA NO	**CRITERIA**	**EVIDENCE**	**SUB-CRITERIA/ CLAUSE**	**MAX SCORE**	**SCORE**	
5	**Post Qualification**	Tender must Provide CV of Safety Officer in the format given on T2.1.9	National Diploma (Safety	0 Completed Projects	**10**	**0**

	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 / Safety Officers Course (NQF 5) or more, **AND**	**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 the successful bidder and if found to be false punitive measures will be effected.	Management)/National Diploma (Environmental Health/Environmental Science/ Environmental Management) with two (2) experience years post minimum qualification and **Number of completed Mechanical, Electrical or Civil Projects Completed as Safety Officer** **OR** SAMTRAC / SHEOMTRAC/ SHEMTRAC / MESHTRAC /NEBOSH / Safety Officers Course (NQF 5) or more with four (4) experience years' post minimum qualification and **Number of completed Mechanical,**	1 - 2 Completed Projects 3 - 4 Completed Projects >4 Completed Projects		**4** **7** **10**

	Valid proof of registration as candidate with SACPCMP in the Construction Health and Safety Sector will be considered		**Electrical or Civil Projects Completed as Safety Officer**			
	Possible score for quality (Ms)				**70**	**100**

Tenderer's who fail to achieve a score of 70 points will not be considered further.

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: Tenderers who FAIL to meet the minimum required score or requirements of tender will be disqualified. Tenderer's who fail to achieve a score of 70 points will not be considered further.

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

C.3.11.2 & C.3.11.3

The procedure for the evaluation of responsive tenders is Method 2 (Financial Offer and Specific Goals):

Award and Allocation Strategy:

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.

1. APPLICATION OF THE PREFERRENCE POINTS SCORING SYSTEM

The following preference point systems are applicable to all bids:

- The 80/20 system for requirements with a Rand value of up to R50 000 000 (all applicable taxes included); and
- If unclear, any preference points scoring may be included and the lowest acceptable tender will be used to determine the preference points to be used for the evaluation. Where the lowest acceptable tender is below R50 million, the 80/20 preference point system must be used and if the lowest acceptable tender is above R50 million, the 90/10 preference point system must be used.
- The Specific Goals for the tender will be stated in MBD 6.1. In MBD 6.1, the tenderer must indicate how many points they are claiming for each Specific Goal and must submit all the required supporting documentation for the points to be verified and awarded by JW. The BEC will evaluate the submitted supporting documentation and confirm Specific Goal points claimed by the tenderer. Specific goals to be allocated by the BEC will depend on verification documentation submitted.
- Only tenderers that have completed and signed MBD 6.1 and submitted applicable verification documents will be allocated Specific Goal points for preferencing.

(a) The value of this bid is estimated to exceed / below R50 000 000 (all applicable taxes included) and therefore the 90/10 or 80/20 preference point system shall be applicable.

(b) Preference points for this bid shall be awarded for:

Price; and

Specific Goals.

(c) The maximum points for this bid are allocated as follows:

DESCRIPTION	POINTS
PRICE	80
SPECIFIC GOALS	20
Total points for Price and Specific Goals must not exceed	**100**

(d) Failure on the part of a bidder to submit proof of specific goals points claimed in MBD 6.1 will not result in disqualification but will result in points not being awarded for Specific Goals.

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 must 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:

V. 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.

Locality:

VI. 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.

Qualifying Small Enterprises (QSE)

VII. Promotion of procurement from QSE's that are black owned.

Exempted Micro Enterprises (EME):

VIII. Promotion of procurement from EME's that are black own.

SUB-CONTRACTING:

Promotion of sub-contracting a Historically Disadvantaged Individuals (HDI) company. 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.,

Table 1:

The specific goals allocated points in terms of this tender	**Number of points allocated (80/20 system)**
Business owned by 51% or more -Black People	5
Business owned by 51% or more-Women	15
Total	**20**

The following verification documents must be submitted with the tender document:

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 Construction BBBEE Certificate issued by SANAS accredited verification agency or a Construction Sworn Affidavit.
Business owned by 51% or more-**Women**	• Valid Construction BBBEE Certificate issued by SANAS accredited verification agency or a Construction Sworn Affidavit. • CIPC registration document showing percentage of ownership and share certificate where applicable

The following are the requirements for a valid Sworn Affidavit in terms of the BBBEE Sector Codes of Good Practise:

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
	BO QSE	Between R80m and R400m
Tourism Sector Code		

Specialised Enterprises	BO QSE	Between R5m and R45m
	BO EME	Less than R5m
	BO QSE	Between R10m and R50m
	BO EME	Less than R10m

Note: Sworn affidavit received from tenderer that do not meet the above requirement will not be consider for the allocation of points for specific goals.

Requirements for a valid BBBEE Certificate are as follows:

a) Copy of a certified valid BBBEE certificate (Only Valid BBBEE accredited by SANAS), or a 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 above 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.

2. **ADJUDICATION USING A POINT SYSTEM**

(a) The bidder obtaining the highest number of total points will be awarded the contract.

(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.

3. POINTS AWARDED FOR PRICE
THE 80/20 OR 90/10 PREFERENCE POINT SYSTEMS

A maximum of 80 or 90 points is allocated for price on the following basis:

80/20 **or** **90/10**

$$Ps = 80\left(1 - \frac{Pt - P\min}{P\min}\right) \quad \text{or} \quad Ps = 90\left(1 - \frac{Pt - P\min}{P\min}\right)$$

Where

Ps = Points scored for comparative price of bid under consideration

Pt = Comparative price of bid under consideration

Pmin = 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 ie 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;
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 work;
   ii) has the required and experienced key personnel; and
   iii) Owns the primary equipment to effectively and efficiently execute the work.

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 ---

Johannesburg Water (SOC) Ltd

VOLUME 1

RETURNABLE DOCUMENTS AND SCHEDULES

T2.1 LIST OF RETURNABLE DOCUMENTS

The tenderer must complete the following returnable documents:

Document			Page
1. Returnable Schedules required for tender evaluation purposes			
T2.1.1	Record of addenda to tender documents		RD.5
T2.1.2	Certificate of Authority		RD. 6
T2.1.3	Compulsory Enterprise Questionnaire		RD.11
T2.1.4	Preferential Procurement		RD.14
		Special Subcontracting Conditions	RD.15
	MBD 6.1	Preference points claim form in terms of the preferential procurement regulations	RD.17
			RD.**Error! Bookmark not defined.**
	MBD 4	Declaration of any potential conflict of interest	RD.**Error! Bookmark not defined.**
	MBD 8	Declaration of bidder's past Supply Chain management practices	RD.29
	MBD 5	Declaration for Procurement above R10 Million (VAT Included)	RD.31
	MBD 9	Certificate of independent bid determination	RD.33
T2.1.5	Proposed qualifications		RD.36
T2.1.6	Schedule of the Tenderer's experience		RD.37
T2.1.7	Contactable reference template		RD.38
T2.1.8	Schedule of key personnel		RD.40
T2.1.9	Curriculum vitae of key personnel		RD.43

T2.2 LIST OF RETURNABLE DOCUMENTS

Document		Page
2. Other documents required only for tender evaluation purposes		
T2.2.1	Certificate of Contractor Registration issued by the Construction Industry Development Board	RD.47
T2.2.2	SARS Tax Compliance Status Pin and Proof of CSD registration i.e. MA xxxxxxxxxx number	RD.48

T2.3 LIST OF RETURNABLE SCHEDULES

Document		Page
3. Returnable Schedules that will be incorporated into the contract		
T2.3.1	Imported content: forward exchange cover for imported goods	RD.50

T2.4 LIST OF RETURNABLE SCHEDULES

Document		Page
4. Other documents that will be incorporated into the contract		
T2.4.1	Returnable Annexure A – SHE Acknowledgment Form	RD.53
T2.4.2	Returnable Annexure B: Acknowledgement of Tender Drawings	RD.54

Document		Page
C1.1	**FORM OF OFFER AND ACCEPTANCE**	C.1
C1.2	**CONTRACT DATA (PART 2)**	C.5
C1.3	**FORMS OF SECURITIES**	F.1
C2.1	**PRICING DATA**	PD.1
	Bill of Quantities	PD.4-47
	Summary of Bill of Quantities	PD.48

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.

T2.1 LIST OF RETURNABLE DOCUMENTS

Document		Page
1. Returnable Schedules required only for tender evaluation purposes		
T2.1.1	Record of addenda to tender documents	RD.5
T2.1.2	Certificate of authority	RD.6
T2.1.3	Compulsory Enterprise Questionnaire	RD.11
T2.1.4	Preferential Procurement	RD.14
T2.1.5	Proposed qualifications	RD.36
T2.1.6	Schedule of the Tenderer's experience	RD.37
T2.1.7	Contactable reference template	RD.38
T2.1.8	Schedule of key personnel	RD.40
T2.1.9	Curriculum vitae of key personnel	RD.43

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 .....

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. JW3504 and any contract resulting from it on behalf of the company.

Chairman: .....

As Witnesses: 1.....

2.....

Date: .....

(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.

(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.

(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.

(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: .....

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 ie MA xxxxxxxxx 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
- ☐ a member of any provincial legislature
- ☐ a member of the National Assembly or the National Council of Province
- ☐ a member of the board of directors of any municipal entity
- ☐ an official of any municipality or municipal entity
- ☐ 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 an accounting authority of any national or provincial public entity
- ☐ an employee of Parliament or a provincial legislature

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

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
- ☐ a member of any provincial legislature
- ☐ a member of the National Assembly or the National Council of Province
- ☐ a member of the board of directors of any municipal entity
- ☐ an official of any municipality or municipal entity
- ☐ 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 an accounting authority of any national or provincial public entity
- ☐ an employee of Parliament or a provincial legislature

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:

i) authorizes the Employer to verify the tax compliance status from the South African Revenue Services that my / our tax matters are in order;
ii) confirms that the 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;
iii) 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;
iv) 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
iv) 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

Forms for Completion by the Tenderer included in this section are:

Form No.	Form Title	Description	Page
JW6.1	Special Conditions	Sub-contracting and Skills Transfer	RD.15
MBD 6.1	Empowerment and Preferential Procurement	Procedures and adjudication criteria for the information of the Tenderer	RD.17
MBD 4	Declaration of any potential Conflict of Interest	Form to be completed by the Tenderer	RD.**Error! Bookmark not defined.**
MBD 8	Declaration of bidder's past supply chain management practices	Form to be completed by the Tenderer	RD.29
MBD 5	Declaration for Procurement above R10 Million (VAT Included)	Form to be completed by the Tenderer	RD.31
MBD 9	Certificate of Independent Bid Determination	Form to be completed by the Tenderer	RD.33

Note:

All information supplied must be current and valid. Proposed or imminent changes to a Tenderer's status may be mentioned but the declarations must reflect current circumstances.

JW 6.1 (b) SPECIAL CONDITIONS

The successful Tenderer must therefore subcontract a minimum of **0%** of the value of this contract to an entity(s) described below. 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% black owned by black people;
- An EME of QSE which is at least 51% owned by black people who are youth;
- An EME of QSE which is at least 51% owned by people who are 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 veteran;
- 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. A subcontracting agreement between main contractor and the subcontractor shall be submitted to JW upon appointment and must include minimum information below.
    - Name of sub-contractor and BBBEE status
    - Area and location of project
    - Scope of work issued to the sub-contractor
    - Value of the work issued including P&G's (auditable)
    - Assistance provided to the sub-contractor e.g. acquisition of materials, machinery and tools
    - Skills transfer plan

3. The successful contractor must submit periodic SMME reports to the Project Manager as follows:
    - Name of sub-contractor and BBBEE status
    - Area and location of project
    - Scope of work issued to the sub-contractor
    - Value of the work issued (auditable)

- Monthly payments made to the subcontractor (auditable)
- Assistance provided to the sub-contractor e.g. acquisition of materials, machinery and tools
- Performance of the sub-contractor

4. Upon completion of the project, the contractor is required to provide a final report to JW on skills acquired, description and value of work performed as well as their overall performance.

(The above information will assist the sub-contractor to improve their CIDB grading)

Skills transfer

It is an absolute requirement that the successful tenderer empowers the appointed sub-contractor/s through the transfer of skills. In this regard a skills transfer plan must be submitted prior to commencement of each work package.

I / we representing the tenderer hereunder agree to the above conditions.

Name of Tenderer:_____

Authorised signatory:_____ **Date**:_____

Tenderers who **FAIL** to complete and sign schedule JW6.1 will not be evaluated further

MBD 6.1

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 80/20 system for requirements with a Rand value of up to R50 000 000 (all applicable taxes included); and
- the 90/10 system for requirements with a Rand value above R50 000 000 (all applicable taxes included).

1.2 **To be completed by the organ of state**

a) The applicable preference point system for this tender is the 80/20 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.

1.4 **To be completed by the organ of state:**

The maximum points for this tender are allocated as follows:

	POINTS
PRICE	80
SPECIFIC GOALS	20
Total points for Price and SPECIFIC GOALS	**100**

1.5 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.

1.6 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 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 80/20 OR 90/10 PREFERENCE POINT SYSTEMS

A maximum of 80 points is allocated for price on the following basis:

80/20

$$Ps = 80\left(1 - \frac{Pt - P\,min}{P\,min}\right)$$

Where

Ps = Points scored for price of tender under consideration

Pt = Price of tender under consideration

Pmin = Price of lowest acceptable tender

1.1. FORMULAE FOR DISPOSAL OR LEASING OF STATE ASSETS AND INCOME GENERATING PROCUREMENT

1.1.1. POINTS AWARDED FOR PRICE

A maximum of 80 points is allocated for price on the following basis:

80/20

$$Ps = 80\left(1 + \frac{Pt - P\,max}{P\,max}\right)$$

Where

Ps = Points scored for price of tender under consideration

Pt = Price of tender under consideration

Pmax = Price of highest 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:

4.2 In cases where organs of state intend to use Regulation 3(2) of the Regulations, which states that, if it is unclear whether the 80/20 or 90/10 preference point system applies, an organ of state must, in the tender documents, stipulate in the case of—

(a) an invitation for tender for income-generating contracts, that either the 80/20 or 90/10 preference point system will apply and that the highest acceptable tender will be used to determine the applicable preference point system; or

(b) any other invitation for tender, that either the 80/20 or 90/10 preference point system will apply and that the lowest acceptable tender will be used to determine the applicable preference point system,

then the organ of state must indicate the points allocated for specific goals for both the 90/10 and 80/20 preference point system.

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

(Note to organs of state: Where either the 90/10 or 80/20 preference point system is applicable, corresponding points must also be indicated as such.

***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 (80/20 system)**	**Number of points claimed (80/20 system) (To be completed by the tenderer)**
Business owned by 51% or more -Black People	5	
Business owned by 51% or more-Women	15	
Total	**20**	

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 –

(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(S)

SURNAME AND NAME: .....
DATE: .....

ADDRESS: .....

.....

.....

.....

1. SUB-CONTRACTING

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

(***Tick applicable box***)

YES		NO	

1.1.1 If yes, indicate:

i) What percentage of the contract will be subcontracted_____(minimum of 11%)
ii) The name of the sub-contractor(s):

.....

.....

.....

.....

.....

iii) The black sharehold 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 last 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		

2. DECLARATION WITH REGARD TO COMPANY/FIRM

2.1 Name of company/firm: ……

2.2 VAT number registration number: ……..

2.3 Company registration number: ……

2.4 TYPE OF COMPANY/ FIRM

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

[TICK APPLICABLE BOX]

2.5 DESCRIBE PRINCIPAL BUSINESS ACTIVITIES

……
……
……
……
……..

2.6 COMPANY CLASSIFICATION

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

[*TICK APPLICABLE BOX*]

2.7 **MUNICIPAL INFORMATION**

Municipality where business is situated: .....

Registered Account Number: .....

Stand Number: ……

2.8 Total number of years the company/firm has been in business: ……

2.9 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;

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 –

(f) disqualify the person from the bidding process;

(g) recover costs, losses or damages it has incurred or suffered as a result of that person's conduct;

(h) 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;

(i) 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

(j) 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 state[1].

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, hareholder[2]):……..

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. ….……

……..

[1]MSCM 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……
……..

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 *audi alteram partem* 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

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**

2.1 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.

2.2 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

……..

……..

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 bids[1] 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 consortium[3] 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:

   (a) prices;
   (b) geographical area where product or service will be rendered (market allocation)
   (c) methods, factors or formulas used to calculate prices;

[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.**

(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

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 .....

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

Contactable Reference Template

To Johannesburg Water (SOC) Ltd

I, the undersigned being duly authorised to do so, hereby furnish a reference to Johannesburg Water relative to tender Contract No**. CONSTRUCTION OF A BALANCING TANK THROUGH MIXERS REDESIGN AND REINSTALLATION (15 MIXERS) WITH REINSTATEMENT OF ASSOCIATED ANCILLARIES AT BUSHKOPPIE WASTEWATER TREATMENT WORKS.**

Name of Tenderer: ……

Description of Goods / Services provided
……

……

……

Contract Value: ……

Duration: Year-Month-Day when the Goods / Services were provided

Start date (Year- Month -Day) when the above was provided:
……/……/……

End date (Year- Month -Day) when the above was provided:
……/……/……

Name of authorised person:
……

Signature:……..…….. Date ……..……

Telephone/Mobile:
……

Email:
……

Completed on behalf (Name of Client)
……

NB: This document must be completed by the referee and included in the tender submission. Alternatively, the client's letterhead may be used for this purpose provided it complies with the functional criteria requirements. A separate form must be completed for each reference as required in the evaluation criteria.Information provided will be verified and if found to be false or misrepresented, punitive

measures will be instituted against the respective party including blacklisting and restriction from participating in any future government tender.
IF BIDDER WAS A SUBCONTRACTOR ON THE PROJECT – PROOF OF SUBCONTRACTING AGREEMENT BETWEEN BIDDER AND MAIN CONTRACTOR PLUS REFERENCE LETTER TO BE SUBMITTED AS STATED ABOVE

Contactable Reference Template

To Johannesburg Water (SOC) Ltd

I, the undersigned being duly authorised to do so, hereby furnish a reference to Johannesburg Water relative to tender Contract No **CONSTRUCTION OF A BALANCING TANK THROUGH MIXERS REDESIGN AND REINSTALLATION (15 MIXERS) WITH REINSTATEMENT OF ASSOCIATED ANCILLARIES AT BUSHKOPPIE WASTEWATER TREATMENT WORKS.**

Name of Tenderer: ……

Description of Goods / Services provided
……

……

……

Contract Value: ……

Duration: Year-Month-Day when the Goods / Services were provided

Start date (Year- Month -Day) when the above was provided:
……/……/……

End date (Year- Month -Day) when the above was provided:
……/……/……

Name of authorised person:
……

Signature:……..…….. Date ……

Telephone/Mobile:
……

Email:
……

Completed on behalf (Name of Client)
……

NB: This document must be completed by the referee and included in the tender submission. Alternatively, the client's letterhead may be used for this purpose provided it complies with the functional criteria requirements. A separate form must be completed for each reference as required in the evaluation criteria.Information provided will be verified and if found to be false or misrepresented, punitive

measures will be instituted against the respective party including blacklisting and restriction from participating in any future government tender.

IF BIDDER WAS A SUBCONTRACTOR ON THE PROJECT – PROOF OF SUBCONTRACTING AGREEMENT BETWEEN BIDDER AND MAIN CONTRACTOR PLUS REFERENCE LETTER TO BE SUBMITTED AS STATED ABOVE

T2.1.8 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 CONTRACTOR'S ORGANISATION		KEY PERSONNEL TO BE IMPORTED IF NOT AVAILABLE LOCALLY		UNSKILLED PERSONNEL TO BE RECRUITED 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)

T2.1.9 Curriculum Vitae of Key Personnel

Provide separate forms for each position listed in Form: Key Personnel

Contracts Manager

Name:	**Date of birth:**
Profession:	**Nationality:**
Qualifications:	
Professional Registration Number:	
Name of Employer (firm):	
Current position:	**Total Months Relevant Experience:**
Employment Record:	

Experience Record Pertinent to Required service:

START DATE dd month year	End DATE dd month year	ROLE WHICH PROVES RELEVANT EXPERIENCE

Certification:

I, the undersigned, certify that, to the best of my knowledge and belief, this data correctly describes me, my qualifications and my experience.

……. …….....

Signature of person named in the schedule *Date*

Site Agent

Name:	**Date of birth:**
Profession:	**Nationality:**
Qualifications:	
Professional Registration Number:	
Name of Employer (firm):	
Current position:	**Total Months Relevant Experience:**
Employment Record:	

Experience Record Pertinent to Required service:

START DATE dd month year	End DATE dd month year	ROLE WHICH PROVES RELEVANT EXPERIENCE

Certification:

I, the undersigned, certify that, to the best of my knowledge and belief, this data correctly describes me, my qualifications and my experience.

..... …….....
Signature of person named in the schedule *Date*

Safety Officer

Name:	**Date of birth:**
Profession:	**Nationality:**
Qualifications:	
Professional Registration Number:	
Name of Employer (firm):	
Current position:	**Total Months Relevant Experience:**
Employment Record:	

Experience Record Pertinent to Required service:

START DATE dd month year	End DATE dd month year	ROLE WHICH PROVES RELEVANT EXPERI-ENCE

Certification:

I, the undersigned, certify that, to the best of my knowledge and belief, this data correctly describes me, my qualifications and my experience.

..... …….....
Signature of person named in the schedule *Date*

T2.2 LIST OF RETURNABLE DOCUMENTS

Document		Page
2. Other documents required only for tender evaluation purposes		
T2.2.1	Certificate of Contractor Registration issued by the Construction Industry Development Board	RD.47
T2.2.2	SARS Tax Compliance Status Pin and Proof of CSD registration i.e. MA xxxxxxxxxx number	RD.48

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 xxxxxxxxxx number.

SIGNATURE:.....…… DATE: ….....

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

T2.3 LIST OF RETURNABLE SCHEDULES

Document **Page**

3. Returnable Schedules that will be incorporated into the contract

T2.3.1 Imported content sheet: forward exchange cover for imported goods RD.50

T2.3.1 Imported Content Sheet: Forward Exchange Cover for Imported Goods

The Tenderer shall, in the attached schedule, for each item which a price is tendered, state the item number as it appears in the Schedule of Quantities, a brief description of the item, the country of origin, the value of the imported content of all goods comprising that item, the number of items for which he requires forward exchange cover, and the total amount for which forward exchange cover will be required.

Each Part of the Schedule of Quantities must be dealt with separately.

In the event of components being imported from more than one country, a separate entry shall be made for each country.

The Tenderer shall state the applicable rate(s) for the relevant country(ies) as at the date seven days prior to the closing date for the receipt of tenders.

Exchange rate(s) as at ..... (*insert date*)

Country	Exchange Rate

SIGNED ON BEHALF OF TENDERER : .....

NAME (in print) : .....

DATE : .....

Equipment Schedule

Item No. in SQ	Brief Description	Country of Origin	Value of Imported Content	No. of Items	Amount (R)
				Quantity Scheduled	

T2.4 LIST OF RETURNABLE SCHEDULES

Document		Page
4. Other documents that will be incorporated into the contract		
T2.4.1	JW 6.4 Returnable Annexure A – SHE Acknowledgment form	RD. 53
T2.4.2	JW 6.5 Returnable Annexure B: Acknowledgement of Tender Drawings	RD. 54

T2.4.1 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: COVID-19 Guidelines
- Annexure 2: Baseline Risk Assessment and COVID-19 Risk Assessment
- Annexure 3: Medical Screening Policy
- Annexure 4: Contractor Competency Evaluation
- Annexure 5: Sign off form
- Annexure 6: Environmental Management Plan
- Annexure 7: Environmental Specification

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*	

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Johannesburg Water SOC Ltd

Johannesburg Water

VOLUME 1

PART 1: AGREEMENT AND CONTRACT DATA

Employer:		Contractor:	
Witness:		Witness:	

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C1.1.2 .... Form of Acceptance 4
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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:

JW JW13504 : RECTIFICATION OF CONTRACT JW13504 – CONSTRUCTION OF A BALANCING TANK THROUGH MIXERS (15 MIXERS) REDESIGN AND REINSTALLATION, AND REINSTATEMENT OF 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 RATES TO PROVIDE THE WORKS 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 _____ **Date** _____

Employer:		Contractor:	
Witness:		Witness:	

Volume	***1***	2			3	4	**Part**	*T1*	T2	**C1**	C2	C3	C4

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:

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,

FOR EMPLOYER OFFICIAL USE ONLY

Name(s)		
Capacity		

For the Employer ***Johannesburg Water SOC Ltd, Turbine Hall,65 Ntemi Piliso, Newtown, Johannesburg***

(Name and address of organisation)

Employer:		Contractor:	
Witness:		Witness:	

Volume	***1***	2			3	4	**Part**	*T1*	T2	**C1**	C2	C3	C4

Name and signature of witness _____ **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 _____

Volume	***1***	2			3	4	**Part**	*T1*	T2	**C1**	C2	C3	C4

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.
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

(Name and address of organisation)

Name and signature of witness **Date**

For the Employer:

Signature(s)

Name(s)

Capacity

Johannesburg Water SOC Ltd, Turbine Hall,65 Ntemi Piliso, Newtown, Johannesburg

(Name and address of organisation)

Name and signature of witness **Date**

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 (2015), published by the South African Institution of Civil Engineering, is applicable to this Contract.

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 12 months.
1. 1.1.15	The name of the Employer is Johannesburg Water (SOC) Limited Contact person is: Mr Peter Louw
1.2.1.	The address of the Employer is: Physical / Postal / Tel: 011 688 1676 Turbine Hall / P.O. Box 61542 / Fax: 011 688 1521 65 Ntemi Piliso Street / Marshalltown / Email: Newtown / 2107 / peter.louw@jwater.co.za
1.1.1.16	The name of the Engineer is Johannesburg Water (SOC) Limited's CAPEX – Engineering Service Unit. The contact person is Sydney Manganyi
1.2.1.2	The address of the Employer's Agent is: Physical / Postal / Tel: 011 688 1948 Turbine Hall / P.O. Box 61542 / Fax: 011 688 1521 65 Ntemi Piliso / Marshalltown / Email: Street / 2107 / sydney.manganyi@jwater.co.za@jwater.co.za Newtown
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). The Employer will require Health and Safety documentation from the Contractor to acquire this permit. • Organogram of resources

Volume	***1***	2			3	4	**Part**	*T1*	T2	**C1**	C2	C3	C4

GCC Clause	Information
5.3.2	The Contractor shall deliver his programme of work 21 days before the Commencement Date.
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.
5.8	The special non-working days are All Public Holidays in terms of the Public Holidays Act as amended. Working days shall be Monday to Friday, between 07h00 to 17h00.
5.8.1	The year-end break ''builder's break'' commences on 16 December until the first working Monday of January of the succeeding year as defined by the SAFCEC on annual basis.
5.13.1	The penalty for failing to complete the Works is the greater of: An amount equal to daily Time Related P&G rate (as calculated from the Time Related P&G section in the Bill of Quantities) or R4 000.00 per day, whichever is greater.
5.16.3	The latent defects period is 10 years.
6.2	The time to deliver the Form of Guarantee is within 28 days from the Commencement Date.
6.2.1	The liability of the guarantee shall be 10% of the tendered sum
6.8.2	Contract Price Adjustment shall **NOT BE APPLICABLE**. This Contract shall be a **FIXED PRICE**. period.
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%.
6.10.4	**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 supplier's statement.
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 on clause 6.10.4 as amended.
6.10.6	A Retention Money Guarantee is not permitted

Volume	***1***	2			3	4	**Part**	*T1*	T2	**C1**	C2	C3	C4

GCC Clause	Information
6.11	Delete Clause 6.11.
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	Delete Clause 8.6.1 and replace it with the following: Notwithstanding anything elsewhere contained in the Contract and without limiting the obligations, liabilities or responsibilities of the Contractor in any way whatsoever (including but not limited to any requirement for the provision by the Contractor of any other insurances) the Employer shall effect and maintain as appropriate in the joint names of the Employer and the Contractor and where relevant Sub-Contractors the following insurances which are subject to the terms, limits, exceptions and conditions of the Policy :
8.6.1.1	**Contract Works Insurance** – which will provide cover against accidental and Physical loss of or damage to the Works, Temporary Works and Materials intended for incorporation in the Works from whatsoever cause arising other than causes set out in Clause 8.3.1for which the Contractor is responsible for the Works in terms of Clause 8.2.1, and for a sum insured which shall, unless otherwise specified in the Contract, be the aggregate of :
8.6.1.1.1	The Contract Price,
8.6.1.1.2	a sum to cover the value (specified at the time of delivery to the Contractor) of materials supplied by the Employer for incorporation in the Works and not included in the Contract Price, and
8.6.1.1.3	a sum to cover professional fees, not included in the Contract Price, payable in respect of the repair or reinstatement of damage to the Works.
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	Delete clause 8.6.1.3 and replace with the following: **Public Liability Insurance** which will provide indemnity against legal liability in the event of accidental death of or injury to third party persons and/or loss or damage to third party property arising directly from the execution of the Contract and occurring during the period of Insurance with a limit of indemnity of R5million in respect of all claims arising from any one occurrence or series of occurrences consequent on or attributable to one source or original cause.
8.6.1.6	Add the following clause to 8.6.1 Full details of the Contract Works and Public Liability insurances effected by the Employer may be obtained from the Employer and the Contractor/Sub-Contractors are deemed to be aware of the terms, exclusions and conditions of these insurances.
8.6.1.7	Add the following clause to 8.6.1 The Employer shall pay the premium in connection with the insurances effected by the

Volume	***1***	2			3	4	**Part**	*T1*	T2	**C1**	C2	C3	C4

GCC Clause	Information
	Employer in 8.6.1.1, 8.6.1.2 and 8.6.1.3 above.
8.6.2	Delete clause 8.6.2 and replace with the following: The Employer/Contractor/Sub-Contractors and/or any other party who obtains indemnity under the policies effected under 8.6.1.1, 8.6.1.2 and 8.6.1.3 above shall become liable for the deductibles (first amount payable) which are applicable in respect of each and every occurrence or series of occurrences attributable to one source or cause giving rise to loss or damage or indemnifiable liability.
8.6.3	Delete clause 8.6.3 and replace with the following: In the event of an occurrence which is likely to give rise to a claim under the insurance effected by the Employer, the following procedure shall be adhered to:
8.6.3.1	Add the following clause to 8.6.3 In addition to any statutory requirements and/or other requirements contained in the Conditions of Contract, the Contractor shall immediately notify the Employer's Insurance Brokers through the Employer's agent, giving the circumstances, nature and an estimate of the loss or damage.
8.6.3.2	Add the following clause to 8.6.3 The Contractor shall, when required, complete a claims advice form, available from the Employer's Insurance Brokers, to whom the form shall be returned without delay through the Employer's agent. Each claim must be approved by the Employer before submission to the insurance broker.
8.6.3.3	Add the following clause to 8.6.3 The Contractor shall afford all access to the representatives of the Insurers for the purpose of the assessment of any loss or damage.
8.6.3.4	Add the following clause to 8.6.3 Negotiations on the settlement of claims shall be conducted by the Contractor/Sub-Contractor with the Insurers through the Employer's Insurance Brokers via Employer's agent.
8.6.4	Delete clause 8.6.4 and replace with the following: Any amount which becomes payable to the Contractor or any of his Sub-Contractors as a result of claim under the Contract Works Insurance shall if required by the Employer be paid net of the deductible to the Employer who shall pay the Contractor from the proceeds of such payment upon rectification repair or reinstatement of the loss or damage but this provision shall not in any way affect the Contractor's obligations liabilities or responsibilities in terms of the Contract.

Volume	***1***	2			3	4	**Part**	*T1*	T2	**C1**	C2	C3	C4

GCC Clause	Information
8.6.5	Delete clause 8.6.5 and replace with the following: The Contractor shall insure all Constructional 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 brought on to the Site against all risks of physical loss or damage for the period such Plant shall be on the Site to the full value thereof. In respect of 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 by ensuring 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, through the Employer's agent, the policy or policies of insurance and receipts for payment of the current premiums.
8.6.6	Delete clause 8.6.6 and replace with the following: 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).
8.6.7	Delete clause 8.6.7 and replace with the following: 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 R2,5million.
8.6.8	Add the following clause to 8.6 The Contractor and the Sub-Contractors shall effect and maintain at their own cost any additional insurance, which they deem necessary to cover damage or loss or injury not insured in terms of the insurance effected by the Employer. 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 through the Employer's agent, the policy or policies of insurance and the receipts for payment of the current premiums. If the Contract entails manufacture and or assembly of the Works or part thereof on a site other than the Contract site, the Contractor must satisfy the Employer that all materials and equipment intended for incorporation into the Works are adequately insured during manufacture and assembly. If the Employer has an insurable interest in such works during manufacture or assembly, such interest shall be recorded by way of endorsement on the policies concerned. The Contractor shall furnish the appropriate insurance policies to the Employer within 21 days from the Commencement Date.
8.6.9	Add the following clause to 8.6 Submission of the Tender will be construed by the Employer as acceptance by the Contractor that he is satisfied with the insurance effected by the Employer supplemented by any additional insurance which he shall specify in the manner provided for in the Schedule of Rates.

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GCC Clause	Information
8.6.10	Add the following clause to 8.6 The Contractor shall give all notices and observe all conditions and requirements imposed by any and all relevant insurance policies which shall be read as being part of the General Conditions of Contract and which shall be binding on the Contractor.
8.6.11	Add the following clause to 8.6 In addition to any statutory obligations, or other requirements contained in the Conditions of Contract, the Contractor shall report in writing to both the Employer's Agent and the Employer's Insurance Brokers 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 and/or the Employer's Insurers 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 Engineer and/or the Employer's Insurers full facilities for carrying out such enquiries.
8.6.12	Add the following clause to 8.6 Negotiations on the settlement of claims under the insurance effected by the Employer shall be conducted by the Contractor/Sub-Contractor with the Insurers through the Employer's Insurance Brokers via the Employer's Agent.
8.6.13	Add the following clause to 8.6 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.
8.6.14	Add the following clause to 8.6 The Employer shall not be liable for or in respect of any damages or compensation payable at law in respect or in consequence of any accident or injury to any workman or other person in the employ of the Contractor or any Sub-Contractor save and except an accident or injury resulting from any act or default of the Employer, its agents or servants and the Contractor shall be deemed to have indemnified and shall keep indemnified the Employer against all such damages and compensation (save and except as aforesaid) and against all claims, demands, proceedings, costs, charges and expenses whatsoever in respect thereof or in relation thereto.
8.6.15	Add the following clause to 8.6 The Contractor shall insure in the joint names of the Employer, the Contractor and all Sub-Contractors (whether nominated or otherwise) for an amount of R2million per occurrence against the liability stated in Sub-Clause 8.6.6 with an Insurer approved by the Employer (which approval shall not be unreasonably withheld) and shall continue such insurance during the whole of the time that any persons are employed by him on the Works and shall submit to the Engineer such policy of insurance and the receipt of payment of the current premium. Provided always that in respect of any persons employed by any Sub-Contractor, the Contractor's obligation to insure as aforesaid under this Sub-Clause shall be satisfied if the Sub-Contractor shall have insured against the liability in respect of such persons in such manner that the Employer is indemnified under the policy of insurance but the Contractor shall require such Sub-Contractor to produce to the Employer's Agent such policy and the receipt for payment of the current

GCC Clause	Information
	premium.
8.6.16	Add the following clause to 8.6 If the Contractor shall fail to effect and keep in force the insurances referred to in this Clause or for any other insurance which he may be required to effect in terms of the Contract, then and in any such case the Employer may effect and keep in force any such insurance and pay such premium or premiums as may be necessary for that purpose and from time to time deduct the amount so paid by the Employer as aforesaid from any monies due or which may become due to the Contractor or recover the same as a debt due from the Contractor.
8.6.17	Add the following clause to 8.6 The Contractor shall ensure that all proposed and appointed Sub-Contractors are fully aware of the contents of Clause 8.6.1
8.6.1.1.2	The value of the materials supplied by the Employer to be included in the insurance sum is nil.
10.4.2	Dispute resolution shall be by arbitration if amicable settlement has failed.
10.5.3	The adjudication board shall consist of one member.
7.8.2	**Cost of making good of defects** Amend Clause 7.8.2.1 as follows: In the first line, correct the spelling of 'therefore'.

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 6.7 and PS 6.9, 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 R15,000.00 per report per occasion; and
- If the Contractor fails to complete the latter 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 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 labour or SMME

- The Employer shall levy a penalty on 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 50,000.00 per report per occasion; and
- If the Contractor fails to complete the latter 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 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) Penalties irreversible

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 for 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) Penalties irreversible

The Contractor shall note that all penalties once imposed shall be non-recoverable or 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 take and comply with Employers Health and Safety representative or Environmental representative on matters regarding Health & Safety, as well as Environmental.

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 the like acts shall have been done by any persons employed by him 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.

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.

C1.2.1.2.6 Returns of labour (EPWP), 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 constructional plant, equipment and material as the Employer's Agent or his duly authorized representative may require. Contractor to report on SMME's as per requirements of JW6.1.

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 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 authorize representative and the Contractor shall afford full opportunity for the Employer's Agent or his duly authorize 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 the:

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 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.

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.

C1.2.2 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 …….. …….. …….. …….. …….. …….. …….. Postal …….. …….. …….. …….. …….. …….. …….. Tel: …… Fax: …… Email: …….. ……..
Clause 6.8.3	The variation in cost of special materials is Type Unit Rate **NOT APPLICABLE**

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Johannesburg Water (SOC) Ltd

Johannesburg Water

VOLUME 1

PART 1.3 : FORMS AND SECURITIES

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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.

C1.3.1 Form of Guarantee

TO BE PRINTED ON THE OFFICIAL LETTERHEAD 0F THE GUARANTOR.

PERFORMANCE GUARANTEE

WHEREAS Johannesburg Water (SOC) Ltd (hereinafter referred to as "the Employer" or "beneficiary") entered into a Contract with

_____
(hereinafter called "the Contractor")

on the _____ day of _____ 20____ for

_____

at _____

AND WHEREAS it is provided by such Contract that the Contractor shall provide the Employer with security by way of a guarantee for the due and faithful fulfilment of such Contract by the Contractor;

AND WHEREAS _____
has/have at the request of the Contractor, agreed to such guarantee;

NOW THEREFORE WE, _____
Do hereby guarantee and bind ourselves jointly and severally as Guarantor and Co-principal Debtors to the Employer under renunciation of the benefits of division and excussion for the due and faithful performance by the Contractor of all the terms and conditions of the said Contract, subject to the following conditions:

1. The Employer shall, without reference and/or notice to us, have complete liberty of action to act in any manner authorised and/or contemplated by the terms of the said Contract, and/or to agree to any modifications, variations, alterations, directions or extensions of the Completion Date of the Works under the said Contract, and that its rights under this guarantee shall in no way be prejudiced nor our liability hereunder be affected by reason of any steps which the Employer may take under such Contract, or of any modification, variation, alteration of the Completion Date which the Employer may make, give, concede or agree to under the said Contract

2. This guarantee shall be limited to the payment of a sum of money.

3. The Employer shall be entitled, without reference to us, to release any guarantee held by it, and to give time to or compound or make any other arrangement with the Contractor.

4. This guarantee shall remain in force and effect until the issue of the Certificate of Completion in terms of the Contract, unless we are advised in writing by the Employer before the issue of the said Certificate of his intention to institute claims, and the particulars thereof, in which event this guarantee shall remain in full force and effect until all such claims have been paid or liquidated

5. Our total liability hereunder shall not exceed the sum of _____

Employer:		Contractor:	
Witness:		Witness:	

_____

_____ (R_____)

6. The guarantor reserves the right to withdraw from this guarantee by depositing the Guaranteed Sum with the beneficiary, whereupon the Guarantor's liability hereunder shall cease.

7. We hereby choose our address for the serving of all notices for all purposes arising herefrom as

_____

IN WITNESS WHEREOF this guarantee has been executed by us at _____

on this _____ day of _____ 20____

As witnesses

1. _____

_____
Signature

2. _____

Duly authorised to sign on behalf of _____

Address _____

_____

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 properly or any other cause whatsoever, and also in respect of all legal or other expenses that may be incurred by the Employer in examining, resisting or settling any such claims; for the due performance of which the Contractor binds itself according to law.

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. _____

_____
Signature

2. _____

Duly authorised to
sign on behalf of _____

Employer:		Contractor:	
Witness:		Witness:	

_____

Address _____

_____

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 mandatary") as envisaged by Section 37(2) of the Occupational Health and Safety Act, No. 85, of 1993 as amended.

I _____ representing

_____ (mandatary) do hereby acknowledge that

_____ (mandatary) 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 mandatary _____

Signature on behalf of Employer _____

Compensation Fund Registration No. of mandatary _____

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

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. 'Mandatary' 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 Aid by the mandatary.

4. All documents attached or referred to in the above agreement from 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 mandatary 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 _____

1.0 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;

2.0 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.

3.0 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.

Employer:		Contractor:	
Witness:		Witness:	

4.0 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 _____

Johannesburg Water (SOC) Ltd

VOLUME 2

CONTRACT

PART 3:

SCOPE OF WORK

PART 4:

SITE INFORMATION

C3 SCOPE OF WORK

GENERAL

This section specifies and describes the supplies, services and engineering and construction works which are to be provided and any other requirements and constraints relating to the manner in which 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 requirements to be met.

Portion 2: PARTICULARS OF REQUIRED CIVIL WORK

Portion 3: PARTICULARS OF REQUIRED MECHANICAL WORK

Portion 4: PARTICULARS OF REQUIRED ELECTRICAL WORK

Portion 5: PARTICULARS OF REQUIRED CONTROL AND INSTRUMENTATION WORK

Portion 6: PARTICULARS OF REQUIRED RECTIFICATION OF BALANCING TANK MIXERS

DETAILS STANDARDISED GENERIC SPECIFICATIONS are included in volume 2 & 3 of the Tender Document.

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

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PORTION 1: PROJECT SPECIFICATION

PS 1 DESCRIPTION OF THE WORKS

PS 1.1 Employer's Objectives

The Bushkoppie Wastewater Treatment Works is a BNR activated sludge plant with a nominal treatment capacity of 200Ml/d. The plant has a conventional process train for wastewater treatment by the activated sludge process but does not have a balancing tank to balance the diurnal variations in the settled wastewater inflow to the activated sludge reactors with the result that process stability is affected with consequential difficulty in complying with the effluent standards

In an attempt to standardize the equipment at the Wastewater Treatment Works, the tender document shall be compiled specifying proven type equipment that is currently installed at the works. The Client's preference to what materials are acceptable in various applications shall be adhered to.

PS 1.2 Mixer Rectification Scope of Work Overview

The scope of works entails rectification of the Balancing Tank Mixers through redesign and reinstallation of the mixers in accordance with the Johannesburg Water Particular Specification as incorporated under Contract No. JW 13504.
The project scope of works shall include but not be limited to the following:

PS 1.2.1 Mechanical Works

- Balancing Tanks Mixers Redesign
- Surface Mounted Vertical Shaft Mixers (Supply of New Mixers, OR Modifying existing Mixer assembly), Installation, testing and commissioning.
- Pump Station - Major Service / Maintenance Overhaul for pump assembly with a Cornell 12NHTM-F18DB- Pump and WEG 280SM-55kW-6P-380V Motor.
- Pump Station- Major Service / Maintenance Overhaul for sump pump
- Pump Station- Major Service / Maintenance Overhaul for lifting equipment inside the pump station

PS 1.2.2 Electrical Works

- Refurbished of MCC (motor control centre) for balancing tanks and pump station.
- Refurbishment of local control stations for the balancing tank and pump station equipment.
- Supply, delivery, installation and termination of new low-voltage power and control cables and all accessories where required.

- Supply, delivery and installation of missing earthing for the refurbishment of MCC building earthing and earth bonding refurbishment of all related equipment and metal structures.
- Testing and commissioning of the complete electrical and associated automation installation.

PS 1.2.3 Control and Instrumentation Works

- System Integration and PLC Programming
- Flow Meters and Ultrasonic Level Meters Service and calibration.
- Servicing and maintenance of the motorized modulating valve.

PS 1.3 Initial Overview of the Scope of Works (Original Scope of Works)

The scope of this contract includes civil, building, structural, mechanical, electrical & control and instrumentation work and includes the following:

It is proposed to construct a balancing tank north-west of the existing sludge fermentation tanks between the access road to the Head of Works and the South Eastern Outfall Sewer, to balance the variations in settled sewage flow to the reactors.

Under normal operation, settled sewage inflows in excess of 2,3 m^3/s (equivalent to an average flow of 200Ml/d) will be drawn off from the inlet channel to the reactors, upstream of the structure at which flow is divided to the reactors. This excess flow will be diverted to a pump station located on the fermentation thickener terrace from where it will be pumped to the balancing tank. The pump station will be equipped with four horizontal spindle centrifugal pumps with variable speed electric motors so that the pumped flow can pace the flows in excess of 2,3 m^3/s drawn from the inlet channel. The flow into the balancing tank will be controlled by a modulating, electrically actuated valve, to minimize air entrainment. The balancing tank will be positioned at an elevation that will allow flow to gravitate from the tank to the inlet channel downstream of the primary sedimentation tanks during low inflow periods. Outflow from the balancing tank will be regulated by an on/off electrically actuated control valve.

The flow control will be based on the depth of flow in the inlet channel upstream of the flow division to the reactor. Flow division to the reactors is by means of venturi flumes in the inlet channel. By calibration of these flumes, the depth of flow in the inlet channel can be related to the flow in the channel and this depth of flow used to control the removal or addition of flow to the channel to achieve a balanced flow to the reactors.

The primary function of the balancing tank is flow balancing, but some degree of load balancing will also be achieved depending on the magnitude and timing of the diurnal variation in the influent load. The side-line system will achieve better load balancing than an in-line system because better mixing of the influent load over a 24h period is achieved by removing part of the incoming load when the

balancing tank is filling and returning this load to the inlet when the balancing tank is emptying, whereas the balancing capability in the in-line system depends on the average retention time in the tank which is only a fraction of a day.

The proposed infrastructure is indicated on the Process & Instrument Diagram on the attached drawing JW13504-CE-050.

The unit processes of the works must remain in operation during the contract period.

PS 1.4 Scope of Contract

The scope of work under this project will be on a live, operational site and the proposed tenders must therefore take cognisance of this fact when compiling their respective Occupational Health and Safety Plans and shall accommodate appropriate working procedures. It is considered essential that the final effluent 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 to be performed under this contract shall consist of the following:

Concrete Balancing Tank (volume of 25000m^3)
MCC Room
Pump station and various pipelines
Access roadway
Mechanical equipment including mixers, pumps
Electrical equipment
Instrumentation equipment
Alterations to existing channels and pipes

PS 1.5 Location of the Works

The equipment called for under this Contract will be installed at the Bushkoppies Wastewater Treatment Works.

The Treatment Works is located south of the N12 and west of the N1 Freeways, between Eldorado Park and Soweto, approximately 1 kilometre to the southeast of the N12 and Golden Highway (R553) intersection.

PS 1.6 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 Engineer.

The Contractor shall provide all necessary temporary drainage works, temporary pumps and other equipment as might be required for the protection, drainage and dewatering of the Works.

The Contractor shall construct and maintain all temporary access, haulage and construction roads, subject to the approval of the Engineer, and permit all those with legitimate business free and unhindered usage of such roads.

PS 2 ENGINEERING

PS 2.1 Employer's Design

There is no Employer design. The As -built drawings are based on the design completed by Knight Piesold Consulting (Pty) Ltd, Nyeleti Consulting (Pty) Ltd, PDNaidoo & Associates (Pty) Ltd and WSP Consulting Engineering(Pty) Ltd on behalf of the Employer.

When and where specific reference is made or preference shall be given to specified equipment, the Tenderer shall include such as his main offer in the Tender. Should the Tenderer fail to comply with these requirements, this may lead to the disqualification of the tender submitted.

Tenderers are free to propose alternative equipment to that proposed by the Engineer and, provided that drawings with details of each alternative proposal are submitted with the Tender, such alternative proposals shall be considered in the adjudication of a Tender. Full details of any changes must be included with the tender. The cost of any changes to the Engineer's design shall be for the Contractor's account where full details of the changes were not submitted with the tender.

Tenderers must satisfy themselves that the layouts as proposed by the Engineer suit in all respects the equipment proposed by the Engineer or by the Tenderer as the case may be. Where equipment other than that proposed by the Engineer is accepted, it shall be the sole responsibility of the Contractor to ensure that the associated equipment including pipework is compatible with the accepted material and proposed structures.

In the case of the Engineer's acceptance of an alternative proposal, the Contractor shall submit in triplicate to the Engineer 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 Engineer'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

Civil, Building and Structural

The drawings listed in the Drawing Schedule in Volume 4 are issued as part of the Contract Documents. Sufficient drawings to enable the Contractor to commence work will be issued to the Contractor at the start of the Contract period and further drawings will be issued to the Contractor from time to time as the work progresses.

The original Contract Documents and Drawings shall remain in the custody of Johannesburg Water (JW). The Consultant shall produce copies as and when required by JW and the Contractor.

Three complete copies of all contract drawings and of the Specifications (excluding SANS 1200 and the Standardised Specifications) shall be furnished free of cost to the Contractor for his own use. The Engineer shall within ten days after receipt by him of a request for the same, furnish the Contractor with any details that, in the opinion of the Engineer, 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 Engineer and kept at the Works in the Contractor's charge until completion thereof. The Engineer or his representative shall at all times have reasonable access thereto and all drawings shall be returned to the Engineer by the Contractor on the completion of the Contract.

Mechanical, Electrical & C&I

Reduced drawings have been prepared by the Engineer and are included in Volume 4. The drawings are scanned and have no drawing package intelligence. The drawings show the general plan and sectional dimensions of the civil structures into which the electrical, control and instrumentation equipment is to be installed. The design drawings supplied by the Engineer under this contract will have omissions in terms of equipment detail (such as circuit breaker types, surge arrestor types & ratings, instrument types and details, etc.) because these would not be known at the time of tender. It is therefore an explicit requirement of this contract that the successful contractor keep ONE SET of these drawings updated. Updates can be hand written updates, provided that it is clearly legible. After commissioning, this updated set must be submitted to the engineer to enable updating of all design drawings to “As-Built” status.

The Contractor shall keep and maintain a drawing register on site which shall be made available to the Employer and the Engineer. The register shall reflect the drawing number, title, revision number and for what purpose the drawing was issued, e.g. construction.

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 Engineer to finalise the civil drawings and details. Co-operation between the Contractor and the Engineer is essential.

The Contractor shall allow a period of four weeks for the Engineer to finalise the civil drawings if necessary.

PS 3 PROCUREMENT

PS 3.1 Preferential Procurement Procedures

Please refer to JW10 Empowerment and Preferential Procurement, page RD.14 and complete pages RD.20 and RD.21 in the Returnable Document pages.

PS 3.2 Supply and Delivery of Equipment

A delivery period of 24 weeks, within which all materials and equipment must be delivered to site, is envisaged. If the Tenderer considers the delivery time of 24 weeks inadequate for particular items, he 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 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 Schedule of Quantities.

PS 3.2.1 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. The Contractor must strive to keep the number of suppliers to a minimum.

Payment for materials and equipment shall only be effected if the Contractor can prove ownership of the items.

In the case that off-site storage is agreed by the Engineer and Johannesburg Water then payment shall only be effected if the contractor can prove ownership and that cession of ownership from the contractor to Johannesburg Water takes place.

NOTE - It shall be the contractors 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 which shall only take place any time up to 15 months after delivery of the equipment.

PS 3.2.2 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 3.2.3 Particulars of Equipment Offered

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

Technical information regarding medium voltage switchgear, 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 3.3 Subcontracting

The Contractor shall obtain the written approval of the Engineer before appointing any subcontractor. The Contractor shall be solely responsible for the supervision of and payments to such a Sub-contractor (s), and the approval of a subcontractor by the Engineer shall not indemnify the Contractor from any of his liabilities in terms of the Contract .See GCC 2010- Clause 4.4

The portions of work to be executed by selected specialist subcontractors is as follows:

- Mechanical, Electrical & C& I works.

PS 4 CONSTRUCTION

PS 4.1 Applicable SANS 1200 Standards

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

SANS 1200 A	1986	Section A: General
SANS 1200 AB	1986	Section AB: Engineer's Office
SANS 1200 C	1980	Section C: Site Clearance
SANS 1200 D	1988	Section D: Earthworks
SANS 1200 DA	1988	Section DA: Earthworks(small works)
SANS 1200 DB	1986	Section DB: Earthworks (pipe trenches)
SANS 1200 DK	1996	Section DK: Gabions and Pitching
SANS 1200 DM	1981	Section DM: Earthworks (roads, subgrade)
SANS 1200 G	1982	Section G: Concrete (structural)
SANS 1200 GE	1984	Section GE: Precast Concrete (structural)
SANS 1200 HA	1990	Section HA: Structural Steelwork (sundry items)
SANS 1200 HB	1985	Section HB: Cladding and Sheeting
SANS 1200 HC	1988	Section HC: Corrosion protection of structural steelwork
SANS 1200 LB	1983	Section LB: Bedding (pipes)
SANS 1200 LD	1982	Section LD: Sewers
SANS 1200 LE	1982	Section LE: Stormwater Drainage
SANS 1200 ME	1981	Section ME: Subbase)
SANS 1200 MJ	1984	Section MJ: Segmented Paving
SANS 1200 MK	1983	Section MK: Kerbing and Channelling

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,

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: Standards South Africa,

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PS 4.2 Particular Generic Specifications

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.

General	
G01	Colour Coding Of Equipment
G02	Corrosion Specification

Civil	
PWA	Watertightness Testing of Tanks
PWB	Building Work
PWC	Subsurface Drains
PWD	Pipelines and specials

Mechanical Works	
M05	Anaerobic and Anoxic Mixing Equipment
M08	Mechanical Gearboxes
M17	Mechanical Actuator Equipment
M18	Mechanical Centrifugal Pumps
M20	Mechanical Valves: Manufacture and Supply

Electrical Works	
E01	Electrical Motors
E02	Electrical Cable Racking
E03	Electrical Isolator Pushbutton station (Local Start/Stop) 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
E11	General Electrical Earthing and Lightning Protection
E12	Electrical Medium Voltage Cables
E17	Variable Speed Drive (VSD) Units
E18	Electrical Miniature Substations
E21	Electrical Lighting and Illumination

Electrical Works (Automation And Control)	
Volume 3	Programmable Logic Controller (PLC) Panels
Volume 5	Clean Power And Surge Protection
Volume 6	Cabling
Volume 7	Networking
Volume 8	Flow Measurement
Volume 9	Level Measurement
Volume 19	Field Junction Boxes And Panels

The listed specifications are bound in Volume 3.

PS 4.3 Plant and Materials

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 Engineer shall be replaced or repaired by the Contractor at his own expense to the satisfaction of the Engineer, 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 Engineer's approval in writing.

PS 4.4 Construction Equipment

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

PS 4.5 Existing Services

The existing treatment works must remain in operation during the execution of the contract. The Employer must have access to the works at all times. If the work to be done requires the treatment works to be out of operation for a short period, prior arrangements must be made at least one week in advance with the Engineer.

There are a number of points of connection to the existing structures, channels, pipelines, as well as electrical and control networks with the new works that should be regarded by the Contractor as being tie-ins to live systems. The Contractor must give the Engineer and the Works Manager ten days written notice of any disruption to the normal plant operations, and shall comply with all requirements of the Works Manager in arranging the required connection.

The known existing services are shown on the drawings. The positions of the services cannot be guaranteed. On establishing on Site, the Contractor shall determine the positions of all pipelines and cable routes on Site with the assistance of the Engineer's and the Employer's staff on Site. The Contractor shall take precautions to prevent any damage to existing services

Any damages which might occur shall be repaired at the cost of the Contractor, to reinstate the services to that of the original status prior to the commencement of the Contract.

PS 4.6 Site Establishment, Facilities Available and Required

PS 4.6.1 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 measured 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 his 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.

JW does not guarantee continuity of supply and in such cases the Contractor shall make his 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.

Treated effluent for carrying out the water test will be available at the combined effluent manhole at the module 1 clarifier terrace, which lies within 220m from the balancing tank. Used effluent water must be returned and discharged into this manhole.

PS 4.6.2 Power Supply for Construction Purposes

Supply of Electricity

The Contractor shall make a connection to the 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 his 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 Engineer and the Work 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 his 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.

Application for Supply

A request for power shall be submitted to the Works Manager via the Engineer at least two weeks before a power supply is required.

PS 4.6.3 Lifting Equipment

Lifting equipment is not available on the site.

PS 4.6.4 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 is shown on drawing 14120-CE-001. The Contractor shall advise in his tender the area required for site establishment.

Although the security of the Works is outsourced by Johannesburg Water to a security firm, the Contractor shall make his own arrangements to secure the facilities provided.

No employees, apart from a security guard, may be housed on the Site of the Works.

Upon completion of the work in terms of this contract, the site must be cleared of all structures, concrete slabs and waste and excavations must be backfilled.

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

PS 4.6.5 Telephone Facilities

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

PS 4.6.6 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 the minimum acceptable standard. These must be placed in a position to be approved by the Engineer. The facilities must be to the Engineer's approval and must be maintained in a clean and sanitary condition.

PS 4.6.7 Storage Facilities

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

PS 4.6.8 Site Facilities Required

PS 4.6.9 Facilities for the Engineer

(a) Two name boards (Provisional Quantity) shall be erected and the boards shall comply with the format and size shown on Drawing No. JW13504-CE-016 bound in Volume 4, as a reduced drawing.

No other name board than stated above shall be allowed and on completion of the works, the Contractor shall remove the board from the Site of Works on completion of the maintenance period and prior to the release of retention monies.

(b) Office Building

Three offices, complete with furnishings as specified, must be provided by the Contractor for the exclusive use by the Engineer.

The Contractor must consult with the Engineer prior to the supply and erection of the office.

(c) Carports

A carport to provide for four motor vehicles shall be provided adjacent to the Engineer's office for his exclusive use. The carport shall have side cladding and shall be constructed in such a way as to shelter the parked vehicles from the prevailing winds and rain.

(d) Ablution and Latrine Facilities

The Contractor shall, in addition to catering for his own staff, provide ablution and latrine facilities adjacent to the Engineer's office for the exclusive use of the Engineer and his 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.

(e) 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 shall provide two sets of safety helmets and rubber boots for the exclusive use of the Engineer and his staff.

(f) Services for Office and Ablutions

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

PS 4.7 Measurement and Payment

The site facilities described in PS 4.7.1 for the Engineer have been provided for in the Preliminary and General Items.

PS 4.8 Facilities for the Contractor

The Contractor must provide, maintain and remove his own facilities to the satisfaction of the Engineer. The Contractor shall provide the area around his 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 he deem it 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 tendered sums for as scheduled by the Engineer, 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 4.9 Waste Disposal Sites

The Contractor shall make his own arrangements for solid and liquid waste disposal. Disposal shall take place at an approved Site. No approved sites are available within the Bushkoppie Works terrain.

PS 4.10 Site Usage

Access to the Site is by means of existing tarred roads through the main access gate, which is controlled by a security company appointed by Johannesburg Water. No restriction on access to the Site of Works shall be placed on persons or vehicles involved with the execution of the Works. All traffic must be restricted to the maximum speed of 40 km/h and vehicles must be driven with extreme caution. The Contractor shall only make use of the site area as indicated on the drawings or as directed by the Engineer.

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

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

Movement within the Site of Works is restricted so as to avoid damage to the existing services, structures, trees and, where practical, to the gardens. The making good of any damage caused by non-observance of such restrictions shall be for the Contractor's account.

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

PS 4.11 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 4.12 Alterations, Additions, Extensions and Modifications to Existing Works

The work involves the breaking in and connection to the main existing reinforced concrete channel. The flow in the main channel cannot be interrupted. Work must be scheduled to be carried out at the times of lowest possible flow. The contractor must ensure necessary resources and equipment 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 to the existing treatment process shall be discussed and agreed with the Engineer and the Works Operational staff.

The proposed sequence of **connecting the pump sump and pipelines** into the existing main channel would involve the following:

- constructing new pump station and seal wet well from dry well (not for pipelines)
- install temporary work on the wet side of the channel to create a coffer dam during time of diurnal low flow
- cut out concrete and make good concrete edges and install penstocks or pipe behind the coffer dam
- remove the temporary work during time of diurnal low flow

The proposed sequence **of alterations A1 & A2 to main channel** would involve the following:

- Relocate sludge pumping main from channel 3
- Install 2 new penstocks in channel 3 at bifurcation , test & and close penstocks
- Construct new diagonal wall in channel 3
- Install temporary work to allow removal of brick wall in channel 3
- Precut as far as possible common wall between channel 2 and 3 from channel 3
- Close penstocks in channel 2 at low flow (all flow temporarily to channel 1 from 0h00 to 5h00) Complete cut out of concrete in common wall between channel 2 and 3 and make good concrete edges Install & fix precast diagonal wall into place in channel 2.On completion open penstocks on channel 3
- Install temporary works to allow for cleaning of channel and dowelling
- Insert precast flow splitter ahead of channel 2, seal & pump out channel 2

The proposed sequence of **alterations A3 (after A1&A2 completed) to channel feeding Reactor 1&2** would involve the following:

- Close penstocks in channel 1 at low flow (all flow temporarily to channel 1 from 0h00 to 5h00) Divert flow to channel 3 and install dowels. Install precast dividing walls. Reopen penstocks in channel 1

The proposed sequence of **alterations A3 (after A1&A2 completed) to channel feeding Reactor 3&4** would involve the following:

- Close penstocks in channel 3 at low flow (all flow temporarily to channel 1 from 0h00 to 5h00) Divert flow to channel 1 and install dowels. Install precast dividing walls. Reopen penstocks in channel 3

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 Engineer and the Works Operational staff. Where necessary, detailed method statements will be required to be provided. Allow four weeks for approval of method statements.

PS 4.13 Inspection of Adjoining Properties

The Contract does not require the Contractor to perform inspections of adjoining properties.

PS 4.14 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. JW 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 bench marks he has provided.

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 Engineer. The cost of these secondary setting out points shall be borne by the Contractor, and shall be deemed to be included in his 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 4.15 Accommodation and Care of Employees

Accommodation will not be provided by JW and the Contractor shall make his own arrangements for accommodation where required.

PS 4.15.1 Housing

No employees, apart from security guards, may be housed on the Site of Works. Although the security of the Works is outsourced by JW, to a security firm, the Contractor shall make his own arrangements to secure the facilities provided for under the Contract.

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

PS 5 MANAGEMENT OF THE WORKS

PS 5.1 Applicable SANS 1921 Standards

For the purposes of this Contract the following National Standard shall be applicable:-

SANS 1921 -1: 2004 first edition (1): Construction and Management Requirements for Works Contracts: Part 1: General engineering and construction works.

PS 5.2 Planning and Programming

PS 5.2.1 Detailed Programme

A detailed programme in terms of the General Conditions of Contract clauses 5.6.1 to 5.6.2.6, complete with a cash flow budget for the execution of the works must be made available to the Engineer for approval within 14 days after the receipt of the letter of acceptance. Aspects that shall require co-ordination with the Employer must be indicated clearly and provision must be made for it in the programme.

It is expected that this Contract will be awarded during June 2015 and the works must be operational towards Dec 2016.

No work of a permanent nature may be executed before the programme has been approved by the Engineer.

The Engineer retains the right to alter, as circumstances may require, the sequence in which installation is to be executed. Such alterations shall only be made after consultation with all parties concerned.

In drawing up the programme, reference shall be made to clauses PS 3.2, PS 4.5, PS 5.3 and PS 5.7. Also allow for the stipulation that the new works as a whole must be fully operational for an uninterrupted period of 14 days before the equipment shall be considered as being successfully installed and commissioned (PS 5.7).

There will be numerous subcontractors at work on the same site. The Contractor will be required to adjust his programme to accommodate the access and working needs of sub-contractors. The Contractor will be required to interface his programme with the programmes of the sub-contractors in consultation with the Engineer during the construction period.

The Contractor shall submit with his tender his proposed programme of construction for approval by the Engineer. Thereafter, the Contractor may not deviate from his proposed sequence of construction without the prior approval of the Engineer. The contract programme submitted shall show the manner and order of all proposed work fronts. The Contract programme shall take account of the following:

- The Contractor shall appoint a project programmer/ planner for liaison during the Contract.
- No deviation from the approved sequence of construction shall be accepted without prior written approval.

- The programme shall not be in the form of a bar chart only, but shall be in MS project format complete with resources for each activity and show clearly the anticipated quantities of work to be performed each month, together with the anticipated cashflow for each month of the project.

- 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 programme is deviated from in any other way, the Contractor shall, within one week after being notified by the Engineer, 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 necessary to ensure completion of the Works or any part thereof within the time for completion.

- 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 General Conditions of Contract.

- The approval by the Engineer of any programme shall have no contractual significance other than that the Engineer 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 Engineer to instruct the Contractor to vary the programme should circumstances make this necessary.

PS 5.2.2 Methods and Procedures

The Contractor is to supply detailed method statements, complete with resources, as to how he intends to complete the work on the project.

PS 5.3 Sequence of the Works

As per Clause 5.6.1 of the General Conditions of Contract the Contractor shall submit for approval to the Engineer, within the time stated in the Contract Data, a detailed programme showing the order of, procedure and method in which he proposes to carry out the Works and as well as his method of measurement of progress.

Details of certain mechanical equipment, which will have an influence on the final design of certain components and drawings thereof of some of the civil works to be constructed under this contract. The Contractor will, therefore, be required to take this into account in drawing up his programme. Areas, which will be affected by this constraint, are:

1) Pumping station ;
2) Mixer bridges

The Contractor shall, whenever required by the Engineer, furnish for his information particulars in writing of the Contractor's arrangements for the carrying out of the works and of the plant and temporary works that the Contractor intends to supply, use or construct as the case may be. The submission to and approval by the Engineer of such programme, or the furnishing of such particulars will not relieve the Contractor of any of his duties or obligations under the contract.

The Tenderer shall submit with his tender separate management and supervisory organisation charts and supervisory and labour histograms as well as an estimated cash flow for the project.

Constraints

The following activities will need to be carried out, and in some cases completed, before the bulk excavation can commence. This is to ensure uninterrupted workings of the existing units at the Works.

a. Relocation of services at the balancing tank and pumping station.

Alterations to existing live channels shall be carried out at times suitable to the operation of the plant and shall be scheduled for low flow conditions which occur outside normal working hours.

PS 5.4 **.**Software Application for Programming

All construction programmes for the Completion of the Works shall be submitted to the Engineer in an approved format and software programme. (MS projects is considered acceptable software)

PS 5.5 **Quality Plans and Control**

Quality plans and the control shall be in accordance with the requirements of the Particular Specifications as compiled and included herein after and forming part of the Contract document. These shall be completed and inserted in the data books after commissioning.

PS 5.6 **Other Contracts and Facilities to Other Contractors and Authorities on Site**

This contract entails civil, mechanical, electrical and control and instrumentation works and shall be awarded to one main contractor. The main contractor shall be responsible to co-ordinate all works of a civil, mechanical, electrical and control and instrumentation nature.

It is expected of the Contractor to schedule his work in such a way to ensure optimal completion of the work as a whole. The Engineer retains the right to intervene and prescribe where and when work must be executed in order to ensure a well-coordinated completion of the works as a whole.

Access is to be made available to employees of Johannesburg Water to any portion of the works whenever required for normal operation and maintenance of the existing works.

PS 5.7 Testing, Completion, Commissioning and Correction of Defects

PS 5.7.1 Installation and Commissioning

The Contractor shall be responsible for co-ordinating all works of a civil, mechanical and electrical and control & instrumentation nature, all to the approval of the Engineer. The completion time (in weeks) quoted by the Tenderer must not make provision for any statutory or other holidays which may occur during the contract period. In determining the contractual completion date a week shall be taken to be five (5) working days (Saturdays and Sundays excluded).

The contractual completion date shall be postponed with a number of days equal to statutory holidays that fall on working days within the actual installation period.

The Contractor shall be responsible for commissioning the equipment which shall comprise putting it into operation, testing, calibration, proper adjustment of the equipment, and thoroughly running it. After the entire installation has been completed and the individual installations have been tested, the Contractor shall commission the equipment supplied and installed by him as required by the Engineer. After the works for each section, as agreed with the Engineer, has been put into operation, the Contractor shall operate the equipment installed under this contract for a continuous period of 14 successive days and simultaneously train the Employer's plant supervisors in the correct operation and maintenance thereof. The Certificate of completion shall only be issued if all the equipment within a section has passed the 14 day continuous test run and the Employer's plant supervisors have been sufficiently trained to continue with the operation of the plant. A Partial Certificate of completion refers to equipment within a section having passed the 14 day continuous test run and the Employer's plant supervisors have been sufficiently trained to continue with the operation of the plant.

The term "installation and commissioning" of material and equipment shall include the on-site handling, on-site transport, positioning, erection, connection, anchoring, installation and protection thereof, as well as the successful completion of all the specified tests on completion as defined under PS 5.7.2 and PS 5.7.3 and the successful completion of the commissioning period, including the training of the Employees plant supervisors. The tendered rates shall cover all costs for installation and commissioning by the Contractor, including all cost of consumables, labour, erection gear, testing equipment, attendance, additional site visits and profit.

Section payments against each item in accordance with the progress of the work shall be made on a pro rata basis for up to seventy five (75) percent of the amount tendered against each item on completion of installation and site testing, but with the 14 day continuous plant test pending.

No other payment for installation and commissioning of materials and equipment shall be considered other than that under the "installation and commissioning" items in the Schedule of Quantities.

PS 5.7.2 Testing

General

The Contractor shall be responsible for the completed installation passing any tests specified or required by the relevant Local Authority or ACT. The Engineer

shall be entitled to be present at such test and the Contractor shall give the Engineer reasonable notice of the dates of the test. Where test certificates are required in terms of any clause of the Specifications or ACT, such certificates shall be submitted to the Engineer immediately after the relevant test have been completed and before the tested equipment is delivered, installed or commissioned as the case may be.

Before handing over the plant the Contractor must carry out tests as specified in detail in the various Sections. The entire cost of testing, including supply of test equipment must be borne by the Contractor and an adequate allowance for such tests must be made in the tendered price. The results of all performance tests shall be fully documented and copies in triplicate submitted to the Engineer prior to final acceptance of the equipment.

The Completion Date will be taken as the date on which the relevant portion of the plant as a complete unit is commissioned or when all the performance tests, have been completed to the satisfaction of the Engineer, whichever date is the later. Johannesburg Water will accept the plant in question on the completion date as herein defined.

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 applicable shall be supplied. Such additional tests in the manufacturer's "Works", which in the opinion of the Engineer 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.

Tests on Site

All Site tests shall normally be carried out in the presence of, but always to the satisfaction of the Engineer 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.

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 shall be accepted as approved laboratories in which tests or design work required in terms of a specification may be carried out.

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 5.7.3 Servicing

Without limiting in any way, the obligations or responsibilities of the Contractor for maintenance, the Contractor shall make regular quarterly visits to the plant during the maintenance period to supervise the maintenance of the plant. 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 Engineer 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 maintenance 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 maintenance period shall not terminate until the Engineer is satisfied that the Contractor has finally checked the adjusted equipment.

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

The tendered rate shall exclude the cost of providing lubricants but shall cover the cost of servicing visits and operation as specified above.

PS 5.8 Format of Communications

All communication shall be in writing. The format of all communication shall be as approved by JW. The address shall be as stated in the Contract data.

PS 5.9 Key Personnel

Tenderers shall state, in the format of a schedule, the posts for which he shall consider key personnel for the Site of Works. The number of such key personnel occupying the Site shall not be required at the tender stage. The contractor once formally requested, by the Engineer, shall make available the contact details of all the key personnel on site.

The Contractor shall not withdraw from the Site of the Works any of his erection and installation staff until such time as the plant has been completely erected and installed, except with the written consent of the Engineer.

PS 5.10 Management Meetings

The Contractor shall be required to attend separate monthly management progress meetings. Minutes shall be kept by the Engineer who shall distribute such minutes to the Employer and the Contractor. The Contractor must include for attending technical meetings as and when required by the Engineer.

PS 5.11 Forms for Contract Administration

The Employer shall provide all standard forms for the administration of the contract. The Contractor shall be required to correspond on the standardized format.

PS 5.12 Daily Records

The Contractor shall be required to keep a daily on Site record activity report. The activity report shall be submitted to the Engineer's Representative for signature on a daily basis. Daily records shall include all on site activities and progress made shall be kept by the Contractor. These records shall include all material deliveries for the day, personnel employed on the Site of Works, equipment delivered to site or storage and the number of man-hours for the

week in question. Plant used during the on-site activities shall need to be recorded by the Contractor.

PS 5.13 Payment Certificates

Monthly payment certificates shall be submitted by the Contractor in the format approved by the Engineer.

Payment for particular items scheduled shall conform to the payment clauses of the Project Specifications and that of the Particular Specifications.

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.

No claims whatever for extras shall 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 5.7, and PS 6.7.

Before becoming entitled to any of the above payments, the Contractor shall lodge with the Engineer 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 Engineer.

Payment Certificates shall be delivered to The Engineer by the 10th of each month.

PS 5.14 Permits

Whatever import, transport, equipment certification permits etc are necessary for the completion of the Works to be carried out under this contract shall be the contractor's responsibility to obtain.

PS 5.15 Recording of Weather and Abnormal Rainfall

No extension of time for completion will be granted on account of normal inclement weather, but extension of time shall be determined for abnormal rainfall or wet conditions in accordance with the formulae given below, separately for each calendar month or part thereof. It shall be calculated for the full period for completion of the Contract plus any granted extension thereof:

$$V = (Nw - Nn)\, Rw/Rn \quad \text{..... if } (Nw - Nn) > 0$$

The symbols shall have the following meanings respectively:

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 10 mm or more is recorded.

Nn = Average number of days, as derived from existing rainfall records, on which a rainfall of 10 mm or more has been recorded for the calendar month.

Rw= Actual rainfall in mm recorded for the calendar month.
Rn = Average rainfall in mm for the calendar month under consideration as determined from existing rainfall records.

When calculating extension of time for a part of a month pro rata values of Rn and Nn shall be used.

The factor Rw/Rn shall be deemed to be a fair allowance for days on which wet conditions disrupted or prevented work, but on which a rainfall of 10 mm or more was not recorded. If the value of Rw/Rn exceeds 2,5 it shall be taken as 2,5.

If Nw for any month is smaller than Nn, the formula used shall be

V1 = (Nn-Nw)

The total extension of time for completion shall be the sum of the values of V, minus the sum of the values of V1.

Total extension of time $= \Sigma V - \Sigma V1$

The following are the most reliable values of Nn and Rn available and shall be used unless other values are mutually agreed upon beforehand:

MONTH	***Nn***	***Rn***	***MONTH***	***Nn***	***Rn***
January	4,6	124.9	July	0,1	3.2
February	3,0	104.3	August	0,1	5.9
March	3.2	96,2	September	0,8	24.0
April	1,4	39.3	October	2,2	70,9
May	0,3	13.2	November	3,5	100.7
June	0,1	5.2	December	3.7	111.8
YEARLY AVERAGE					699.5

Source of information: Weather Bureau, Department of Transport, Pretoria, for Sandton.

Accurate rain gauging shall be done at the offices of the Resident Engineer. This data will be regarded as the actual recorded rainfall for the Contract. The readings will be done by the Resident Engineer and the Contractor may attend when rainfall is being gauged.

Any extension of time determined in accordance with the above requirements shall be granted in terms of Clause 5.12 of the General Conditions of Contract, specifically Clause 5.12.2.2: Abnormal climatic conditions.

The Contractor shall allow in his rates and prices for all the effects of adverse weather conditions. In this regard the Contractor should note that all vehicles are susceptible to mobility difficulties in certain parts of the site except that which is prepared to receive traffic.

PS 6 FEATURES REQUIRING SPECIAL ATTENTION

PS 6.1 General Conditions of Contract (GCC)

Although the Contract comprises work which includes that of a mechanical, electrical and control and instrumentation nature, the Contract Document is compiled in accordance with the General Conditions of Contract for Construction Works, Second Edition (2010) and Tenderers are therefore required to price the Tender accordingly.

PS 6.2 Security

Though the security of the Bushkoppie Works is outsourced by JW to a security company, the Contractor shall make his own arrangements to secure the on-site facilities provided for the execution of the Contract. The Contractor's required security arrangements shall cover all his works, materials, plant and equipment and personnel.

PS 6.3 Schedule of Quantities for Mechanical, Electrical & C&I Work

The schedules for the electrical, control and instrumentation works differentiate between the supply and delivery of equipment and the installation and commissioning thereof so as 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 electrical, control and instrumentation works.

PS 6.4 Additional Meetings

The costs of all additional meetings or inspections over and above the normal, that take place because of the Contractor not keeping to his program or because of the quality of his work shall be for the account of the Contractor and shall be deducted from the following payment certificate. An amount of R5000.00 per meeting shall be paid by the Contractor to compensate for the travelling cost, time, etc. of both the Engineer and the Employer.

PS 6.5 Certificate of Completion

The Certificate of Completion shall be issued after the successful commissioning of all equipment as described in PS 5.7. The twelve months defects liability period shall start on the date stated in the Certificate of Completion.

Guarantees shall be reduced or returned to the Contractor after issuing of the Certificate of Completion and retention monies shall be paid out after the defects liability period has elapsed. The Certificate of Completion shall not be issued until the documents required in terms of this Contract have been lodged with and accepted as satisfactory by the Engineer.

The issuing of the Certificate of Completion could be delayed if the equipment supplied under this contract cannot be commissioned. If the issuing of the Certificate of Completion is delayed for reasons beyond the contractor's control, the Contractor shall be compensated for his 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.

Measurement and Payment | Unit

Compulsory postponement of the issuing of the Certificate of Completion .....Rate/day

PS 6.6 Foreign Exchange Risks

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 when that is stated in the Letter of Acceptance.

Amounts tendered shall be adjusted for foreign exchange variations up to the date for commencement of the Contract; any fluctuations after this date shall be for the Contractor's account.

PS 6.7 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 Engineer.

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 6.8 Operation Manual

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.

(b) A complete spares 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 Engineer is satisfied that they shall 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 three suitably bound copies and deliver them to the Engineer.

The manuals shall be drawn up in English.

In addition to the above, the Contractor, and where necessary the suppliers of equipment, shall be required to instruct the works personnel in the proper and correct operation of the equipment installed for a maximum period of 1 day. The timing of this training shall be determined in consultation with the Employer and the Engineer.

Mechanical, Electrical, and C&I Requirements for as built drawings

All duly signed As Built Drawings are to be submitted in a transparent plastic format as supplied by REGMA or similar.

Transparent plastic specification for 914mm x 45m 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 format.

In addition to the above a bound volume in A3 paper prints of all Electrical drawings are to be supplied.

PS 6.9 General

PS 6.9.1 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
IEC	:	International Electrotechnical Commission

PS 6.9.2 Metric Symbols

Symbols prescribed by the System Internationale (SI) are used in these Specifications.

PS 6.9.3 Definitions

OHS ACT : Occupational Health and Safety Act, 1993 (Act 85 of 1993), as amended and including any regulations made thereunder.

PS 6.9.4 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 6.10 Installation of Equipment

PS 6.10.1 Safety

The Contractor shall at all times observe proper and adequate safety precautions on the Site. Where adequate, safety precautions are not being observed, the Engineer may order the Contractor to comply with minimum safety requirements at the Contractor's expense and compliance with such an order shall not absolve the Contractor from any of his responsibilities and obligations under the Contract and the Occupational Health and Safety Act.

PS 6.10.2 General

A skilled erector shall be in charge of the work at all times and any instructions and explanations which the Engineer 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 6.10.3 Operation of Valves

The Contractor may not operate any valves, sluice gates or any other equipment currently in use on the works without permission from the Works Manager

PS 6.11 Work Outside Normal Working Hours

Should the Contractor wish to work outside normal working hours (Monday to Friday 07h00-17h00) he is to obtain permission from the Engineer. This permission shall not be unreasonably withheld.

PS 6.12 Community Liaison and Community Relations

See Clause 1.4 of the Environmental Management Plan forming part of this document. The Contractor shall in consultation with the local ward counsellor employ a full time Community Liaison Officer for the duration of the contract.

PS 6.13 Employment of Local Labour

The Contractor shall make every effort to employ staff from the local communities within the Johannesburg Metropolitan Area. Unskilled workers may only be brought in from outside the local communities if such personnel are not available locally

The Contractor shall make every effort to employ staff from the local communities within the Johannesburg Metropolitan Area. Unskilled 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, steelfixers, shutter hands, drivers, clerks etc.is required: The minimum total number of man days of work provided to the community, local to the construction site, shall be 6000 for the contract.

PS 7 HEALTH AND SAFETY SPECIFICATION FOR CONSTRUCTION WORK

Tendering Contractors are to prepare Health and Safety Plans in accordance with Johannesburg Water's Health and Safety Specification (refer to Volume 2: 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:

Regulation 5(1)(b): A client must prepare a suitable, sufficiently documented and coherent site specific health and safety specification for the intended construction work based on the baseline risk assessment

Regulation 5(1)(f): A client must include the health and safety specification in the tender documents;

Regulation 5(1)(i): A client must discuss and negotiate with the principal contractor the contents of the principal contractor's health and safety plan contemplated in regulation 7(1), and must thereafter finally approve that plan for implementation;

Regulation 5(1)(m): A client must ensure that a copy of the principal contractor's health and safety plan is available on request to an employee, inspector or contractor;

Regulation 5(1)(n): take reasonable steps to ensure that each contractor's health and safety plan 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, which 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;

Regulation 7(1)(b): A principal contractor must open and keep on site a health and safety file, which must include all documentation required in terms of the Act and these Regulations, which must be made available on request to an inspector, the client, the client's agent or a contractor;

PS 7.1 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 identification and assessment of risks. The tendering Contractors are required to consider *inter alia* the following risks (where applicable):

Project- and site-specific risks:

- Excavation and safeguarding of trenches;
- Working in confined spaces;
- Working next to roads;
- Traffic control;
- Plant and machinery operation;
- Existing services;
- Offloading of material;
- Overhead power lines;
- Hand tools;
- Laying of pipes;
- Laying of cable trays and cables;
- Machine operator;
- Third party exposures;
- Use of portable electrical tools;
- Location of site camp;
- Levelling of materials;
- Storage and handling of material;
- Storage of hazardous materials;
- Fire prevention and protection;
- Fuel supply;
- Refuelling vehicles/plant;
- Welding;
- Gas welding and cutting operations;
- Handling of compressed gas cylinders;
- Handling of asbestos;
- Aggregate/Sand Delivery;

- Form and Support work;
- Landscaping;
- Lifting equipment;
- Loading/unloading supervision;
- Material delivery;
- Material handling;
- Installing cable mounting poles;
- Gas explosions;
- Excavator;
- Drivers – of vehicles;
- Electrical Distribution boards;
- Demolitions;
- Corrosive liquids;
- Other contractors;
- Hand drills;
- Pedestal Drills;
- Bench grinders;
- Pedestal Grinders;
- Placing concrete;
- Portable ladders;
- Scaffolding;
- Site Establishment;
- Working on elevated positions;
- Working close to existing services i.e. electrical, water, etc;
- Working close to water and on bridges;
- Working with pressure vessels under pressure;
- Workshops;

Safe work and emergency procedures need to be prepared to address the abovementioned risks.

PS 7.2 Guide to Risk Assessments

PS 7.2.1 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 analyze 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 7.2.2 How serious is it?

Probability

A Common
B Has Happened
C Could Happen
D Not Likely
E Practically impossible

Consequences

1 Fatality or permanent disability.
2 Major injury.
3 Average Lost Time Injury.
4 Minor Injury.
5 Medical Treatment or less.

Consequence	Probability A	B	C	D	E
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).
4 - 5 =	High	Within 1 month.
6 - 7 =	Moderate	> 4 weeks.
8 - 9 =	Acceptable	No action but shall consider from time to time.

PS 8 ENVIRONMENTAL PLAN

Tendering Contractors are to adhere to the mitigation measures listed in the Environmental Management Plan (EMP) (refer to Volume 2: 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).

PORTION 2: PARTICULARS OF REQUIRED CIVIL WORKS

VARIATIONS AND ADDITIONS TO THE STANDARDISED SPECIFICATIONS

The number of each clause and each payment item in this part of the Project Specification consists of the prefix PS followed by a number corresponding to the number of the relevant clause or payment item in the Standard Specification. The number of a new clause or payment item, which does not form part of a clause or payment item in the standard specification and which is included here, is also prefixed PS but followed by a new number which follows on the last clause or item number used in the relevant section of the Standard Specifications.

SABS 1200 A: CIVIL ENGINEERING CONSTRUCTION: GENERAL

PSA 3 MATERIALS

PSA 3.1 QUALITY

Add the following to this sub-clause:

The Contractor must supply and/or take delivery as necessary, deliver all material and is responsible for the handling, transport and storing of the material. All material but especially fragile material must be handled with care and any damaged material must be repaired or replaced according to the Engineer's instructions at the Contractor's expense.

Before material is used the Engineer must approve the manufacturer's published instructions. All material used must carry the appropriate official standardisation mark and the Tenderer must produce on request certificates that show that the material comply with this requirement.

PSA 5 CONSTRUCTION

PSA 5.1.1 Setting out of the works

Add the following":

the attention of the Contractor is drawn to the fact that precise position, slope and description of any part of the Works may be changed by the Engineer as the work progresses. 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 or orders that he may receive from time to time from the Engineer. The Contractor shall be held responsible for the accuracy of the setting out for the full period of the Contract. The Engineer shall check the accuracy of lines, surfaces, curves, and measurements in general. The Contractor should also use equipment and instruments that can ensure the necessary accuracy as he shall be held responsible for the correction of any error at his own expense.

The Contractor shall update the plans which are kept on Site so that all the changes approved by the Engineer are reflected on the drawings. These drawings will represent “As

Built" records and must consequently reflect the Works as they are actually built. No extra payment will be made for this. These drawings must be checked periodically by the Engineer and after completion of the Contract they shall be handed over to the Engineer.

PSA 5.1.2 Preservation and replacement of beacons and pegs subject to the Land Survey Act

Delete this sub-clause and replace with the following:

The Contractor's attention is drawn to the provisions of Sections 35 and 36 of the Land Survey Act, 1927 (Act No 9 of 1927), in terms of which he will be deemed to be responsible for the safety of any survey beacons, survey bench marks and plot boundary pegs encountered on the Site, as well as for all costs incurred in the replacement by a Registered Land Surveyor, in terms of the said Act, of any such marks or pegs that are moved or damaged.

PSA 5.4 PROTECTION OF OVERHEAD AND UNDERGROUND SERVICES

Delete the existing clause and replace with the following:

The Contractor will be held responsible for any damage to overhead or underground services and he shall take all necessary measures to protect them. All work or protective measures shall be subject to approval of the authority concerned. In the event of a service being damaged, the Contractor shall immediately notify the authority concerned as well as the Engineer. The Contractor shall not repair any such service unless instructed to do so.

Timeous written notice shall be given by the Contractor to the Engineer 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 program 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.

Where no underground services are shown on the drawing or scheduled but the possibility of their presence can reasonably be inferred, the Contractor shall ascertain, by exploratory excavations using hand tools, or by specialist equipment for the detection of services as instructed by the Engineer, whether any such services exist within the relevant section of the Site. The Contractor shall complete such an investigation well in advance of the start of construction work in the said section and he shall submit a report in good time to enable the Engineer to make whatever arrangements are necessary for the protection, removal or diversion of the services before any construction work commences.

Whilst every effort will be made to ensure that any information relating to underground services is correct the Council takes no responsibility for the accuracy, nor 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 Council 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.

After an existing service has been passed in laying the water pipe, but before backfilling has been started, the Engineer or relevant authority shall be informed in order that they may certify in writing that the service has not been damaged.

The Council reserves the right to prosecute under the terms of Local Government Ordinance No. 17 of 1939 and the Electricity Act No. 40 of 1958 where Council Services have been wilfully or negligently damaged.

PSA 7.2 APPROVED LABORATORIES

Add the following to this sub-clause:

Any testing laboratory that the Contractor proposes to use for the purposes of quality control on the Works, shall be subject to approval by the Engineer.

PSA 8 MEASUREMENT AND PAYMENT

PSA 8.1.2 Preliminary and general item or section

Add the following to this sub-clause:

The gross amount for payment reference items 8.3 plus 8.4 (excluding standing time) may not exceed more than a maximum of 15% of the total tendered contract amount *excluding* contingencies. If an amount tendered for this item exceeds the above, the tender will be altered to the reduced amount.

The tendered rates will be fixed and the tendered amount will be determined from these fixed rates and will be subject to any changes in the actual quantity of the work done under Contract, which may be more or less, and which may necessitate altering the duration of the Contract.

Payment for the tendered time-related sums will be effected on the basis of the contract period subject to payment for the relevant fixed-charge item having been made. Should a fixed-charge item not be required for any period during the Contract or provision of any fixed-charge item be delayed by the Contractor, the sum tendered for the relevant time-related item shall be reduced proportionately.

It may be expected from the Contractor to prove ownership of the camps and equipment on site and that the value of these exceeds the amount claimed for this item.

In the case of the Contractor not satisfying the Engineer concerning proofing ownership or value of the camps and equipment, the Engineer may hold back on full payment regarding this item.

PSA 8.2.2 Time-Related Items

The following shall be added:

"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 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, an extension of time equivalent to the number of normal working days falling within that holiday period will be granted, but the time related charges paid over such 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."

PSA 8.3 Scheduled Fixed-Charge and Value-Related Items

Payment References 8.3.2.1 a) and b) shall be deleted

Add the following items:

8.3.5 Quality Control Plan and Compliance thereof …….....Unit : Sum

8.3.6 Compliance with the Occupational Health and Safety Act and Specification……Unit : Sum

8.3.7 Compliance with the Environmental Management Plan……. Unit : Sum

8.3.8 Liaison with Authorities, opportunities to, and Co-operation with Others on site .....Unit : Sum

8.3.9 Security Electric Fence at Contract Administration Office

Provide an electric fence around the perimeter of the Contract Administration Complex..... Unit Sum

8.3.10 Compliance with the Occupational Health and Safety Act and Specification at tie ins with and work on existing channels ……Unit : Sum

The sums tendered shall include for all the requirements contained in the relevant Specifications.

PSA 8.4 Scheduled Time-Related Items

Payment References 8.4.2.1 a) and b) shall be deleted.

Add the following items:

8.4.6 Quality Control Plan and compliance thereof….Unit : Sum

8.4.7 Compliance with the Occupational Health and Safety Act and Specification……Unit : Sum

8.4.8 Compliance with the Environmental Management Plan……. Unit : Sum

8.4.9 Liaison with Authorities, opportunities to and Co-operation with others on site.....Unit :Sum

8.4.10 Security at Contract Administration Office Complex

Maintain an electric fence around the perimeter of the Contract Administration Complex Unit Sum

8.4.11 Compliance with the Occupational Health and Safety Act and Specification at tie ins with and work on existing channels ……Unit : Sum

The sums tendered shall include for all the requirements contained in the relevant Specifications.

PSA 8.5 Sums Stated Provisionally by Engineer

Sub-item b) 3) shall be deleted.

Add the following:

"Sub-item c) 1) For work to be executed by a subcontractor

2) Overheads, charges and profit on (c)(1) above'

"PSA 8.5.1 Additional Tasks as required by the Engineer ..... Unit : Provisional sum.

Allow a provisional sum for additional tasks required by the Engineer."

"PSA 8.5.2 Additional survey as required by the Engineer ..... Unit : Provisional sum

Allow a provisional sum for additional survey required by the Engineer"

"PSA 8.5.3 Training of labour..... Unit : Provisional sum

Allow a provisional sum for training of local Labour as referred to in PS 6.6."

"PSA 8.5.4 Employment of Community Liaison Officer (CLO). Unit: Provisional sum

Allow a provisional sum for full time employment of CLO as referred to in PS 6.13"

"PSA 8.5.5 Acceptance control tests by the Engineer. Unit: Provisional sum

Allow a provisional sum for acceptance control tests ordered by the Engineer"

"PSA 8.5.6 Contractor's percentage to cover costs of overheads, charges and profit related to handling the relevant provisional sums referred to"

PSA 8.8 Temporary Works

All scheduled items under this Sub-Clause shall be deleted, the costs thereof being deemed to be included in the rates rendered for other items of work called up in the Bill of Quantities.

Add the following items:

"PSA 8.8.7 Position, construct and re-survey survey-beacons ..... Unit : No.

The rate tendered shall cover all work required to position, construct, level benchmarks and re-survey the survey beacons. .The rate shall include for an independent check of the co-ordinates and levels of the benchmarks."

"PSA 8.8.8 Contractor's percentage to cover costs related to overheads, charges and profit related to handling the relevant temporary works."

"PSA 8.8.9 Deviation of water in existing channel for tie-inns ..... Unit : PC Sum.

The rate tendered shall cover all work required to design, manufacture and install steel frame and plate flume (or similar) to deviate water in the existing channel. The rate shall also include sealing off the temporary deviation and maintaining during tie-inn.

SABS 1200 AB: CIVIL ENGINEERING CONSTRUCTION: ENGINEER'S OFFICE

PSAB 1 SCOPE

Delete the second sentence and replace with the following:

It covers a scheduled number of ~~identical~~ offices and allows for mobile, semi-mobile and prefabricated accommodation.

PSAB 3 MATERIALS

PSAB 3.2 OFFICE BUILDING (S)

This Sub-Clause is deleted and replaced with the following:

PSAB 3.2.1 Offices

Buildings for offices shall be constructed of timber or other approved materials and shall have double walls filled with insulating material and lined on the inside with timber or other approved material. Ceilings shall be provided for all buildings. Offices shall have timber or concrete floors. Concrete floors shall be covered with vinyl floor tiles. Offices shall be weatherproof, well ventilated and insulated so as to provide comfortable working conditions.

After erection the offices shall be painted with an approved paint and the paint work shall be maintained during the contract period.

Each door shall be provided with a suitable 3 lever lock and two keys.

The siting and orientation of all buildings shall be to the Engineer's satisfaction and shall be decided upon in consultation with him and confirmed in writing before erection. All accommodation shall include the provision of 220 V electricity and, where required, fresh, clean, potable water, and sewerage, including septic tanks if necessary, which will be considered part and parcel of the accommodation provided and will not be paid for separately, except insofar as the cost thereof is covered under item "Services".

The clear height of all offices between floor and ceiling shall be 2,4 m minimum. All windows shall be of the type that can open over the full window area.

All accommodation shall meet with the approval of the Engineer.

Three types of offices are called for, namely, Type 1 and Type 2. The minimum internal floor areas of the offices shall be 12 m^2 for the Type 1 office and 24 m^2 for the Type 2 office.

The Type 1 and Type 2 offices shall be furnished with the following:

One desk size 1500 x 900 mm complete with lockable drawers;
One lockable general purpose steel cupboard with shelves;
Two chairs;
Sufficient racks and hangers for hanging contract drawings. The hangers shall be of the "Barhold" type, with one hanger to five drawings;
One hand wash basin complete with taps and rain and towel rail;

Double 80 watt fluorescent light fittings complete with ballast and tubes (2 per office;
One drawing table of at lest 3 m^2 surface area;
One draughtsman's stool,
Two 220/250 volt 15 amp points;
One 220/250 volt 15 amp power point on a separate circuit (for a computer);
Uninterrupted power supply is not required;
One air conditioning unit , minimum 1,5 kW capacity;
Venetian blinds or roller blinds, opaque type to all windows;
One lockable steel clothes locker (with lock and keys);
Shelving of total length 3 m of nominal width 300 mm.

In addition to the above the Type 1 office shall be equipped with the following:

One four drawer steel filing cabinet;
One pinning board 2700 x 900 mm made of a suitable material for fixing plans, and firmly attached to the wall.
One plain paper photocopier (A4 size)

The Type 3 office will be the meeting room and shall be furnished with the following:

Two tables 1800 x 900 x 900 mm high;
Ten chairs;
Acceptable lighting and heating;
A whiteboard of area 1,5 m^2 with a set of whiteboard marker pens.

PSAB 3.2.2 Carports

Carports with a roof of corrugated iron sheeting shall be so constructed that the vehicles parked under them will at all time be protected against the direct rays of the sun. The carports shall be at least 20 m^2 in area and the floors shall consist of a layer of broken stone or concrete to alleviate dusty and muddy conditions.

PSAB 3.2.3 Areas around Offices

The access and other roads around the offices shall be treated to make them dust free, either by using crushed stone, suitable dust-laying oils or bituminous surfacing, or by other approved means. They shall be well-drained and kept trafficable and free from mud at all times. Footpaths shall be similarly treated to provide convenient access to all buildings.

PSAB 3.2.4 Ablution Facilities (1 x Male and 1 x Female)

Ablution units shall be well-ventilated units. They may be constructed from asbestos cement sheeting with steel frames or from other suitable approved materials and the floors shall be of concrete with vinyl floor tiles. Latrines shall provided with vitreous enamel W.C. pans with PVC seats and covers. Showers, with adequate hot and cold running water in suitable cubicles shall also be provided.

Add the following sub-clause:

PSAB 3.3 SAFETY EQUIPMENT

The Contractor shall supply the following equipment for the exclusive use of the Safety Officer for the duration of the Contract:

i. Four safety harnesses and ropes (25mm diameter and 6 m in length);
ii. A portable petrol driven air blower with flexible hose (150 mm diameter and 4 m in length);
iii. Two closed circuit oxygen breathing apparatus complete with full face masks and oxygen cylinders;
iv. One gas tester, Gas Alert Micro, from NP Environmental Services CC, contact No. (011) 784 7671 or similar.

PSAB 3.4 OWNERSHIP

The ownership of all offices, furnishings and equipment, car ports, accommodation, sanitary equipment, and other items provided by the Contractor shall, when they are no longer required by the Engineer revert to the Contractor upon the written advice of the Engineer and shall be dismantled and removed from the site.

All equipment listed above shall be delivered and maintained in good working order for the duration of the Contract.
The Contractor shall keep the equipment continuously insured against any loss, damage or breakage and he shall indemnify the Engineer, his staff and the Employer against any claims in this regard.

PSAB 3.5 MAINTENANCE

The Contractor shall provide all labour, equipment and material which may be necessary to keep all offices and laboratory in a neat and clean condition and any repairs shall be executed immediately after the request of the Engineer.

PSAB 4 PLANT

PSAB 4.1 TELEPHONE

This Sub-Clause is amended to include:
"In addition, the Contractor shall provide in the Engineer's office an approved facsimile machine and an approved make cellphone for the use of the Engineer and the Employer. The Contractor shall keep the equipment continuously insured against any loss, damage or breakage and he shall indemnify the Engineer, his staff and the Employer against any claims in this regard.
The Contractor shall pay all telecommunication accounts timeously for the duration of the Contract.

The Contractor shall pay all costs incurred in complying with the above. A provisional sum is included in the Bill of Quantities to cover this item. The facsimile machine will not become the property of JW after the completion of the Contract. The cellphone will become the property of JW after the completion of the Contract."

This clause shall be read in conjunction with Clause PS 4.6

PSAB 4.2 SURVEY EQUIPMENT

(New sub-clause) *Add the following new sub-clause:*

The Contractor shall provide the following survey equipment on the site from the commencement to the completion of the Works:

- One theodolite capable of reading to twenty seconds of arc plus tripod
- One automatic reading Engineer's level plus tripod
- One levelling staff (4 m long, 1 cm gradations)
- Two tachometric staffs (5 m long, 1 cm chess board pattern)
- Six steel-tipped ranging rods each 2,5 m long
- One hammer (2 kg)
- Two canvas carry-bags
- One 30 m steel tape

The tachometer may be shared by arrangement between the Contractor and the Engineer or his representative on site, but the remaining instruments shall be provided for the exclusive use of the Engineer or his representative on site.

The Contractor shall keep the equipment continuously insured against any loss, damage, or breakage and he shall indemnify the Engineer and the Employer against any claims in this regard. Upon completion of the works the survey equipment as listed above shall revert to the Contractor.

The Contractor shall maintain the equipment in good working order and keep it clean until the completion of the works.

SCHEDULED ITEMS

PSAB 4.2 (a) Survey Equipment (fixed-charged) ……Unit: Sum

PSAB 4.2 (b) Survey Equipment (time-related) …….. Unit: Sum

PSAB 5 CONSTRUCTION

PSAB 5.2 ENGINEER'S OFFICE(S)

This Sub-Clause is amended to include:

"The Contractor shall be responsible for all sanitary services necessary to keep latrines in a clean, neat and hygienic condition.

When no sewers or treatment facilities are available, the Contractor shall provide chemical toilets.

The Contractor shall provide for the removal and disposal of all rubbish."

PSAB 5.4 TELEPHONE

Delete this sub-clause.

PSAB 5.5 SURVEY ASSISTANTS

This Sub-Clause is deleted and replaced by:

PSAB 5.5 ATTENDANCE ON THE ENGINEER

When called upon do so, the Contractor shall provide two suitably trained labourers to assist the Engineer's staff in carrying out survey work, control sampling and testing, setting-out, measurement of the Works, etc."

PSAB 8. MEASUREMENT AND PAYMENT

This clause is deleted in its entirety and replaced by:

PSAB 8.1 BASIC PRINCIPLES

The schedules items below will be deemed to cover all the Contractor's obligations in terms of this Specification, the sole exception being the provision and maintenance of sanitary facilities and maintaining areas around offices
(PS 4.6), which work is deemed to be included in the price tendered under Standard Specification SANS 1200 A and the variations and additions thereto.

The units of measurement and payment shall be the number of each item provided or the lump sum as stipulated and shall be full compensation for supplying and erecting the accommodation, furniture and equipment as specified, for the proper maintenance thereof during the tenure of the Contract and for the subsequent removal thereof from the site on the completion of the Works. The prices tendered will be held to be fixed irrespective of whether the time required to complete the Contract exceeds or falls short of the tendered time for completion or whether the scope of the Contract is changed.

The scheduled items below will be paid for in the first payment certificate after the Contractor has met all his obligations under these items to the satisfaction of the Engineer.
The tendered rates and sums shall be fixed except for contract price adjustment and retention.

PSAB 8.2 SCHEDULED ITEMS

PSAB 8.2.1 Provide, maintain, service and remove furnished offices as follows:

a) Type 1..... Unit : No.
b) Type 2..... Unit : No.
c) Type 3..... Unit : No.

The tendered sum shall include the provision of electric power, potable water and disposal of wastes and all costs connected with the requirements stipulated in Clause PSAB 3.2.1

PSAB 8.2.2 Provide, maintain and remove carports ..... Unit : No

The sum tendered shall cover all costs connected with the requirements stipulated in Clause PSAB 3.2.2.

PSAB 8.2.3 Provide and maintain survey equipment..... Unit : Sum

The sum tendered shall cover all costs connected with the requirements stipulated in Clause PSAB 4.2.

PSAB 8.2.4 Provide and maintain safety equipment..... Unit : Sum

The sum tendered shall cover all costs connected with the requirements stipulated in Clause PSAB 3.3.

PSAB 8.2.5 Provision of the telecommunications services ..... Unit : Provisional Sum

The provisional sum tendered shall cover all costs connected with the requirements stipulated in Clause PSAB 4.1.

PSAB 8.2.6 Attendance upon the Engineer ..... Unit : Sum

The sum tendered shall cover all costs connected with the requirements stipulated in Clause PSAB 5.5.

PSAB 8.2.7 Testing by independent laboratory ..... Unit Provisional Sum

Allow the provisional sum for testing ordered by the Engineer and carried out by an independent laboratory. This item is intended to provide for any tests ordered by the Engineer which are not covered by the project particular or standardised specifications.

PSAB 8.2.8 Protective clothing and testing equipment ..... Unit : Provisional Sum

Allow a provisional sum for the purchase of protective clothing and testing equipment required by the Engineer and his staff

PSAB 8.2.9 Photographic record of work..... Unit : Provisional Sum

Allow a provisional sum for the monthly progress photographs including aerial photography required for the project.

PSAB 8.2.10 Stationery for the Engineer's Staff ..... Unit : Provisional Sum

Allow a provisional sum for the supply of stationery to the Engineer and his staff for the project.

PSAB 8.2.11 Computer Equipment for the Engineer's Staff ..... Unit : Provisional Sum

Allow a provisional sum for the supply of computer equipment to the Engineer and his staff for the project.

PSAB 8.2.13 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, 8.2.9, 8.2.10 and 8.2.11.

SABS 1200 C: SITE CLEARANCE

PSC 5 CONSTRUCTION

PSC 5.9 DEMOLITION OF CONCRETE

The concrete shall be demolished in such a way that as not to damage adjacent concrete or structures and existing structures shall be protected against falling debris using old rubber conveyor belts or 20mm min thickness timber panels.

Temporary support work shall be provided for slabs or beams or stair cases.

For partial removal of concrete, the outside perimeter of the area to be removed, shall be cut back and the concrete be removed in fragments. The size of these fragments shall be such as to allow safe removal without damage to adjacent structures or elements or injury to people and with minimal damage to reinforcement.

Unless otherwise indicated by the engineer, the reinforcement shall not be removed. If the demolition is required to gain temporary access, the reinforcement may be bent back.
If the concrete is to be replaced, all loose aggregate and concrete must be removed prior to placing new concrete or repair mortar.
Demolition involves cutting into existing services which may be in operation. A method statement must be submitted and the shut down time and period must be negotiated with the Station. Allow at least 3 weeks for approval of such method statement

PSC 8 MEASUREMENT AND PAYMENT

PSC 8.2 SCHEDULED ITEMS
The provisional sum shall cover the cost of control tests specifically ordered by the Engineer. Tests shall be executed by an approved commercial laboratory.

PSC 8.2.11 Demolition of concrete minimum strength 25MPa
Describe dimension and / position ……..…Unit: m^3
The rate shall include protection of existing structures, temporary support, removal and disposal as well as making good existing concrete surfaces. It also includes grouting up new pipes where applicable.

SABS 1200 D: EARTHWORKS

PSD 3 MATERIALS

PSD 3.3 SELECTION

PSD 3.3.2 Backfilling and embankments
Add the following:
All materials excavated from the engineered mattress shall be stockpiled separately, to be used later for backfill. The Contractor shall take the necessary steps to ensure that the excavated material is not contaminated during excavation or stockpiling.

SABS 1200 DB: CIVIL ENGINEERING CONSTRUCTION: EARTHWORKS (PIPE TRENCHES)

PSDB 3 MATERIALS

PSDB 3.1 CLASSES OF EXCAVATION

Delete this sub-clause and replace with the following:

The excavation of material will, for purposes of measurement and payment, be classified as intermediate or hard.

TABLE 1: CLASSIFICATION OF MATERIALS

CLASSIFICATION	*DESCRIPTION*
INTERMEDIATE	Material that can be efficiently removed by the rated plant fitted with a “rock bucket”.
HARD / ROCK	Material that cannot be economically removed except by drilling and blasting or the use of rock breaking equipment.

PSDB 3.5 BACKFILL MATERIAL

Delete DB 3.5 a) from this sub-clause and refer to PSLB 3.5 and PSLB 3.2 for specification.

PSDB 3.6 MATERIALS FOR REINSTATEMENT OF ROADS AND PAVED AREAS

PSDB 3.6.1 Subbase and base

Delete this sub-clause and replace with the following:

The quality of materials used for all pavement layers in bituminous roads shall comply with PSDB 5.9.5 and those for constructed footways shall comply with PSDB 5.9.7.

PSDB 3.6.4 Premix carpet

Delete this sub-clause and replace with the following:

Only hot premix may be used for road surfacings unless written approval is obtained from the Engineer to use cold premix.

PSDB 4 PLANT

PSDB 4.1 EXCAVATION EQUIPMENT

Add the following to this sub-clause:

Should any portion of a pipe trench exceed the specified depth, the Contractor will be held responsible for any additional costs which may arise as a result of such over-excavation. Concrete filling or imported compacted fill may be ordered by the Engineer below the bottom of the trench.

The maximum trench widths at the pipe soffit must be according to Clause PSDB 5.2 and if these widths are exceeded stronger pipes or more expensive bedding materials will be ordered at the Contractors expense. This principle will also apply where trenches are widened locally because of isolated rock outcrops.

PSDB 5 CONSTRUCTION

PSDB 5.1 PRECAUTIONS

PSDB 5.1.1 General

Add the following to this sub-clause:

The Contractor shall programme his activities in such a way that long sections of trenches do not lie open for undue periods of time, as it poses a security risk. The pipes shall be laid as soon as possible after excavation of the trenches and the trenches then backfilled. Under no circumstances will trenches be left open for more than 1 (one) week, except when approval has been given by the engineer or his representative.

PSDB 5.1.4 Existing services that intersect or adjoin trenches

Add the following to this sub-clause:

Where it is necessary for a pipeline to pass under existing drains, the Contractor shall carefully excavate and backfill around them. During the course of the work, the drains shall be adequately supported to the satisfaction of the Engineer. Any damage shall be reported without delay and shall be made good by the Contractor before backfilling.

PSDB 5.2 MINIMUM BASE WIDTHS

Delete "minimum" and "not less than" throughout this clause:

The specified trench width (refer to trench cross sections in tender drawings) shall be strictly adhered to. Should the excavated trench width exceed the specified width adjacent to and for 300 mm above the barrel of the pipe, remedial measures shall be directed and shall be provided at the Contractor's cost unless it can be shown that such excess width is due to factors beyond the Contractor's control.

PSDB 5.4 EXCAVATION

Add the following to this sub-clause:

Where the pipe trench crosses surfaced roads the Contractor shall neatly cut two parallel grooves into and through the "black top" before excavating between the grooves. The cost of this operation, where not scheduled separately, will be held to be covered in the general rates for excavation.

PSDB 5.5 TRENCH BOTTOM

Delete the existing clause and replace with:

Compaction of the trench bottoms shall be by the way of power driven plant.

The Contractor shall maintain the floors of completed trenches in good condition. Floors softened or eroded through stormwater, seepage water or otherwise, must be rectified by removal of the softened material and its replacement with approved material firmly compacted in layers not exceeding 0,15 m in compacted thickness or with 10 MPa concrete where directed, at the Contractor's cost.

Accurately located recesses shall be cut into the bedding cradle or trench bottom to accommodate pipe joints and such recesses shall be properly shaped and sized to enable jointing to be carried out without difficulty.

The placing of hardcore or concrete screed shall be entirely at the Contractor's cost in any section of the work where softening of floors has been due to the method of excavation or inadequate provision for drainage.

Floors of trenches in bad or waterlogged ground shall be excavated and replaced with hardcore filling, a hardcore base and/or a 20 MPa concrete screed as directed.

i) Hardcore filling shall consist of 75 – 150 mm stone well rammed and compacted.
ii) Hardcore base shall consist of 50 – 75 mm stone laid and compacted across the full width of the trench.

Preparation of trench bottoms shall be included in the schedule rates for excavation. Approved granular material imported to the site, or hardcore base, hardcore filling or concrete screed, used on trench floors will be paid for separately.

PSDB 5.6 BACKFILLING

In addition to the existing clauses, work shall be carried out in accordance with PSDB 5.9 and the COP. Backfilling of trenches in bituminous roads shall be done according to PSDB 5.7.2, PSDB 5.9.5 and the tender drawings in constructed footways according to PSDB 5.9.7.

PSDB 5.6.1 General

Add the following to this sub-clause:

Notwithstanding the requirements of sub-clauses 5.6.1 and 5.6.6, no pipe joint or pipe fitting shall be covered by either the blanket or the backfill prior to the successful completion of the visual inspection and the pressure testing of the relevant section of the pipeline.

Insert the following after the first paragraph:

Trenches shall be backfilled level with adjacent surfaces immediately after completion of pipe laying and successful pressure testing (in addition all joints shall be watertight under normal operating conditions). Should pipe laying not be completed before work is due to cease for the day, the Engineer shall be entitled to instruct the Contractor to backfill the trench and re-excavate it the following day in order to complete pipe laying. The cost of the above activity shall be included in the Contractor's rates for excavation.

PSDB 5.6.3 &5.6.4 Disposal of soft excavation material

Replace the sub-clause with the following:

All excavated material from the trench shall be disposed of at approved tipping sites to be located by the contractor and approved by the engineer. All excavated material shall be spoiled within 48 hours of excavation failing which the Engineer shall be entitled to suspend work under contract.

The prior approval of the Engineer must be obtained before any surplus material may be deposited, spread and levelled at agreed sites within the area of the works.

PSDB 5.7 COMPACTION

PSDB 5.7.2 Areas subject to traffic loads

Add the following to this sub-clause:

The contractor shall reinstate the subbase and base as specified in SABS 1200 DB with the addition that all materials used shall be stabilised with 4% cement. The surfacing shall be 40mm Premix asphalt.

The following degrees of compaction are required:

	Depth (mm)	Mod. AASHTO density %
Surfaced Roads	0 – 150	97
	150 – 300	95
	300+	93

Areas within the road reserves and outside of roadway shall be treated as unsurfaced roads.

Areas in constructed footways compaction shall be done in accordance with PSDB 5.9.7.

PSDB 5.8 CONSTRUCTION IN HEADINGS

In addition to the existing clause the following shall apply:

Generally in soft material the buttresses and portions of ground left for the purpose of supporting the sides of the trenches or headings providing access to private properties, shall be broken down as the refilling and compaction proceeds.

Where excavation for branch pipelines are refilled, after the main pipeline excavations, the materials in the latter shall be stepped or raked back and compacted in 300 mm layers, simultaneously with the refilling of the branch pipelines excavation.

PSDB 5.9 REINSTATEMENT OF SURFACES

In addition to the existing clause the following shall apply:

Should the Contractor fail to reinstate the surface of any trench or any other excavation, other than where reinstatement is being carried out by the JRA, within two weeks of the conduit concerned having been laid or other work having been approved, the Engineer may, at his discretion, arrange for such reinstatements to be carried out by some other agency and the cost of this work shall be deducted from monies due to the Contractor. The Contractor shall not be relieved of any responsibility for defects or claims arising from the condition of any trench reinstated by an outside agency on the instructions of the Engineer.

PSDB 5.9.2 Private property and commonage

Delete existing clause and replace with the following:

Reinstatement of surfaces shall be in accordance with the Project specification, variations and additions to the SABS 1200 specification and COP.

Restoration of servitudes, parks, un-constructed roadways and verges, etc. shall be with the same type of surfacing and to at least the same standard and conditions as existed before excavation took place. All excess material shall be removed and not spread over the unconstructed areas. All topsoil stockpiled in accordance with PSC 5.6 shall be replaced as the final layer.

In grassed areas or lawns, the grass sods shall be neatly cut out from grassed areas to be excavated and shall be preserved and kept damp until they can be replaced during the reinstatement. All other material to be used for reinstatement shall be suitably stored for such purpose.

Any garden plants other than grass shall be removed and replanted according to the instructions of the owner of the adjacent property or of the relevant authority. The scheduled rates for excavation shall include for the reinstatement of unpaved areas.

Any settlement below original ground level that occurs during the execution of the Contract or the Defects Liability Period shall be made good by the Contractor within a reasonable period as determined by the Engineer.

PSDB 5.9.5 Bitumen roads

Delete the existing clause 5.9.5.2 and replace with the following:

The Contractor will construct the surfacing with premix according to the method and procedures that will have been indicated to him by the engineer with a premix layer of 40mm thick.

PSDB 5.9.5.3 Kerbing

Add this subclause:

Wherever possible existing kerbing that has been removed shall be cleaned and stacked in a safe manner without restriction to vehicular or pedestrian traffic.

The Contractor shall replace all removed kerbing. In the event of kerbing being broken they shall be either be recast on site by the contractor or replaced with kerbs of similar appearance and physical properties, after approval by engineer.

PSDB 5.9.6 Maintenance of reinstated surfaces

In addition to the existing clause the following shall apply:

This subclause is applicable to the surfacing of bituminous roads as well as all surfacing of constructed footways.

Notwithstanding any quality control testing by the Council, all surfacing of bituminous roads and constructed footways, which have subsided 10 mm or more, or surfacing which have not been reinstated to the satisfaction of the Engineer, shall be re-reinstated in accordance with the accepted procedures of the JRA and to the satisfaction of the Engineer.

Re-reinstatement shall be carried out within 7 days of receipt of the Engineer's instruction.

The cost of all re-reinstatement work (including the cost of premix required) shall be for the Contractor's account.

PSDB 5.9.7 Constructed footways

Add this subclause:

The contractor shall backfill and reinstate all pavement layers and surfacing of constructed footways as specified below and to the satisfaction of the Engineer.

The reinstatement and backfilling of pavement layers for footways shall include the following:

- The construction of a surfacing of 25 mm of premix, concrete blocks, concrete slabs or brick paving;
- The construction of a base layer with a minimum thickness of 150 mm; and
- The construction of the subgrade in 150 mm layers to a depth of 450 mm below the top of the surfacing.

The selection of materials and the densities to which they are compacted, shall be as given in PSDB 5.7.2.

PSDB 7 TESTING

PSDB 7.1 DENSITY TESTS AND INSITU SHEAR STRENGTH TESTS

Delete the existing clause and replace with the following:

Quality control testing of compaction densities and insitu shear strengths shall consist of the following:

(i) <u>Backfill other than structural layers of bituminous roads and constructed footways</u>

Quality control shall be done by means of density tests. The minimum density shall be the same as that of the undisturbed surrounding ground or 90% of modified AASHTO density, whichever is the higher.

(ii) <u>Structural layers of bituminous roads and constructed footways</u>

Quality control shall be done by means of insitu shear strength tests using either a Dynamic Cone Penetrometer (DCP) or Rapid Compaction Control Device (RCCD). The structural layers to be tested and the required shear strengths shall be as defined in PSDB 5.9.5 and PSDB 5.9.7.

(iii) Premix surfacing of roads and footways

Quality control shall be done by means of density tests. The minimum density shall be 95% of Marshall density.

Quality control testing of compaction densities and in-situ shear strength will be carried out by an independent laboratory, approved by the Engineer. Any independent testing will not relieve the Contractor of his responsibility to ensure adequate compaction and material quality throughout and the Contractor should therefore carry out his own regular tests. The Contractor shall furnish the Engineer with the originals of all such test results.

In the event that the Contractor does not conduct his own regular compaction and in-situ shear strength tests and relies on the results of the independent laboratory the Contractor will be liable for the costs associated with the re-testing of all failed sections of reinstated trench.

If any test result shows that the specified compaction or shear strength requirements have not been met, the Contractor shall at his own expense and within 7 days of receipt of the Engineer's instruction take the following remedial action:

A.) Backfill material other than structural layers of bituminous roads and constructed footways

(i) Trench excavations (other than road crossings)

The backfill material shall be removed to a depth of 450 mm for a distance of 2 m on either side of the point at which the test was taken. If the backfill material is suitable, it shall be replaced and re-compacted to the specified densities. Otherwise suitable material shall be imported and compacted and the excess material removed.

Where adjacent test results show that the backfill densities are below specified requirements, the entire length of trench between the points at which the tests were taken shall be re-excavated and re-compacted as required above.

Density testing along trench excavations shall be carried out at intervals, as directed by the Engineer.

(ii) Trench excavations (road crossings)

As for (i) above save that the backfill material shall be removed to a depth of 450 mm over the full length of the trench.

(iii) All other excavations

As for (i) above save that the backfill material shall be removed to a depth of 450 mm over the extent decided by the engineer.

B.) Structural layers of bituminous roads and constructed footways

In the case where a structural layer does not meet the shear strength requirements, the structural layer in question shall be removed. If, however, any other layers have been constructed on top of the layer in question, then all such layers shall also be removed at the cost of the contractor, even if the shear strengths of these layers meet the specification.

(i) Trench excavation (other than road crossings)
The layer shall be removed to its full depth for a distance of 2 m on either side of the point at which the test was taken. If the material is suitable, it shall be replaced and re-compacted to the specified shear strength. Otherwise suitable material shall be imported and compacted and the excess material removed.

Where adjacent test result show that the shear strengths are below specified requirements, the entire length of trench between the points at which the tests were taken shall be re-excavated and re-constructed as required above.

Insitu shear strength testing along trench excavations shall be carried out at intervals, as directed by the Engineer.

(ii) Trench excavation (road crossings)
As for (i) above save that the layer shall be removed to its full depth over the full length of the trench.

(iii) All other excavations
As for (i) above save that the layer shall be removed to its full depth over the extent of the excavation.

C.) Premix reinstatement

(i) Trench excavations (other than road crossings):
The premix shall be removed for a distance of 1m on either side of the point at which the test was taken and reinstated.
(ii) Trench excavations road crossings:
As for (i) above save that the premix shall be removed over the full width of the road.

(iii) All other excavations:
As for (i) above save that the premix shall be removed over the full extent of the excavation.

The Council shall not be liable for additional costs or delays arising from remedial work required to excavations which have already been finally reinstated before the Council's test results become available.

PSDB 7.2 INSPECTION AT INTERMEDIATE STAGES OF CONSTRUCTION

The Contractor shall call for an inspection of the works at the following intermediate stages of construction.

(i) After completion of the trench excavation and preparation of the trench bottom, and before any pipe is laid.
(ii) After the selected backfill material has been placed around the pipe, and before the remainder of the trench is backfilled.
(iii) Before placing of premix on roads or any final surfacing on constructed footways.

Work shall not progress through the specified stages without the approval of the Engineer or his representative on site.

Failure to comply with the provision of this clause shall result in the suspension of work for a period as determined by the Engineer.

PSDB 8 MEASUREMENT AND PAYMENT

PSDB 8.1 BASIC PRINCIPLES

PSDB 8.1.1 For disposal of surplus material refer to clause PSDB 5.6.3.
Lengths shall be completed and backfilled before payment will be made.

PSDB 8.1.2 (b) The depth ranges to be measured for payment shall be as scheduled.

PSDB 8.1.4 No overhaul shall be measured for payment. Refer to clause PSD 5.2.5.1.

PSDB 8.2.3 Computation of quantities
The indicated/scheduled/specified widths shall be the maximum widths to be measured for payment.

PSDB 8.3.2 (b) Extra-over for intermediate material and rock
The extra-over rates for excavating in intermediate and rock materials shall cover the additional cost of excavating and handling materials classified as such and shall include the cost of importing suitable bedding and backfill materials and the disposal of unsuitable material to the Contractor's tipping site and the replacement of same with suitable material.

PSDB 8.3.5 Existing services that intersect or adjoin a pipe trench

a) Services that intersect a trench
Delete and "whether or not their presence is known before they are uncovered"
Replace "200 mm" with "500 mm".

b) Services that adjoin a trench
Delete existing sub-clause from "In a case where a trench..." to ".... measured for shoring (see 8.3.4 (a)).", and replace with:

In the case where an uncovered existing service as defined in (a) above, but excluding water leads for erf connections, where such leads are being renewed, runs parallel within or at an angle between the centre lines of the

service and the trench in plan of less than 45° within the trench of minimum specified base width determined in accordance with PSDB 5.2, this length of service will be measured for payment.

Add the following to the end of the sub-clause:

(v) all work involved in locating the service by hand excavation,

(vi) notifying and attending upon the proprietor of the service,

(vii) supporting and protecting the service while the pipeline is installed, inspected, tested and backfilled.

PSDB 8.3.6 Finishing

Delete the existing clause and replace with the following:

The area for finishing will be computed from the length of finished road or paved surface, as applicable, and the trench width determined in accordance with PSDB 5.2. Payment for finishing will be additional to that for excavation covered by PSDB 8.3.2.

The rate shall cover the cost of temporary accommodation of traffic (including the signs and bypasses), excavation (including the equipment that is required to break up, remove and, if necessary, stockpile the original surface material), and subsequently of reinstatement as specified in PSDB 5.9 and shall include the cost of delays and the cost of any risk of having to repair damage, as specified in 5.10 of the Standard Specifications.

PSDB 8.3.6.1 Construction of pavement layers for bituminous roads

For Road Category using 25mm thick surfacing layers ..... Unit: m²

The rate shall cover the cost of constructing all pavement layers, including the base, subbase, selected subgrade and subgrade, in accordance with PSDB 5.9.5, but excluding the premix surfacing layers.

The rate for construction of pavement layers must provide for all plant, labour and material costs associated with the work.

PSDB 8.3.6.2 Reinstatement of bituminous surfacing for roads

Hot premix of thickness 40 mm ..... Unit: m²

The rate for reinstatement of bituminous surfacing shall include all costs for the supplying and laying of the premix in accordance with PSDB 5.9.5 but shall exclude the pavement layers provided for in PSDB 8.3.6.1. The rate must provide for all plant, labour and material costs associated with the work.

SABS 1200 G: CIVIL ENGINEERING CONSTRUCTION: CONCRETE

PSG 2 INTERPRETATIONS

PSG 2.3 b) Quality
This clause is amended to include:
Set (of concrete cubes). A set of cubes shall consist of 6 cubes of nominal side 150 mm of which 3 will be crushed at 7 days after making and the remaining 3 at 28 days.

PSG 3 MATERIALS

PSG 3.2 CEMENT

PSG 3.2.1 *Replace the entire clause with the following:*
Only Ordinary Portland Cement (OPC) and Pulverised Fuel Ash (PFA) shall be used in all concrete for this contract. No other types of cement shall be permitted.

Pulverised Fuel Ash (PFA) shall comply with the following specifications:
a) PFA shall be obtained from only one power station, from which the PFA has been approved by SANS for use in concrete.
b) All PFA shall comply with requirements of SANS 1466 (1998)

PFA shall be used aqs partial replacement of the OPC in concrete. A maximum of 33% (by mass) of the total cementitious material in the concrete may by PFA and shall be mixed before delivery on site.

The OPC / PFA mix shall be stored in the same manner as OPC. When stored in silo's the PFA / OPC mix shall require increased silo capacity, more efficient filters and aeration compared to OPC only.

PSG 3.4 AGGREGATES

PSG 3.4.2 Use of Plums - the use of plums will be permitted in accordance with clause 3.4.2.

PSG 3.5 ADMIXTURES

PSG 3.5.1 Approval of Admixtures Required
This clause is deleted and replaced with:
"No form of concrete admixture will be allowed".

PSG 3.5.1 Air-Entraining Agents

This clause is deleted and replaced with:
'No form of air-entraining agent will be allowed".

PSG 3.6 REINFORCEMENT

Add the following:

Cover blocks for reinforcement shall be concrete, of at least the same strength as specified for the structure in which it will be used.

PSG 4 PLANT

PSG 4.5 FORMWORK

PSG 4.5.2 Finish - unless otherwise noted formwork is to be in accordance with the following classification :

a) Rough - where in contact with backfill;
b) Smooth - where exposed.

(See clauses 5.2.1 a & b)

Smooth formwork to exposed faces is to be carried down to 150 mm below adjoining final ground or paving level.

Formwork is required to the 1 : 1 sloping surfaces of concrete walls. The means of
anchoring forms shall be approved by the Engineer.

PSG 4.5.3 Ties

This clause is amended to include:
The type of tie to be used on water retaining structures is to be approved by the Engineer".

PSG 5 CONSTRUCTION

PSG 5.1 REINFORCEMENT

PSG 5.1.1 Bending
PSG 5.1.1.3 This clause is deleted and replaced with the following :
"Under no circumstances will hot bending of bars be allowed".

PSG 5.1.2 Fixing

This clause is amended to include :
"Welding of reinforcement in any position in any structure is not permitted".

PSG 5.1.3 Cover

Unless otherwise stated on the drawings all cover to reinforcement shall allow for "severe" exposure conditions.

PSG 5.5 CONCRETE

PSG 5.5.1.2 Consistency

This clause is deleted and replaced by "See Table A - PSG 5.5.1.7."

PSG 5.5.1.5 Durability

This clause is deleted and replaced by "See Table A - PSG 5.5.1.7."

PSG 5.5.1.7 Strength Concrete

This clause is amended to include Table A (attached to the back of this specification).

The permeability of test cylinders (if ordered by the Engineer) shall not be greater than 5×10^{-7} mm/second.

The following clauses are added: ..

PSG 5.5.1.8 No-fines concrete

No-fines concrete shall be composed of single-sized coarse aggregate, cement and water. The cement and aggregate shall be mixed in an approved mechanical mixer with just enough water to form a smooth grout that will completely coat each particle of aggregate and will be fluid enough to flow together to form a fillet at each point of contact of aggregate particles. Not more than 20 litres of water per 50 kg cement shall be used.

The aggregate, in addition to complying with the applicable requirements of SABS 1083 and SABS 794, shall be of nominal size not greater than 20% of the minimum thickness of no-fines concrete to be placed and shall be measured by volume in approved measuring boxes. The proportion of aggregate and cement shall be

a) stone aggregate of nominal singe size 19,0 mm, 9 parts : cement, I part; or
b) clinker aggregate, 6 parts : cement, 1 part.

Reinforcement, if any, shall be precoated with cement slurry which shall be allowed to dry before the concrete is placed.

No-fines concrete shall be placed within 30 minutes after mixing. It shall be so worked that it fills the space to be concreted and that adjacent aggregate particles are in contact with each other. No-fines concrete shall not be vibrated.

Removal of formwork for no-fines concrete shall comply with 5.2.5, but the minimum curing period shall be 2 days longer than that required at the applicable ambient temperature in terms of 5.5.8.

The void ratio for no-fines concrete shall not be less than 27.5%.

No-fines concrete shall be cured by sacking or plastic sheeting for at least 3 days after placing.

PSG 5.5.1.9 Sand-cement screeds

All materials shall comply with the requirements of Clause 3.

The screed shall be composed of 1 : 3 cement-sand mortar. The ingredients shall be measured in proper gauge boxes on a steel or timber mixing platform with water added and thoroughly mixed in to obtain a uniform consistency throughout. Cement screed mixes shall be used within two hours of the first contact of, the cement with water. All screed remaining after this period shall be discarded and not re-tempered.

Preparatory to the application of the screed, the concrete sub-surface shall be well soaked with water and coated with the thinnest practicable layer of (a) in the case of a concrete surface which is rough enough to ensure a good bond - a grout of neat cement well brushed on to it, and (b) in the case of a concrete surface which is not rough enough to ensure a good bond - with a slurry composed of one part by volume of cement to two-and-a-half parts by volume of coarse sand vigorously thrown on by means of a trowel or other suitable device. The screed shall be laid before the grout or slurry has set.

The screed shall be well compacted and rammed-in with a wooden punner and finished off to specified lines and levels with a wood float or steel trowel as particularly specified, and then left to cure, being protected from damage during this period.

PSG 5.5.2 Batching

PSG 5.5.2.3 Aggregates - This clause is amended to read
"Volume batching will not be acceptable".

PSG 5.5.3 Mixing

PSG 5.5.3.1.e) Mixing at construction site - This clause is amended to include:
"The minimum mixing time for truck mixers will be one hundred (100) revolutions, at mixing speed".

PSG 5.5.3.2 Ready-Mixed Concrete - This clause is amended to delete the first sentence and replace it with the following : "The Engineer will permit production of concrete at a central production facility other than on the Site of construction and reserves the right to inspect for approval these central production facilities and to carry out any tests required. The results obtained by such a production facility as part of its quality control system will not be acceptable".

PSG 5.5.5 Placing : - This clause is amended to include
“Concrete may not be placed before the Engineer's approval has been given in writing and a minimum written notice period of 24 hours prior to pouring is required for each part of the structure".

PSG 5.5.6.5 “Particular care is to be taken with the top section of the walls of circular tanks to prevent cracking."

PSG 5.5.7 Construction joints
This clause is amended to include;

PAG 5.5.7.4 "All kickers are to be cast monolithic with base element of the previous pour. (Heights of kickers are to be 75 mm throughout)".

PSG 5.5.7 Protection and curing
Replace the clause with the following:

All concrete other than site concrete and porous concrete shall be cured by maintaining saturation for a minimum of 10 (ten) days after placement or after stripping formwork. No curing compound will be accepted. Curing methods other than the methods listed below, shall be approved in writing by the Engineer prior to placing of concrete.

(i) *Ponded water with a minimum depth of 50 mm*.

(ii) Saturated sand with a minimum thickness of 60 mm.
For floors, the sand shall be kept moist at all times using an irrigation system. Clean river sand shall be applied within 24 hours after completing the specified surface finishing and concrete has gained suffiecient strength as not to damage the surface. In areas with high temperatures or wind, the surface shall be protected with plastic sheeting until it has reached sufficient strength to receive the sand.

(iii) *Covering the previously saturated surfaces with approved plastic she*ets maintained in contact with the concrete surfaces and with all edges and joints sealed by methods approved by the Engineer. The sheets shall be partially removed on a regular basis and moisture added to ensure continuous saturation. Plastic sheets for curing shall not be dark coloured and all lapping joints shall be taped closed.

(iv) *Continuously saturated heavy duty sacking or geotextile* or other approved absorbent material maintained in contact with the concrete surfaces by fastners spaced at 1.5m c/c

(v) Continuous irrigation or sprinkling of the entire concrete area with a mist spraying system
Sprayers shall be spaced at intervals such that the whole area of concrete is wetted and shall be fastened to the concrete at regular intervals The system shall be designed with an automatic timing system to ensure continuous saturation during weekends and public holidays.

Periodical hosing or curing compound will not be accepted as a curing method.

For concrete walls, both sides shall be cured using irrigation as descrpbed above. Sprayers shall be spaced at such intervals to ensure that the whole concrete face is wetted. Curing shall commence the day after concrete has

been cast. If formwork is to remain in position (e.g. to support subsequent lifts), it shall be loosened as soon as the concrete has gained sufficient strength (usually within a day) to allow curing water to thoroughly wet the surfaces of the concrete.

The duration of water application and the intervals of application will be determined on site by the Engineer, and shall be such as to prevent the concrete from drying out. The duration and intervals shall be adjusted to allow for adverse conditions such as high temperatures and/or dry, windy conditions.

Notwithstanding the preceding specifications, the Contractor shall also ensure that the concrete shall not be exposed to thermal shocks during the first 28 days after casting and he shall take the necessary, additional precautionary measures to shield the concrete with plastic sheets or hessian during extreme warm, cold, dry or windy weather conditions. Hessian shall be wetted should the conditions necessitate this. Curing shall be done in such a manner as not to cause staining, contamination or marring of the surface of the concrete.

PSG 5.5.10 Concrete Surfaces

PSG 5.5.10.2 This clause is amended to include:
'Unless otherwise noted on the drawings all exposed unformed surfaces and surfaces to receive grout are to be wood float finished".

"Wood float finish - Degree of Accuracy 11 - once the unformed surface has been brought to a plane surface it shall be uniformly floated using a wood float and shall be free from trowel marks".

“Steel float finish - Degree of Accuracy I - where this finish is specified or shown on the drawings the surface shall be treated as for wood float finish above except that when the moisture film has disappeared and the concrete hardened sufficiently to prevent laitance from being worked to the surface, the screeded surface shall be steel trowelled under firm pressure to produce a dense smooth uniform surface free from trowel marks".

“Power float finish - Degree of Accuracy I - where this finish is specified or shown on the drawings the surface shall be treated as for steel float finish above except that the screeded surface shall be power floated to produce a high quality dense smooth uniform surface free from float marks".

“Bull nose edge to joints - Degree of Accuracy I - Where this finish is specified a nosing tool shall be applied during and after the finishing of the flat surface. The purpose is to thoroughly compact the edge of the concrete and render it watertight prior to application of the joint sealer."

PSG 5.5.11 Watertight Concrete;-
This clause is deleted and replaced with the following:
“Watertight concrete is to be constructed in accordance with BS 8007".

PSG 5.5.12 Concrete in Wet Ground:-

This clause is deleted in its entirety and replaced with the following:
"The Contractor shall be responsible for keeping all excavations free from water".

PSG 5.6 JOINTS

Joints may only be provided at positions indicated on the drawings.

Joint filler shall be closed cell polyethylene with a density of 200kg/m^3. It shall have a minimum recovery of 95% of its original thickness after compression to 50% of it's thickness. 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.

Unfilled joints shall be accurately formed to the dimensions given on the Drawings, and all external corners chamfered or rounded for at least 5 mm. The concrete face against which the fresh concrete is placed shall be treated in good time with an approved bond breaker.

Sealed joints shall be made watertight over the full length of the joints, unless otherwise permitted by the Engineer, and the joint dimensions shall be as shown on the Drawings.

Preparation of joints:
The reaming of joints by sawing or other means shall be undertaken at a stage when edge spalling or ravelling can be avoided and shall be subject to the Engineers's approval.

After removal of the temporary filler material 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 surface.

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.

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.

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.

Formwork shall be designed to accommodate the waterbars without subsequent bending and the waterbars shall be adequately supported and protected from damage and sunlight until finally encased in concrete.
When a waterstop with a center bulb is intersected, the centre bulb shall be continuous throughout the intersection irrespective of the make-up of the intersection.

PVC waterstops shall be manufactured from high-quality virgin material and shall not contain any scrap or reclaimed material. The waterstops shall be light coloured so as 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.

Care shall be taken to ensure that the waterbars are in perfect contact with well compacted void-free concrete throughout, particularly on horizontal joints where special procedures shall be adopted for placing and compacting concrete under the waterbars, to the approval of the Engineer.
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 Engineer.

PSG 6 TOLERANCES

PSG 6.2 PERMISSIBLE DEVIATIONS

This clause is deleted and replaced with the following:
"Permissible Deviations - The Contractor shall construct each of the various parts of the Works within the limits of the permissible deviation set out below appropriate to the degree of accuracy specified in the project specification or shown on the drawings.

If no degree of accuracy is specified, Degree of Accuracy II shall apply.

Degree of Accuracy I shall apply to all cast-in-situ concrete in contact with precast units so as to ensure a proper fit.

		Permissible deviation, mm		
	Degree of Accuracy	III	II	I
a)	Reinforcement			
1)	Spacing between two adjacent bars	+-25	+-20	+-15
2)	Longitudinal location of bends and ends of bars	+-40	+-30	+-20
3)	Cover to reinforcement	+20-0	+10-0	+10-0
b)	Formwork. Formwork shall be so constructed as to ensure that the position of the finished work will be as specified, subject to the relevant permissible deviation given in (c) or (d) below, as applicable.			
c)	Foundations : mass and reinforced concrete - not exposed			
1)	Position on plan of any edge or surface measured from the nearest grid line or agreed center line	+-50	+-35	+-20
2)	Linear dimension on plan cast against excavation sides	+60-0	+40-0	+20-0
3)	Linear dimension on plan cast against formwork	+30-0	+20-0	+10-0
4)	Formation level	-60+0	-50+0	-30+0
5)	Surface level	+-10	+-10	-10+5
d)	Elements or components above foundations - exposed			
1)	Position on plan of any edge or surface measured from the nearest grid line or agreed center line	+-25	+-15	+- 5
2)	Linear (other than cross-section) dimensions	+-30	+-20	+-10
3)	Cross-section dimensions	-0+20	-0+15	-0 +5
4)	Level (deviation from designed level with reference to the nearest transferred datum (TD) of the upper or lower surface, as may be specified, of any slab or other element or component)	-10+10	-10+5	-10+0
5)	Verticality	5 per metre with max 50	5 per metre with max 30	5 per metre with max 10
6)	Abrupt changes in a continuous surface	10	3	2
7)	Flatness of plane surface'			

	(max. deviation of the surface from any straight line of length 3 m joining two points on the surface, determined by means of a straight edge the ends of which are supported on identical blocks of suitable thickness placed one over each of the two points.)		10	5	3
e)	Location of Holding Down Bolts and Cast in items				
	i) from designated location in plan	+-3mm	) for all degrees		
	ii) from designated elevation	+-3mm	) of accuracy		
f)	The tolerances for bow or camber, twist, and squareness, and slip from concrete and prestressed concrete and precast concrete will be stated in the project specification or on the drawings where applicable.				
g)	Cover to Reinfdrcement No deviation from the minimum cover of concrete over reinforcement specified in 5.1.3 will be permitted.				

PSG 7. TESTS

PSG 7.1 FACILITIES AND FREQUENCY OF SAMPLING

PSG 7.1.2 Frequency of Sampling

PSG 7.1.2.1 This clause is amended to include:
"A test result shall be taken as the average of three sample cube strengths".

PSG 7.1.2.2 This clause is amended to include:
"At least one set of samples shall after that be taken from each day's casting and from at least every 50 m3 of concrete of each grade placed or part thereof".

PSG 7.1.2.3 This clause is amended to include:
"A frequency sampling guide is shown below though final testing frequencies will be at the discretion of the Engineer.

i) One set/batch/day or
ii) One set/element/day or
iii) One set/50 m3 /day such that sufficient sets are obtained to enable them to be representative of the concrete placed".

PSG 7.1.2.4 This clause is deleted in its entirety.

PSG 8. MEASUREMENT AND PAYMENT

PSG 8.1 MEASUREMENT AND RATES

PSG 8.1.1 Formwork

PSG 8.1.1.2 Add the following subclauses

Forming Sloping Surfaces
Forming a sloping top surface of concrete will be scheduled for sloping top surfaces of unfinished concrete where the angle of inclination from the horizontal is over 0^{o} and up to 20^{0} , and shuttering will not be measured to such surfaces.

Beams
Unless otherwise stated casing to sides and soffits of beams shall be for all depths of beams. In cases where differentiation for depths is made, items will be scheduled separately where beams exceed 1.00 m overall depth.

Items will be scheduled for casing to soffits of beams.

Items will be scheduled separately where beams exceed 1.00 m overall depth, sides scheduled separately from soffits as described above.

Slabs

Unless otherwise stated centring to soffit of slabs shall be for centring to slabs of all thicknesses. In cases where differentiation is made between slabs of different thickness, items will be scheduled in the following stages:

Centring to slabs exceeding 200 mm thick shall be scheduled separately in stages of 100 mm thicknesses of concrete. No cognisance shall be taken of any additional thickness caused by inverted beams, kerbs, upstands, bases, etc.

Walls and beams

Where no through bolting is allowed or possible, items will be scheduled separately, distinction being made where cast against ground or against existing structures.

Columns

Separate items will not be scheduled for formwork to columns of different shapes, other than to circular columns as described below.

In the case of circular columns separate items will be scheduled in square metres stating diameters in the following stages:

exceeding 0 and not exceeding 500 mm diameter;
exceeding 500 and not exceeding 1 000 mm diameter;
exceeding 1 000 mm diameter.

Curved Formwork

Separate items will be not be scheduled for curved formwork for each element.

Boxing for projections, voids, etc.

Separate items will be scheduled for stated depths of boxed out holes or formed voids within the main surface of the formwork all as stated in clause 8.1.1.2 with the following amendments :

The scheduled item(s) for boxing out will differentiate between forming openings of different sizes and shapes.

Rates for formwork to pockets and openings are to include for any depth of concrete less than 500 mm.

Separate items will be scheduled for boxing to form nibs and projections. These items will be scheduled in lineal metres as an extra over the main formwork, in stages of girth as follows:

exceeding 0 and not exceeding 150 mm
exceeding 150 and not exceeding 300 mm
exceeding 300 and not exceeding 500 mm
exceeding 500 and not exceeding 1 000 mm.

Where nibs and projections exceed 1 000 mm in girth the unit of measurement will be square metres.

Rates for formwork to nibs ad projections are to allow for such nibs and projections being at any position of the element's main formwork, and are to include for splayed faces, ends, angles, etc.

Inverted Formwork

Separate items will be scheduled for inverted formwork where applicable.

Narrow Widths

Separate items will be scheduled for shuttering to narrow widths, measured in lineal metres in the following stages

exceeding 0 and not exceeding 150 mm wide
exceeding 150 and not exceeding 300 mm wide and
exceeding 0 and not exceeding 150 mm high
exceeding 150 and not exceeding 300 mm high.

Narrow width items will not be scheduled to each element.

General

i) Formwork to edges of mass concrete

No separate payment will be made for formwork to the edge of mass infill concrete. The rates tendered for concrete to mass infill shall cover the cost of such formwork.

ii) Formwork to sides of foundations

Formwork to the sides of foundations will not be measured for payment unless this formwork has been scheduled. Authorisation for the use of side formwork will only be given by the Engineer where for reasons beyond the Contractor's control, it is not possible or practical to use the side of the excavation to retain the concrete. The Contractor will be expected to dig neat excavations for foundations with vertical sides. No overbreak will be measured or paid. The concrete shall be cast against the sides of the excavation. Payment for concrete shall be based as normal on the nett volume of concrete as computed from the dimensions of concrete shown on the drawings.

Rates

Rates for formwork are to include for:

Chamfers or splayed edges not exceeding 20 x 20 mm;
Straight cutting - raking and square (circular cutting and waste will be scheduled); Intersections;
Holing formwork for reinforcing, etc. at joints;
Notchings;
Kickers;
Contractors construction joints.

PSG 8.1.2 Reinforcement

PSG 8.1.2.1 This clause is amended to include the following :
"Reinforcement shall be measured to the nett designed lengths as shown on the drawings and the unit of measurement shall be the metric tonne.

The mass of reinforcement shall be calculated and based on the values shown in Table E2 of SABS 0144, no additional allowance being made for rolling margin and waste.
Final account settlement of the total mass of each group of sizes shall be to 3 decimal places of a tonne".

PSG 8.1.2.2 Replace subparagraph (a) with the following:
"The mass of steel bars will be measured as the total mass of steel, irrespective of diameters."

PSG 8.1.2.3 Clause 8.1.2.3 a) is amended by the deletion of "of nominal size 25 mm".
Clause 8.1.2.3 b) is deleted in its entirety.

PSG 8.1.3 Concrete

Add the following:
Payment for concrete in water-retaining structures will be made as follows:
a)Full payment will be made for concrete placed and approved by the Engineer as per sub-clause 8.1.3.3 and other relevant clauses. Payment testing of water tightness will be done separately.

PSG 8.1.3.1.c)Blinding - this clause is deleted and replaced with the following

"Blinding layers will be measured to the nett plan area of the concrete structure resting on the blinding. Rates are to allow for any necessary shuttering or for additional blinding where additional excavation was carried out. Items will be scheduled for blinding in square metres stating the minimum thickness and proportions or grade of concrete".

PSG 8.1.3.1.d)Overbreak - this clause is amended in that "rock" and "intermediate excavation" is amended to read "hard rock or in Class B excavation".

PSG 8.1.3.4 Casting in of pipes and specials (Additional clause):

No separate items will be scheduled for building in items supplied under this Contract except where specially measured in the Schedule of Quantities. The rate for supply and installation shall cover the cost of casting in the items regardless if they are positioned prior to construction or cast in boxed out holes.

PSG 8.3.2 This clause is amended to include:

“Where mesh is used in the form of stools the unit of measurement shall be the mass of the stools in kilograms."

PSG 8.4.7 No-fines concrete
The unit of measurement shall be the cubic metre of no-fines placed in drains.

The rate shall include for all materials and labour required to place, strike-off and cure
the no-fines concrete.

PSG 8.4.8 No-fines concrete with topping
The thickness of the no-fines concrete and the topping will be stated.
The unit of measurement shall be the square metre for the complete operation and the rate shall include for all material and labour required to comply with PSG 5.5.1.8.

PSG 8.4.9 Sand-cement screeds
The unit of measurement for all screeding shall be the square metre of the specified average thickness of screed laid.

The rate shall include for all materials and labour required to comply with PSG 5.5.1.9.

PSG 8.5 JOINTS

This clause is amended to include the following:
Supporting specifications shall include:
BS 2782 Part 3 – Methods of testing plastics
SABS 640 – Flexable Polyurethane(Polyether) foams
BS 8007 – Code of Practise for the design of Concrete Structures for retaining aqueous structures.
Waterstops
Waterstops shall be extruded from high-grade virgin PVC compound

Externally placed Waterstops
Sections are to include a flat top centre box with wide reinforced nailing edges.

Joint Fillers
Compressable closed-cell, polyetherlene foam of 60, 100 and 200kg /m3 are required.

Joint Sealant
The sealant shall be a 2 part gun grade polyether cured polyurethane suitable for both vertical and horizontal surfaces.
Installation of Waterstops
Waterstops are to be installed so they are held firmly in position. The shutter is to be fixed against the waterstop so as to prevent any seepage of concrete through the joint. The concrete surrounding the waterstop is to be properly compacted and no air pockets are to be formed below the waterstop.
All intersection pieces are to be factory manufactured mitre joints and only butt joints will be permitted to be made on site. Site jointing is to be carried out using heat welding equipment supplied by the manufacturer and to the manufacturers instructions. A jig shall be used for the manufacture of all joints.

PSG 8.7 GROUTING

This clause is amended to delete the last sentence and to include the following : "Grouting under structural steel column bases or members or under pumps, motors or other machinery will be measured on site as executed provided the concrete is within the specified tolerances. Should the concrete not be within the specified minus tolerance, site measurements will be adjusted accordingly.

Rates for grouting are to allow for all necessary preparatory work (hacking, slurry etc.) and for all necessary formwork".

TABLE A **CONCRETE MIX SPECIFICATIONS**

GRADE	35 / 19	25 / 19	15 / 19	15 / 19	No Fines	Mortar
Purpose for which the specified grade is Normally use	Water Retaining	Structural	Blinding	Mass	Drainage	Benching
Maximum Water / Cement	0.49	0.63	0.83	0.83		0.48

ratio by mass						
Minimum Cement content in kg /m3 of compacted concrete	375	305	225	200	150	Mix as for 35 / 19 omitting coarse aggregate
Specified strength (Mpa)	35	25	15	15		
Target strength (Mpa)	44	31	19	19		
Maximum aggregate sizr in mm	19	19	19	19	19	
Slump limit in mm	25 - 40	25 - 50	50 - 80	25 - 50		50 – 80
Manner of compaction	Vibrated	Vibrated	Hand	Vibrated	Hand	Hand

SABS 1200 GE: PRECAST CONCRETE (STRUCTURAL)

PSGE 8.2.6 Bearings, finger and pin joints to details given on drawing

Add the following:

The rate shall also include grouting.

SABS 1200 HC: CORROSION PROTECTION OF STRUCTURAL STEEL WORK

PSHC 5.7 COATING SYSTEM

Replace with the following:

Surface preparation

All painting shall be done in the workshop, where possible. If not, then the prime coat shall be applied at the workshop prior to transportation to site.

All loose paint, plaster, grease dust etc. shall be removed. The preparation shall be in accordance with SABS 064.

When delivered on site and prior to paint application, all members shall be rust and dirt free. Any damage to the primer shall be repaired on site after erection.

Painting

The members shall be primed using a red-lead-based primer or zinc chromate with a minimum dry film thickness of 0.3mm.

Overpainting must be within 30days after priming. A universal undercoat shall be applied to a minimum dry film thickness of 0.25mm. Two coats of alkyd, resin-based synthetic enamel shall be applied, each having a minimum dry film thickness of 0.25mm. The paint color shall be approved by the Engineer.

PSHC 8.2 SCHEDULED ITEMS

PSHC 8.2.3 *Surface preparation and coating application*

Combine items a) and b) with:

Corrosion protection……..……Unit: Sum

SABS 1200 LB: CIVIL ENGINEERING CONSTRUCTION: BEDDING (PIPES)

PSLB 3 MATERIALS

PSLB 3.1 SELECTED GRANULAR MATERIAL

Where quality granular material is not found in the excavation, additional material will have to be obtained from commercial or other source by the Contractor.

The applicable typical grading of the selected granular material as shown on drawing LB6 shall be as follows:

For pipes up to 300 mm dia ±4,5mm…0,6 – 19,0 mm – curve(c)

PSLB 3.2 SELECTED FILL MATERIAL

Replace this clause by the following:

Selected fill material must be imported and approved by Engineer. It shall be a material that has a PI not exceeding 12 and that is free from vegetation and lumps and stones of diameter exceeding 6 mm.

PSLB 3.3 BEDDING

Add the following to this clause:

"Bedding for the 700mm steel and 110mm HDPE pipes shall be as for flexible pipes as indicated in drawing LB-2 (a) and constructed according to drawing LB-3 d)."

PSLB 3.5 BACKFILL MATERIAL

Delete this clause and replace with the following:

All backfill material will be imported and be of the same grading and specification as the selected fill specified in PSLB 3.2.

PSLB 5 CONSTRUCTION

PSLB 5.2 PLACING AND COMPACTING OF RIGID PIPES

PSLB 5.2.5 Stone bedding

(New sub-clause) *Add the following new sub-clause:*

Where ordered by the Engineer special drains consisting of 100 mm thickness (see PSDB 3.6) of 6 mm to 19 mm graded stone extending the full width of the trench shall be provided below the bedding to the pipes. The excavation for these drains will be measured in cubic metres at the contract rate applying to unsuitable excavation below the bottom of the trench. The stone filling will be paid for per cubic metre. All measurements in this connection will be to a width equal to the base widths and depths ordered

PSLB 5.4 CONCRETE CASING TO PIPES

Add the following to this sub-clause:

Where concrete casing is ordered by the Engineer it is to be grade 15/38 (see Table A, PSG) concrete with a minimum thickness of 150 mm above the top of the pipe.

PSLB 5.5 STONE AND GEOTEXTILE LAYER

Add the following new sub-clause:

The Engineer may instruct the Contractor to place a layer of 19mm single-sized crushed stone bedding (75mm or thickness as ordered) on the base of the trench. The Engineer may also instruct the Contractor to enclose the stone layer completely within a U44 or similar geofabric blanket with overlap of at least 200mm. This instruction will be given if the Engineer deems the layer necessary to stabilise the waterlogged floor of the trench due to soil conditions, and not to aid the Contractor in the handling of ground or surface water which will remain the responsibility of the Contractor. The Contractor will be paid for this item(s) only if it is placed on the instruction of the Engineer.

PSLB 8 MEASUREMENT AND PAYMENT

PSLB 8.1 PRINCIPLES

PSLB 8.1.3 Volume of bedding materials

Add the following to this sub-clause:

The volume of bedding material shall be measured net i.e. the volume of the pipe is to be deducted.

PSLB 8.1.6 Freehaul

Delete this sub-clause and replace with the following:

Overhaul is not applicable hence all distances applicable to selected granular material and to selected fill material are considered as freehaul distances and no additional payment will be applicable.

PSLB 8.2 SCHEDULED ITEMS

PSLB 8.2.6 Supply and place of 19 mm stone

Add the following new sub-clause:

Supply and place 6 mm to 20 mm stone……..……..……Unit: m³

The rate shall include the cost of acquiring from commercial sources, transporting regardless of distance, off loading and placing in the trench bottom clean 6 mm to 19 mm stone where ordered by the Engineer.

SABS 1200 LD: CIVIL ENGINEERING CONSTRUCTION: SEWERS

PSLD 3 MATERIALS

PSLD 3.5 MANHOLES, CHAMBERS, ETC.

PSLD 3.5.2 Precast Concrete Sections

Replace the last sentence of this sub-clause with the following:

Joints between sections shall be sealed with DENSO SEALOSTRIP or similar approved system.

PSLD 3.5.4 Concrete

Add the following to this sub-clause:

Only dolomitic aggregate shall be used for the manufacturing of concrete.

PSLD 3.5.7 Step Irons

Replace LD 3.5.7 with:

Step irons shall consist of polypropylene coated 12mm thick tensile steel, such as Calcamite or galvanised mild steel or cast iron as sold by Besaans du Plessis or similar approved. HDPE step irons will not be accepted.

PSLD 3.5.8 Manhole covers and frames

Delete this sub-clause and replace with the following:

Only precast concrete manhole covers and frames will be allowable for use in this Contract. All covers must be provided with a 5 mm thick steel lip ring. The dimensions of the covers must comply with the details given on the drawings. Where manholes are subject to traffic loads "heavy duty" covers capable of withstanding a test load of 135 kN must be used. Where traffic loads will not be experienced covers capable of withstanding a test load of 40 kN are required.

The concrete shall comply with SABS 1200 GA.

PSLD 5 CONSTRUCTION

PSLD 5.6 MANHOLES, INSPECTION CHAMBERS, ETC.

PSLD 5.6.2 Benching

Replace the first sentence with the following:

All concrete for benching shall be class 20Mpa/19 mm and only dolomitic aggregate may be used.

Add the following clause:

PSLD 5.11 SUPPLYING, LAYING, JOINTING (INCLUDING WELDING) AND BEDDING OF ND 700mm MILD STEEL PIPES (included in BoQ as sewer pipes):

All supplying, laying, jointing, welding of the ND 700mm steel pipes to be done in accordance with the particular specifications in M21: Mechanical Pressure Pipework. Bedding to be done in accordance with SANS/SABS 1200 and PSDB of the standard specifications.

PSLD 7 TESTING

PSLD 7.1 GENERAL

PSLD 7.1.6 *Delete this sub-clause and replace with the following:*
Only air tests will be performed on pipes of all diameters.

PSLD 7.2.6 Water tightness of manholes
Add the following to this sub-clause:
All manholes must comply with the following test requirements:

The manhole may be tested for water tightness, by filling it with water after sealing all connecting pipes with rubber plugs. The manhole must be left full for 48 hours to ensure that complete water absorption has taken place. After this period the manhole must be topped up to just below the cover and left for 24 hours.
The lowering of the water level may not exceed 5 mm and no moist patches or visible leaks may occur in either the shaft or the chamber. If the manhole does not comply with these requirements the faulty parts must be removed and the caulking of the whole leaking ring must be removed and resealed. This must be done until the manhole passes the test to the satisfaction of the Engineer.

Add the following clause:

PSLD 7.3 TESTING OF ND 700mm MILD STEEL PIPES (included in BoQ as sewer pipes):

All relevant testing of laid ND 700mm mild steel pipes to be done in accordance and to standard of the particular specifications M21: Mechanical Pressure Pipework.

PWA: WATERTIGHTNESS TESTING OF TANKS

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WATERTIGHTNESS TESTING OF TANKS

PWA1. SCOPE

This specification covers the watertightness testing of tanks retaining aqueous liquids.

PWA 1.1 Water tightness

PWA 1.1.1 General

Before testing for water tightness commences, a thorough inspection shall be done to ensure that all joints have been properly sealed and that no cracks are visible on structural elements. Thereafter the outlet valve shall be closed or the outlet pipe temporarily plugged.

Unless otherwise specified by the Engineer, backfill behind the walls of water retaining structures may only commence once the structure has passed the watertightness requirements and has been signed off by the Engineer.

PWA 1.1.2 Initial filling and testing

The structure shall be filled to the normal specified top water level at a uniform rate of 2m in 24 hours.

The structure shall be filled with water at a uniform rate not exceeding 2,0 m in 24 hours until the top water level has been reached. The water level will then be carefully noted and recorded by the Engineer in relation to a fixed bench-mark, and the structure shall be allowed to remain filled for a period of two weeks to permit complete absorption of water by the concrete.

Sufficient time shall be allowed in the Contractor's program for the test.

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 reservoir.

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 Engineer.

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 Engineer, discontinue such filling or testing and 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 defects liability period, the Engineer 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 water-tightness, the Engineer 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 Engineer.

Should the failure of the reservoir to pass the first or any subsequent test for watertightness necessitate the draining of the structure, the Employer reserves the right to 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 reservoir;

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 reservoir for watertightness shall be borne by the Contractor.

PWA 1.1.3 Cost of water

Water for the initial filling will be supplied free of charge by the Employer.

PWA2. MEASUREMENT AND PAYMENT

PWA 2.1 Testing for watertightness of structure……..Unit : Sum

The tendered amount shall include full compensation for the provision of labour, plant and materials necessary for testing the structure for watertightness as specified, as well as for the installation and removal of any temporary plugs to blank off pipes, to the satisfaction of the Engineer.

PWB: BUILDING WORK

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BUILDING SPECIFICATION

PS 9 PWB 1. SCOPE

This Section deals with the requirements for the building work required to be constructed.

PS 10 PWB 2. MATERIALS, WORKMANSHIP AND PRODUCTS

PWB 1.1 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 Engineer and shall be executed in accordance with the relevant manufacturer's written recommendations and instructions.

PWB 1.2 Proprietary Products

For the purpose of submission of tenders 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 Engineer 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.

PS 11 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 2.8mm diameter main wires

with 2.5mm 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 500mm centres, including all necessary countersunk screws and holes.
- Necessary bracing and strutting of door, frames, etc., to prevent distortion.

PWB 3.4 Pavings, 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 900mm 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 3m length will be rejected as unacceptable.

Where brickwork, built to unacceptable tolerances, is not condemned by the Engineer, 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.

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 Engineer for his approval and after approval of same these samples shall be retained by the Engineer.

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 Engineer 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 perpends, 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 perpends 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 his prices for facings accordingly.

PS 12 PWB 4. WATERPROOFING

PWB 4.1 Materials

Damp proofing and waterproofing shall comply with the Specifications and requirements given in Table 2.

TABLE 2

WATERPROOFING MATERIALS

MATERIAL	SANS SPECIFICATION	TYPE AND/OR ADDITONAL REQUIREMENTS
Bituminous damp-proof course to wall, sills, etc.	248 952	Type FV Type B
Polyethylene sheet in damp-proof course to walls, sills etc.	952	Type C
Ditto to floors and basements	297	-
Mastic asphalt for roofing	298	-
Mastic asphalt for damp-proof coursed and tanking	92	Type 60
Bituminous roofing felt	952	Type A
Polyethylene sheet for the waterproofing of flat roofs	580	At least 2.5 mm thick and 1200 mm wide
Chloroprene rubber sheet (for waterproofing)	110	Type 2 Gun Grade
Sealing compounds with two-component polysulphide base		

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 1200 mm reduce the effective span of the sheets by introducing galvanized wire stringers at 600mm c/c. All insulation side seams shall have a minimum overlap of 100mm sealed with 50 mm wide approved adhesive tape.

PS 13 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 38mm battens on 114 x 38mm S.A.P. planed all round, timber trusses to manufacturer's design. Trusses shall be tied to a 114 X 38mm 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 600mm overhang and all externally exposed trusses are to be treated with 2 coats carbolineaum.

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 44mm thick framed, ledged and braced door **(meranti**) with 44mm thick stiles and top rail and 22mm thick middle and bottom ledges and braces. The edges of stiles and top rail to be rebated and grooved for and filled in with 22mm 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 Engineer. 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 Engineer. All exposed faces of joinery which are eventually to be stained, oiled or varnished shall be oiled to preserve them during building operations.

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 Engineer.

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.

PS 14 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 0,75m² in size	3mm
Planes larger than 0,75m² but not exceeding 1,5m²	4mm

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.

PS 15 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 Engineer. Special care shall be taken to preserve arrises 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.

PS 16 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 25mm 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!

PS 17 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 paint of the prescribed finish at his own expense to the satisfaction of the Engineer.

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.

PS 18 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.

PS 19 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 can not be excavated.

PS 20 PWB 12. BOREHOLES

PWB 12.1 Monitoring borehole specification

Drilling and Installation of Water Quality Monitoring Boreholes at depths varying from 5m to 60m.

PWB12.1.1 Borehole Construction

The Contractor is required to drill monitoring boreholes using percussion drilling at NWWTW, located in Johannesburg. The number of monitoring boreholes will total 2. The Engineer will indicate the drilling locations to the contractor on each site.

6½-inch diameter boreholes in the depth range of 20m to 60m are required for the purpose of obtaining chip samples for profiling purposes and for the retrieval of water samples for water quality testing.

The piezometer will comprise of 63mm diameter slotted and un-slotted uPVC casing. The section of the casing situated in the aquifer must be slotted to allow for water quality sampling. The section above the aquifer on the outer side of the un-slotted casing will be backfilled using spoil material obtained from the drilling process. A slotted section comprising 8m of uPVC casing must be installed at the bottom of the borehole. The outer side of the slotted casing will be filled with a gravel pack. A2m thick bentonite seal must be placed above the gravel pack. The uPVC sections must be able to screw into each other. No other type of connection will be allowed.

7-inch diameter reaming with the installation of a 4mm mild steel casing will be required to prevent the collapse of the sides of the borehole near the ground surface. The 6½ inch casing must extend to a depth of at least 5m into the ground and 300mm above natural ground level. At completion of each borehole the borehole must be closed with the use of a steel cap and bolt.

The Contractor shall maintain a suitable day book in which all circumstances pertaining to the execution of the works, delays, etc. This book shall be available for inspection by the Engineer. On completion of the works, a copy of this daybook shall be forwarded to the Engineer.

The following records shall be kept during drilling of the boreholes:

Contractor's name:

- Drilling supervisor's name;
- Location and job title;
- Borehole number;
- Date;
- Field sketch; Type of tool used for boring;
- Diameter of boring tool;
- Depth of upper boundary of each successive soil strata;
- Size depth and type of casing.

Spoil from the drilling process must be disposed of accordingly as approved by the engineer.

PWB12.1.2 Manhole construction

The contractor is required to construct a manhole around each borehole. The manhole will consist of a pre-cast concrete chamber, 1m in height and 750 mm in diameter. The manhole will be fitted with a pre-cast concrete lid. The lid must be vandal resistant.

The manhole will be installed starting not less than 300mm beneath ground level. The manhole will also be provided with a 100 mm insitu cast concrete floor. The contractor must ensure that the manhole is property sealed off and that no grass or weed can grow inside the manhole.

The borehole number will be marked on top of the pre-cast concrete lid as well as on the side of the manhole. The engineer must approve the quality of paint. A proper stencil with a character font size of 19mm must be used.

PWB12.1.3 Monitoring Borehole Numbering Method

The boreholes will be numbered according to the following method:

WORKS	CODES			
Northern Waste Water	GNW01	GNW02	GNW03	Etc

Where: 1st Letter G: Groundwater;
2nd Letter e.g. N=Northern;
3rd Letter W: Works.

The Engineer will provide the contractor with the number for each borehole.

PWB 12.2 Measurement and Payment

a) Establishment on Site.

Payment shall be a lump sum to provide for the Contractor's expenses in connection with the setting up/maintaining his organization, and plant on site, removal on completion of the contract, effecting insurances and indemnities required in terms of the General Terms and Conditions of Contract and meeting all other general obligations and liabilities not specifically measured for payment in these contract documents.

b) Inter-hole Movement.

The tendered price for the installation of each borehole shall include for the movement of all equipment, materials and labour between the different borehole possessions.

c) Set-up Drilling Equipment at Each Borehole Position.

The tendered price for the installation of each borehole shall include for all works to provide access to the position of the setup, all delays, and provision of equipment, labour and supervision required to set-up the drilling rig and to remove the rig on completion of the drilling operation(s).

d) Reaming 7 inch Diameter Hole.

The unit of measurement shall be per linear metre of drilling.

The tendered price shall include for all equipment and materials, labour and supervision, supply of compressed air to drive percussion tool, taking of chip samples at 1m meter intervals of drilling records.

e) Installation of Mild Steel Casing.

The unit of measurement shall be per linear metre of 4mm mild steel casing successfully installed.

The tendered price shall include all work to supply and install the 4mm mild steel casing to a minimum depth of 5m including backfilling with spoil material and clean cutting and continuous welding of any necessary joints.

f) Drilling 6½ Inch Diameter Boreholes.

The Unit of measurement shall be the linear metre of material drilled.

The tendered price shall include for all equipment and materials, labour and supervision, supply of compressed air to drive percussion tool, taking of chip samples at meter intervals, and keeping all records.

g) Installation of uPVC Casing.

The unit of measurement will be the linear meter of uPVC casing successfully installed.

The tendered price shall include all work to supply and install the uPVC casing to the full depth of the borehole, including backfilling, backfilling and clean cutting. It will also include the cutting of the slots for the sections situated on the depth of the monitored aquifer as well as the supply, delivering and placing of a gravel pack consisting of 5-8 mm clean stone aggregate.

h) Borehole Development.

The unit of measurement shall be the number of boreholes.

The tendered price shall include all equipment and material, labour and supervision, supply of compressed air and measuring equipment, for developing the well clean and conducting blow yield tests and keeping of all records.

i) Standing Time.

Should the Contractor at any time during the contract period be required to discontinue the works on the site as a result of a written order from the Engineer, with the result that the Contractor's workers and equipment cannot otherwise be usefully employed, he shall be entitled to compensation for such time loss during normal working hours for time lost exceeding four hours.

The tendered price shall include for full compensation for all revenue lost and any costs whatsoever thus incurred, including all attendant personnel and supervisory staff.

PS 21 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

PWB13.3.1Single 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

PWB13.4.1Design, 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

PWB13.5.1Steel doors and frames……Unit : No

(type and size indicated)

PWB13.5.2Steel window frames……..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.

PWC: SUBSURFACE DRAINS

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SUBSURFACE DRAINS

PS 22 PWC 1. MATERIALS

PWC 1.1 Pipes

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 unplasticized 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 Engineer's 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 Engineer's approval, but the total slot area shall not be less that 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 Engineer.

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.

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 2mm thick geotextile

PS 23 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 center 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 : m^3

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.

PWD: PIPELINES AND SPECIALS

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PWD: PIPELINES AND SPECIALS

PS 24 PWD 1. PURPOSE

These particular specifications are to be read in conjunction with the particular specifications Volume M21: Mechanical Pressure Pipework (Volume M21) included in this tender document.

Although this specification has been written to compliment Volume M21 there may be differences in the specifications. Where these differences in specifications between the specifications below and Volume M21 occur, the specifications and descriptions here below will take preference.

PS 25 PWD 2. MILD STEEL PIPELINES

PWD 2.1 GENERAL DESCRIPTION:

PWD 2.1.1 Scope:

From drawings JW7123-CE-020 - 025 it can be seen that there are three mild steel pipelines in this project: The pumping main transferring water to the balancing tank (295 m); the outlet pipeline (120 m) returning water to the system and an emergency overflow pipeline (88 m) between the balancing tank emergency overflow and the inlet channel.

PWD 2.1.2 Material and product:

All three these pipes are to be compliant with SABS 719 grade B with a wall thickness t=6mm.

The straight sections of pipeline shall be supplied in lengths of 13.192 m.

PWD 2.1.3 Joining of pipe sections

Welding:

The straight sections and many of the specials indicated in the pipe schedule as part of the Bill of Quantities will be joined by the butt welding method. (See volume M21 for standards.)

The lining and coatings of the pipeline sections and specials should at plain ends for welding stop 75mm short of the pipe end to allow for weld splatters and temperature dissipation.

Repair and on site application systems:

When ordering the pipes and specials the contractor must make sure that the supplier also provides coating and lining systems complementary to the factory applied systems, for easy on site repair and completion of the coating and lining of the welded joints.

Flanges:

Where pipe sections, specials and valves are joined by flanges, the flanges will be steel plates that will conform to the requirements and dimensions of SABS 1123.

The finishes at joint surfaces will be in accordance with SABS 1123 clause 4.5.
All flanges shall be supplied complete with bolts, nuts and washers of a material to conform to the requirements of SABS 1123 where applicable, otherwise to the requirements of the Engineer. Gaskets for flanged joints shall be of compressed asbestos fibre to BS 2815 Grade A and full faced, unless otherwise specified in the Project Specification, with a minimum thickness of 3 mm.

PWD 2.2 CORROSSION PROTECTION SYSTEMS

PWD 2.2.1 Coatings

Buried
For sections where the pipeline is buried the coating will comprise of a bitumen fiber glass wrap (2 layers) system. (Type B listed in volume M21 [Paragraph M21.13.3])

Exposed
The sections that are exposed are to be coated with epoxy of the same type as specified for the linings here below, but only for 300µm.

PWD 2.2.2 Lining

For both buried and exposed sections the pipeline will be lined with epoxy.

The epoxy lining should be a single coat, 100% solids, solvent free high build epoxy novolac. (Up to 1mm in single coating pass). It must be a two component system (epoxy and hardening catalyst.) The focus for the protective lining is on protection against abrasion and corrosion.

As an abrasion resistant material it must be able to resist an impact of 4.5Nm at 1mm thick coating and have a hardness of 85 on a rigid shore D type material scale. The adhesion to bare steel of the product should be greater than 25Mpa. Another measure of abrasive resistance of the material should be a tabor abrasion resistance of 30 cycles/micron with a CS17 wheel.
The corrosion protection must be excellent over a broad pH spectrum of acids and alkalies and be able to have cathodic disbondment of less than 4mm rad at 23ºC. The thin wall absorption should be 0.15% and the dialectric strength (oil) of 27 volts/micron.

The lining should be 600µm thick and applied in factory with the bitumen fiber glass wrap coating.

PWD 2.2.3 Joint Protection Wrapping Systems

The welded joints will also need to be protected by a shrink sleeve protective system to be approved of by the engineer.

PORTION 3: PARTICULARS OF REQUIRED MECHANICAL EQUIPMENT

PSX5 DETAILS OF BALANCING TANK

- Drawing References

  The drawings listed are bound here in after the Project Specification in this Document, Volume 4.

  Balancing tank layout and walkways.....Drawing No. JW13504-CE-008

  Balancing tank concrete sections sheet 1 of 2 .....Drawing No. JW13504-CE-009

- Particular Specifications

  This specification shall be read in conjunction with the Particular Specification, PME.

PSX5.1 SURFACE MOUNTED MIXERS FOR BALANCING TANK

PSX5.1.1 Particular Specifications

This specification shall be read in conjunction with the Particular Specification, M05: Anaerobic & Anoxic Mixing Equipment.

PSX5.1.2 General Description of Mixers Required

A total 15 vertical shaft, single speed, dual impeller 11kw surface mounted mixers shall be installed in the balancing tank. The balancing tank is required to remove the diurnal wastewater flow and load variation and to achieve a constant or nearly constant flow and load rates to the biological reactor. The mixers shall be installed to ensure that the settled sewage is kept in suspension. The reactor estimated volumes area as given in the table below:-

Mixer Zone	Approximate Volume (m^3)	Mixing Energy (W/m^3)
Equalisation(1-15)	25 000	4 to 5

*The upper margin limit must be designed for.

Mixing energy is defined as the actual power imparted into the mixed liquor via the turbine by the motor and gearbox assembly.

Mixers shall be axial flow type units with tip speeds not exceeding 2,5 m/s.

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. It is estimated that the S.G. of the settled solids could accumulate to 1.10 and this should be taken into consideration in the design of the mixers.

It should be noted that the mixed liquor may contain limited amounts of rags and fibrous material and that the mixer blades must be designed to prevent a build-up of such material on them. Periodic stopping and restarting of the mixers may be required and this should not be detrimental to the operation of the mixers.

The shape of the mixer blades should 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 preferably be incorporated in the turbine design as supplied by the Engineer. If the Tenderer considers addition anti-vortex baffles being required 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 included in their tender pricing schedules.

The power input and flow pattern shall be such as to minimise vortex formation and surface turbulence and any undue oxygenation. The rotation speed of the mixer shall not exceed 30 r/min, but preferably 25 r/min at design speed. 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.

Mixer shafts shall preferably be tubular Duplex to withstand all forces set up by the turbines and shall be corrosion proofed by means of corrosion resistant epoxy coating in accordance with the tender specification. The turbine blades shall preferably be of the back curved or retreating type of design to assist in centering the unit and self cleaning. They shall be manufactured in stainless steel and shall be structurally sound to prevent instability due to rag build-up.

The mixer assembly shall be balanced and then aligned after installation and shall not impart any perceptible vibration or undue swaying under operating conditions.

Different types of metals shall be isolated from each other to prevent corrosion due to galvanic reaction. All under water fasteners shall be 316ss and mating flanges shall be sealed against the ingress of any crevice corrosion by means of a sealant suitable for underwater conditions.

PSX5.2 details and design parameters FOR SEWAGE PUMPS

Number of Settled sewage Pumps per	:	4(3 duty & 1 standby)
Proposed Pump Rate	:	267 l/s
Type of Sewage	:	Settled Sewage

Assumed and calculated design parameters (The contractor is to use his/her own discretion when selecting parameters and to report any anomalies, changes or assumptions)

PSX5.2.1 Drawing References

The drawings listed are bound as Annexures to the Project Specification in this Document.

Plan view, sections and details ..... Drawing No. JW13504-ME-001

PSX5.2.2 Particular Specifications

This specification shall be read in conjunction with the Particular Specification, M18: Mechanical Centrifugal Pumps.

PSX5.2.3 General Requirements

Settled sewage will gravitate from the primary sedimentation tanks into the reactors. Based on the incoming flow, the excess flow shall be channelled to the sump pump via the hand controlled sluice valves. The operation of the settled sewage pumps shall be a function of the inflow and the capacity of the sump. The eventual pumping capacity of the pumping equipment was based on the analyses of the influent hydrograph and that of the available storage of the existing suction sump volume. The design also took into consideration the need to limit the starting and stopping of the pumps. The excessive starting of the pumps sets can therefore be alleviated by extended pumping times.

PSX5.2.4 Pump Requirements

Horizontal spindle Centrifugal pumps and the plinths shall be provided in the pump station. The pumps shall have a closed impellor. Three (3) of the four (4) pumps shall be duty bound, while the other shall be on standby basis. All pumps motors shall be VSD, with a maximum speed of 1450rpm. All 4 pumps shall have a capability of delivering 267l/s at a head of 14.2m.

The medium to be pumped shall be fine settled sewage and, therefore the bearings, impellers, lubrication, seals etc. shall be designed for this purpose. The pumps will require semi open impellor to be able to handle fibrous material in settled sewage. The Tenderer shall indicate whether a separate lubrication system for the bearings a seals is required.

The proposed pump station layout is shown on the drawing No. JW13504-ME-001 and JW13504-CE- 013. The Tenderer is to confirm that this is an acceptable arrangement fort the pumps offered as well as to advise what the minimum water level is required in the wet well to provide sufficient NPSH for the proper operation of the pump. Tenderers are required to indicate any limitations or required operating procedures applicable to the equipment offered.

The Tenderer is to supply all relevant information regarding the equipment offered, in the Technical Data Sheet bound in Volume 1 of the Document. Failure to complete these sheets may render the Tender invalid.

The noise generated by the pump and motor must be limited to 85 dB when measured at a distance 1m from the pump.

The pumps shall be installed on newly constructed pump plinths. The discharge pipework shall leave the pump at a 90° angle, to provide easy access to the pump motor, and connect to discharge manifold. All pumps shall be tested at the manufacture's works, or some independent organisation, to confirm compliance with the requirements in accordance with M18: Mechanical Centrifugal Pumps.

Performance penalties will be applicable. Penalties as a result of measured efficiencies lower than the guaranteed duty point efficiencies by more than 2% shall be calculated as follows. A penalty of R20 000-00 will be applicable for every kilowatt (kW) by which the gross demand exceeds the guaranteed figure.

PSX5.2.5 Monitoring devices

The following monitoring devices are required:

- Glycerine filled pressure meters (100mm dia) on each pump suction and delivery. The pressure gauges must be calibrated and a calibration certificate submitted to the Engineer.
- Pressure (no flow) switch on delivery pipe of each pump.
- Temperature detectors on motor windings.

PSX5.2.6 Measurement and Payment

Sewage Pumpsets……..……Unit: No

Measurement and payment for the new pumps will distinguish between supply/delivery and install/commissioning. The rate for supply and delivery must include the motor, voltage surge and spike protection, anti-condensation heaters, rating plate and direction of rotation plate, monitoring devices, coupling, safety covers, anchor bolts, testing (see PSX.1.4), and the painting of the pump and motor to the specified colour code. The rate tendered for installation and commissioning must include mounting on the support, fully aligning the pumpset, fixing, painting, marker plates and training the Employer's operators.

PSX5.3 Submersible sump pump

One submersible sump pump shall be capable of delivering 4l/s at a head of 5m. The pump shall be located in the pump station. The motor speed shall be fixed at 1450rpm, with a power requirements shall be 0.75 kW. The pump will discharge into the wet well.

PSX5.4 PIPEWORK

PSX5.4.1 Particular Specifications

This specification shall be read in conjunction with the Particular Specification, M21: pressure pipe work specifications.

PSX5.4.2 New pipework

Unless otherwise stated, all steel pipes are to receive coatings and linings consisting of an approved epoxy, applied according to the Specification. All associated pipework equipment provided in the schedule of quantities shall be used. The Tenderer is to supply all relevant information requested in the Data Sheet.

The new pipework in the pump station shall consists of the following:

- 400 mm diameter pump suction line
- 350 mm diameter pump delivery line
- 700 mm diameter manifold

PSX5.5 Reducers

The suction line has a 400mm diameter and the delivery has a 300mm diameter. Where reducers are used these shall be eccentric on the pump suction and concentric on the pump delivery. It is essential that where reducers are used in horizontal piping the top of the pipe is straight and free from trapped air pockets, or places which could accumulate vapour or air. Measurement and Payment

Measurement and payment will distinguish between supply/delivery and installation/commissioning.

The rates offered under the supply and delivery of pipework must include the sot of manufacture, delivery, coating, protection of the coating during storage and installation, marking, all welding and coating inspections and documentation.

PSX5.6 VALVES

PSX5.6.1 Particular Specifications

This specification shall be read in conjunction with the particular specification, M20: valves for specifications of settled sewage.

PSX5.6.2 General

Non-return and isolating valves on the delivery line of the system shall be supplied and installed. Valves shall be measured per unit of each type and the Schedule of Quantities shall differentiate between different types, classes and diameters. Valves shall be tested and commissioned together with new pumps.

PSX5.7 Gantry cranes and hoists

PSX5.7.1 New crawl beam

The one (1) crawl beam shall be located in the pump station. A crawl beam with a mechanically operated crawl and electrically operated hoist is required to assist with the loading of pumps. The following dimensions and duties are required:

Length of travel:	13.0m
Height (filter floor to bottom of beam):	7 m
Minimum lift height:	6,5 m
Working load:	2 000 kg
Hoist speeds:	3.0 and 0.5 m/minute
Gantry beam:	To be determined by the Tenderer

The rate shall include the supply and installation of the rail, hoist, LT conductor system and sufficient steel rope for the maximum lift.

The rate for supply and delivery must include the design, detailing and working drawings of the gantry crane. The rate shall further include delivery and site handling, and all corrosion protection painting, testing, and labelling.

The rate tendered for installation and commissioning must include mounting, grouting in the anchors (where required), fixing, and training of the Employer's operators etc.

PSX5.7.2 VENTILATION FANS

The pump station shall consist of two (2) ventilation fans. One (1) unit wall mounted shall be located in the pump station for extraction of hot air within the pump station and one (1) unit enclosed type shall be located outside the pump station for the extraction of methane gas from the pump station.

The following are the requirements for the design of the ventilation fans.

Wall mounted extractor fan – specification		
Specification		
Model		30/0.75
Fan Diameter	mm	760/30
Fan Speed	RPM	650
Air Displacement	0mm WG	18500
Voltage	V	(380)230-1ph-50Hz
Power	Watts	750
Noise	dBA	52
Wall Sleeve	mm	
Wall thickness	mm	400

Enclosed type extractor fan – specification		
Specification		
Model		30/0.5
Fan Diameter	mm	760/30
Fan Speed	RPM	580
Airflow	0mm WG	16500
Voltage	V	(380)230-1ph-50Hz
Power	Watts	550

Noise	dBA	52
Wall Sleeve	mm	

PSX5.8 PENSTOCK

PSX5.8.1 Particular Specification

This specification shall be read in conjunction with the particular specification, M17 Actuator Equipment for specifications of settled sewage

PSX5.8.2 Balancing Tank Inlet Control Pentsock (PS03)

One electric actuator penstock shall be supplied and installed together with the associated equipment under the contract. The location of penstocks shall be at the inlet of the balancing tank. The motor speed shall be fixed at 1450rpm with a power rate of 0.37 kW. The penstock material of construction shall be of stainless steel 304 L. The Tenderer shall supply all information on the specification for the penstock, which shall be approved by the engineer.

PSX5.8.3 Manually Operated Penstocks (PS01 & PS02)

Two hand-controlled penstocks shall be supplied and installed under the contract. The location of penstocks shall be between the sump and the overflowing primary sedimentation tank. Installation of penstock PS01 and PS02 will be carried out on a live plant. The penstock material of construction shall be of stainless steel 304 L. The Tenderer will submit a methodology statement on how this is to be undertaken for the approval of the Engineer.

All aspect's relating to occupational health and safety to be taken into consideration in the methodology.

PSX5.8.4 PSX 1.8.4 Manually Operated Penstocks (PS04 & PS05)

Two hand-controlled penstocks shall be supplied and installed under the contract. The location of penstocks shall be at the division channel to the bioreactors. Installation of penstock PS04 and PS05 will be carried out on a live plant. The penstock material of construction shall be of stainless steel 304 L. The Tenderer will submit a methodology statement on how this is to be undertaken for the approval of the Engineer.

All aspect's relating to occupational health and safety to be taken into consideration in the methodology.

PORTION 4: PARTICULARS OF REQUIRED ELECTRICAL WORK

PSX5.9 INTRODUCTION

This part contains the specific requirements for the project regarding work that is to be carried out for a new balancing tank and a balancing pumpstationg to be installed at the Bushkoppies Wastewater Treatment Works. The balancing tank is to consist of fifteen (15) mixers and the balancing pumpstation is to consist of four (4) pumps. The balancing tank is to be controlled from a new MCC to be installed in a dedicated new MCC room at the balancing tank. The new balancing pumpstation MCC shall in turn be fed from the new balancing tank MCC. The new balancing tank MCC shall be fed from a new minisubstation. The new minisubstation will be placed along the existing run of MV underground cable by the existing palisade fence..

Should clauses in the detail specification be in contradiction with clauses in the particular specifications, the detail specification clauses shall take precedence.

PSX5.10 SCOPE OF WORK

The electrical work to be carried out at the Bushkoppies Waste Water Treatment Works at the new Balancing Tank and Balancing Pumpstation comprises in general, the following:

- Breaking of the existing MV underground cable to connect a 630kVA minisubstation.
- Laying of an LV cable linking the new minisubstation and the new Balancing Tank MCC.
- Supply and lay LV cable linking existing generator at Head of Works to the new balancing tank MCC
- Supply, delivery, installation, testing and commissioning of a new MCC (motor control centre) for the balancing tank.
- Supply, delivery, installation, testing and commissioning of a new MCC (motor control centre) for the balancing pumpstation.
- Supply, delivery and installation of start/stop isolator stations at each motor.
- Supply, delivery and installation of cable ladders including all accessories.
- Supply, delivery, installation and termination of new low voltage power and control cables.
- Supply and lay LV cable linking existing generator at Head of Works to the new balancing tank MCC.
- Relocate existing high mast area lighting including redesign supply, delivery and installation of luminaries for the balancing tank area
- Supply, delivery and installation of building small power and lighting for the balancing tank MCC room and the balancing pumpstation.
- Supply, delivery and installation of earthing for new buildings and earth bonding of all related equipment and metal structures.
- Liasing with the nominated automation subcontractor (WSP) regarding the electrical/automation interface requirements.
- Liasing with the Works Manager and/or Electrical Manager during the project,
- Involvement in the testing and commissioning of the complete electrical and automation installation.

PSX5.11 detail specification: new mcc installation

PSX5.11.1 Scope of Work

This specification covers the supply of a 630kVA minisub station and two (2) new MCC's complete with subcircuit wiring, one to be installed in the balancing tank MCC room and the other to be installed in the balancing pumpstation.

The motor sizes indicated in the motor schedule are provisional. The Contractor shall confirm the final sizes of all the motors in order to correctly rate the power circuits (isolator, circuit breaker, overload, etc) of each of the motor starters should it be required.

PSX5.12 MCC Manufacturing

The two (2) new MCC's shall be supplied, delivered to site and installed on position in the new MCC rooms. The new MCC's shall be manufactured in accordance with the requirements of the following particular specifications:

- E04 : LOW VOLTAGE MOTOR CONTROL CENTRES

For standardisation purposes, the new MCC's and all the circuits shall be in all respect of the same pattern and manufacture as the existing **HOW Substation MCC**. Refer to the general arrangement drawing and MCC schedule attached in the annexures for the construction details of the MCC.

The new MCC's shall be front access arrangement.

PSX5.12.1 MCC Wiring

The motor starter circuits shall be wired according to the schematic drawings generated by the Contractor. The control centre shall include no interconnections between control units.

Terminal blocks shall be provided for each motor starter mounted on DIN rails in the respective wireway were all the incoming field cables and outgoing PLC I/O interfacing cables shall be wired to.

PSX5.12.2 Cubicle Identification Labels

Cubicle identification labels shall be similar to the labels of the starters on the existing **HOW Substation MCC**

PSX5.13 Quality Control

The MCC shall go through a quality inspection before being taken to site. This inspection will include physical inspection of the structure and electrical conductors and general wiring. The quality inspection shall include general electrical tests of the power circuit phasing, control circuit wiring, and device electrical operation.

The MCC shall go through a similar quality inspection upon arrival on the site and before physical interconnection with any site services.

The manufacturer shall use integral quality control checks throughout the manufacturing process to ensure that the MCC meets operating specifications.

PSX5.14 Drawings

The Contractor is required to produce the detailed individual wiring diagrams for each starter in AutoCAD format fully in compliance with the Engineer's requirements. All drawings are to be submitted for approval prior to the start of manufacture. Typical schematic drawings of circuits are attached in the annexures.

PSX5.15 DETAIL SPECIFICATION: SUPPLY, DELIVERY, INSTALLATION, TESTING AND COMMISSIONG OF 630kVA MINISUBSTATION

PSX5.15.1 Scope of work

This specification details the equipment and procedures required for supply, delivery, installation, testing and commissioning of a 630kVA minisubstation.

PSX5.15.2 Supply of Minisubstation

The minisubstation shall be supplied, delivered to site and installed on position near the existing palisade fence in the line of the existing MV underground cable. The new minisubstation shall be manufactured in accordance with the requirements of the following particular specifications:

- E18 : ELECTRICAL MINIATURE SUBSTATIONS

The contractor should make allowance for breaking of MV cable, jointing and terminations as will be required at the minisubstation. An appropriate concrete plinth should be supplied and placed in position for the minisubstation.

PSX5.15.3 Manufacturing

The minisubstation must be manufactured by an approved supplier with proven track record within the business. A set of workshop drawings must be presented for approval prior to the commencement of manufacturing of the minisubstation. Minisubstation must be as per specification and adhere to the industry norms. Any deviations must be approved by the engineer and the client prior to manufacture.

PSX5.16 DETAIL SPECIFICATION: LOCAL START/STOP ISOLATOR PUSHBUTTON STATIONS

PSX5.16.1 **Scope of work**

This specification covers the supply of the local start/stop isolator pushbutton stations.

PSX5.16.2 **Supply of local start/stop isolator pushbutton stations**

The local start/stop isolator pushbutton stations shall be manufactured in accordance with the requirements of the following particular specifications:

- E03 : LOCAL START/STOP ISOLATOR PUSHBUTTON STATION EQUIPMENT

For standardisation purposes, all new components and wire colours to be provided by the Contractor shall be similar to the components and wiring in the existing local start/stop isolator pushbutton stations.

PSX5.17 DETAIL SPECIFICATION : LOW VOLTAGE PVC INSULATED POWER AND CONTROL CABLES

PSX5.17.1 **Scope of Work**

This specification covers the supply of 600/1000V PVC insulated power and control cables. Refer to the Cable Schedule attached in the appendices and the Bill of Quantities for the requirements of the cables to be supplied.

PSX5.17.2 **Supply of low voltage cables**

The low voltage cables shall be manufactured in accordance with the requirements of the following particular specifications:

- E05 : LOW VOLTAGE CABLES

PSX5.18 DETAIL SPECIFICATION : LOW VOLTAGE CABLE INSTALLATION

PSX5.18.1 **Scope of Work**

This specification covers the installation requirements of electrical equipment under this contract.

PSX5.18.2 **Low Voltage Cable Installation Requirements**

A low voltage cable installation and the additional requirements detailed below shall be supplied, installed and commissioned between the new circuits installed on the MCC and the respective equipment by the Contractor.

The electrical installation shall be completed in accordance with the requirements of the following particular specifications:

- E06: MEDIUM AND LOW VOLTAGE CABLE INSTALLATION
- E02: CABLE RACKING

The Contractor shall supply and install low voltage power and control cables. Refer to the cable schedules attached in the appendices for the details of the cables to be supplied and installed.

PSX5.19 DETAIL SPECIFICATION: EARTHING AND EARTH BONDING

PSX5.19.1 **Earth bonding of metal structures and equipment**

All new metal parts, structures and equipment are to be earth bonded to the new balancing tank's earth bar system to eliminate static build up. The new MCC earth bar shall in turn be bonded to the existing **HOW Substation MCC's** earth bar.

In general, unless otherwise specified, all bonding shall be done by means of a **16 mm²**, green PVC insulated, hard drawn, stranded copper conductor and crimping lugs or ferrules. The earth bonding from steel structures to the main substation earth bar shall be done by means of a **70 mm²**, bare copper earth wire (BCEW).

The earth bar of the new balancing tank MCC shall be connected to the existing HOW Substation earth bar by means of a **70 mm²**, bare copper earth wire (BCEW).

PSX5.19.2 **Earthing of buildings**

Earthing of the **Balancing Tank, Balancing MCC Building** and **Balancing Pumpstation** shall be earthed as follows:

- The new 70mm^2 ring earth shall go around each new building and structure.
- The depth of installation of the new earth ring shall be 600mm below final ground level.

- Earth spikes shall be installed radially at the points where the new earth ring corners around the new building and structures.
- All BEC wire to BEC wire joints shall be done by means of caldwelding.

PSX5.19.3 **Earthing and lightning protection requirements**

The earthing and earth bonding of structures and equipment shall be completed in accordance with the requirements of the following particular specification:

- E11 : GENERAL ELECTRICAL EARTHING AND LIGHTNING PROTECTION

PSX5.20 DETAIL SPECIFICATION: ELECTRICAL/AUTOMATION INTERFACE

PSX5.20.1 Scope of Work

At the **Balancing Tank MCC** and **Balancing Pumpstation MCC**, the motor starters indicated shall be interfaced with a new **PLC** to be located in the same room. The PLC shall be supplied by others.

The Contractor shall liaise with the nominated automation subcontractor (WSP) to clarify the interface requirements of the system.

PSX5.21 DETAILED SPECIFICATION: SUPPLY OF MOTORS

PSX5.21.1 **Scope of Work**

New electrical motors shall be supplied under this project. This specification covers the supply of any new electrical motor to be supplied. Refer to the Motor Schedule attached in the appendices and the Bill of Quantities for the requirements of the motors to be supplied.

PSX5.21.2 **Supply of electrical motors**

The motors to be supplied shall be manufactured in accordance with the requirements of the following particular specifications:

- E01: ELECTRICAL MOTORS

PSX5.22 DETAIL SPECIFICATION: DESIGN, Supply AND INSTALLATION OF HIGH MAST AREA LIGHTING AT THE BALANCING TANK AREA

PSX5.22.1 **Scope of Work**

- The Contractor is required to relocate the existing high mast area lighting including redesign supply, delivery and installation of luminaries for the balancing tank area. The design shall be based on a requirement of **one (1) high mast area lights.**

The existing high mast light shall be relocated to a new position as shown on drawingJW13504-ME-002. All cables to the existing high mast shall be rerouted to the new position

PSX5.23 DETAIL SPECIFICATION: BUILDING SMALL POWER AND LIGHTING FOR THE BALANCING TANK AREA

PSX5.23.1 **Scope of Work**

The Contractor is required to complete the small power and lighting installation for the new buildings. The Contractor shall be issued with the small power and lighting design in order to commence with the supply of materials and installation thereof. However, the small power and lighting design shall be completed by the Engineer.

PSX5.23.2 **Supply and installation of building small power and lighting**

The building small and lighting shall be completed in accordance with the requirements of the following particular specification:

- E08 : ELECTRICAL WIRING
- E09 : ELECTRICAL BUILDING INSTALLATION

PORTION 5: PARTICULARS OF REQUIRED CONTROL & INSTRUMENTATION WORK

TECHNICAL SPECIFICATION
INSTRUMENTATION INSTALLATION

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PSX5.1 SCOPE OF WORK

The scope of supply of the instrumentation part of this contract shall be the manufacturing, supply, delivery, safe storage on site before installation, installation and commissioning of the process monitoring instrumentation systems listed in this tender document and on the relevant drawings. The instrumentation equipment shall include the following:

- The supply, installation and commissioning of three ultrasonic level meters (18-LIT 001, 18-LIT 002 and 19-LIT 001).

- The supply, installation and commissioning of one open channel flow meter (19-FIT 001).

- The supply, installation and commissioning of instrument junction boxes (IJBs) for each of the three level meters, for the open-channel flow meter and instrument control panels (ICPs) for each of the two electrically-actuated valves (one modulating valve 18-FCV001 and one on/off valve 19-CLV001). The valves and their actuators are supplied and installed under another part of the contract (i.e. it is not part of the C&I scope of work).

- The manufacture, supply and installation of support steel work for field junction boxes (FJBs) and instrument control panels (ICPs).

- The supply and installation of power and signal cables between the field junction boxes, the field instruments and the PLC cubicles.

- The manufacturing, supply, installation, testing and commissioning of two PLC cubicles (one Balancing Tank PLC and one Balancing Tank Pump Station PLC).

- The supply, delivery and installation of the PLC hardware as specified.

- The supply, delivery, installation, splicing and termination of communication fibre-optic cables from the new Balancing Tank PLC panel to the main admin core switches and from the new Balancing Tank Pump Station PLC to the existing main admin core switches. The supply, delivery and installation of two managed industrial Ethernet switches, complete with power supplies.

PSX5.2 general

PSX5.2.1 PLC Equipment

a). PLC Hardware supply

Supply and install two new PLCs for the balancing Tank and the Balancing Tank Pump Station, complete with a floor-standing, bottom-entry enclosure, 24V DC power supply, circuit breakers, surge protection, UPS, etc. and wire it to the relevant field I/O as shown on the attached drawings ING0014-CI-001, ING0014-CI-605-1, ING0014-CI-605-2, ING0014-CI-610 to 613, and ING0014-CI-640-1 to 4. These drawings show the cable block diagram, PLC schematic diagrams and typical I/O wiring requirements and the tenderer must ensure that there is sufficient space for all terminals, fused terminals, circuit breakers, surge protection, etc. There must 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 must be equipped with a true online UPS as specified in the attached “Automation and Control Standards, Volume 5, Clean Power and Surge Protection”. NOTE: The UPS must be a TRANSFORMER-BASED unit (NOT TRANSFORMERLESS) and must have a 3kVA rating. The applicable PLC circuits must also be equipped with proper surge protection as detailed in this same standard (“Automation and Control Standards, Volume 5, Clean Power and Surge Protection”) and as shown on the attached drawings ING0014-CI-605-1, ING0014-CI-605-2, ING0014-CI-610 to 613, and ING0014-CI-640-1 to 4. The panels must comply with all the requirements of the attached “Automation and Control Standards, Volume 3, PLC Panels”. These PLC panels must be labelled “PLC-18: Balancing Tank PLC” and “PLC-19: Balancing Tank Pump Station PLC”. The contractor must allow for the supply and installation of cross-members over trenches to support the PLC panels. The PLC hardware to be supplied under this contract is listed in the tables below.

BALANCING TANK PLC-18

Item		*Reference*	*Description*	*Qty*
1	**Premium Unity Processors - Level 1 (57-1)**	TSXP572634M	Premium Unity Level 2 CPU, with Ethernet TCP/IP Port	1
2	**(Requires Unity Pro v2. or greater)**	TSXPLP01	Premium Lithium Battery In CPU Power Supply	1
3	**Premium Power Supplies**	TSXPSY5500M	PS, 110/220VAC 50W, Double Slot	2
4	**Premium Racks**	TSXRKY12EX	12 Slot Extendable Rack	1
5		TSXRKY8EX	8 Slot Extendable Rack	1
6	**Premium BusX Cables and Accessories**	TSXTLYEX	BusX Terminator (Qty 2)	1
7		TSXCBY030K	BUS X EXT. CABLE 3M	1
8	**Premium Digital Inputs**	TSXDEY16A5	16 DI, 220VAC, Type 2, Terminal	7
9	**Premium Digital Outputs**	TSXDSY32T2K	32 DO, 24VDC Trans, 0.1A Prot, 2 x HE10	1
10	**Premium Analogue Modules**	TSXASY410	4 AO, 11 bit+sign, isolated, terminal	1
11		TSXAEY810	8 AI, high-level, 16 bits, isolated, 25-way SUB-D	1
12	**Premium Accessories**	TSXBLY01	Terminal Block, for I/O Modules	8
13		ABE7R16S210	Sub-base with 16 N/O Relay Contacts 5A, 1 x HE10	2
14		TSXCDP503	Connecting cable TSXDSY32T2K to ABE-7R16S210, 2 x HE10 connectors, 5m	2
15		ABE7CPA02	Sub-base for TSXAEY810	1
16		TSXCAP030	Connecting cable TSXAEY810 to ABECPA02/03, 2 x 25-way SUB-D, 3m	1
17		TSXMRPC001M	Unity: SRAM PCMCIA App+Data Storage Configurable, 1Mb PL7: Replaces TSXMRP0256P	1

BALANCING TANK PUMP STATION PLC-19

Item		*Reference*	*Description*	*Qty*
1	**Premium Unity Processors - Level 1 (57-1)**	TSXP572634M	Premium Unity Level 2 CPU, with Ethernet TCP/IP Port	1
2	**(Requires Unity Pro v2. or greater)**	TSXPLP01	Premium Lithium Battery In CPU Power Supply	1
3	**Premium Power Supplies**	TSXPSY5500M	PS, 110/220VAC 50W, Double Slot	2
4	**Premium Racks**	TSXRKY8EX	8 Slot Extendable Rack	2
5	**Premium BusX Cables and Accessories**	TSXCBY010K	BusX Cable with connectors, 1m	1
6		TSXTLYEX	BusX Terminator (Qty 2)	1
7	**Premium Digital Inputs**	TSXDEY16A5	16 DI, 220VAC, Type 2, Terminal	3
8	**Premium Digital Outputs**	TSXDSY32T2K	32 DO, 24VDC Trans, 0.1A Prot, 2 x HE10	1
9	**Premium Analogue Modules**	TSXASY410	4 AO, 11 bit+sign, isolated, terminal	2
10		TSXAEY810	8 AI, high-level, 16 bits, isolated, 25-way SUB-D	1
11	**Premium Accessories**	TSXBLY01	Terminal Block, for I/O Modules	5
12		ABE7R16S210	Sub-base with 16 N/O Relay Contacts 5A, 1 x HE10	2
13		TSXCDP503	Connecting cable TSXDSY32T2K to ABE-7R16S210, 2 x HE10 connectors, 5m	2
14		ABE7CPA02	Sub-base for TSXAEY810	1
15		TSXCAP030	Connecting cable TSXAEY810 to ABECPA02/03, 2 x 25-way SUB-D, 3m	1
16		TSXMRPC001M	Unity: SRAM PCMCIA App+Data Storage Configurable, 1Mb PL7: Replaces TSXMRP0256P	1

PSX5.3 Documentation

PSX5.3.1 Hardware supply

User manuals - for all equipment supplied by the contractor must be included in the documentation.

Three copies of all documentation must be provided.

PSX5.3.2 Shop Drawings

Before MCC manufacturing or field junction box manufacturing can start, the successful tenderer must submit detailed panel layout drawings for approval by the engineer.

PSX5.3.3 Recommended Spares

The Contractor must quote on a recommended spares list to be approved by the Engineer.

PSX5.4 DETAILED PLC SYSTEM SPECIFICATION

PSX5.4.1 New Balancing Tank Plant

a). PLC Panels

A new PLC cubicle must be manufactured, delivered and installed in a new MCC building to be constructed next to the Balancing Tank. Another new PLC cubicle must be manufactured, delivered and installed in a new MCC building to be constructed next to the Balancing Tank Pump Station. These PLC panels must be constructed as detailed in item 2.1.1 above.

b). System Integration and PLC Programming

The system integration and PLC programming will be carried out by others. However, the contractor has to allow a cost to assist with commissioning.

PSX5.5 FIELD EQUIPMENT

PSX5.5.1 Level And Flow Meters

a). Ultrasonic Level Meters

Supply and install three ultrasonic level meters, 18-LIT001, 18- LIT002 and 19-LIT001 as shown on P&ID ING0014-PID-001 and ING0014-PID-001 LEGEND. Connect these ultrasonic level meters to the new PLC-18: Balancing Tank PLC and the new PLC-19: Balancing Tank Pump Station PLC as shown on the attached cable block diagram ING0014-CI-001. The level meters must comply with all the requirements of the attached "Automation and Control Standards, Volume 9, Level Measurement".

b). Open Channel Flow Meter

Supply and install one open channel ultrasonic venturi flow meter, 19-FIT001 as shown on P&ID ING0014-PID-001 and ING0014-PID-001 LEGEND. Connect this ultrasonic flow meter to the new PLC-19: Balancing Tank Pump Station PLC as shown on the attached cable block diagram ING0014-CI-001. The open channel venturi flow meter must comply with all the requirements of the attached "Automation and Control Standards, Volume 8, Flow Measurement".

c). Field Junction Boxes For Level And Flow Meters

Supply and install instrument junction boxes (IJBs) for the level and flow meters mentioned in items 4.1.1 and 4.1.2 above. The junction boxes will contain the transmitters, terminals, circuit breakers for local isolation, surge protection, etc. The junction boxes must comply with all the requirements of the attached "Automation and Control Standards, Volume 19, Field Junction Boxes". The attached drawings (ING0014-CI-640-1 and ING0014-CI-640- 4) show typical examples of the equipment contained in such Field Junction Boxes.

PSX5.6 ELECTRICALLY ACTUATED VALVES

PSX5.6.1 Modulating Electrically Actuated valves

One motorised modulating valve, 18-FCV001 as shown on P&ID ING0014-PID-001 and ING0014-PID-001 LEGEND will be supplied and installed by others (i.e. not part of the C&I scope of work).

PSX5.6.2 Open/Close Electrically Actuated Valves

One motorised on/off valve, 19-CLV001 as shown on P&ID ING0014-PID-001 and ING0014-PID-001 LEGEND will be supplied and installed by others (i.e. not part of the C&I scope of work).

PSX5.6.3 Instrument Control Panels For Valves

Supply and install the instrument control panels (ICPs) for the valves mentioned in items 4.2.1 and 4.2.2 above and connect the valves to PLC-18: Balancing Tank PLC and PLC-19: Balancing Tank Pump Station PLC as shown on the attached cable block diagram ING0014-CI-001. The instrument control panels will contain the indicating lamps, pushbuttons, selector switches, relays, terminals, circuit breakers for local isolation, surge protection, etc. The instrument control panels must comply with all the requirements of the attached "Automation and Control Standards, Volume 19, Field Junction Boxes". Special attention must be paid to the requirement for a double door system with a glass panel in the outer door, called for in this specification (i.e. Volume 19, Field Junction Boxes). The attached drawings (ING0014-CI-640-2 and ING0014-CI-640- 3) show typical examples of the equipment contained in these Instrument Control Panels for a modulating valve and for an on/off (or open/close) valve.

PSX5.7 CABLING

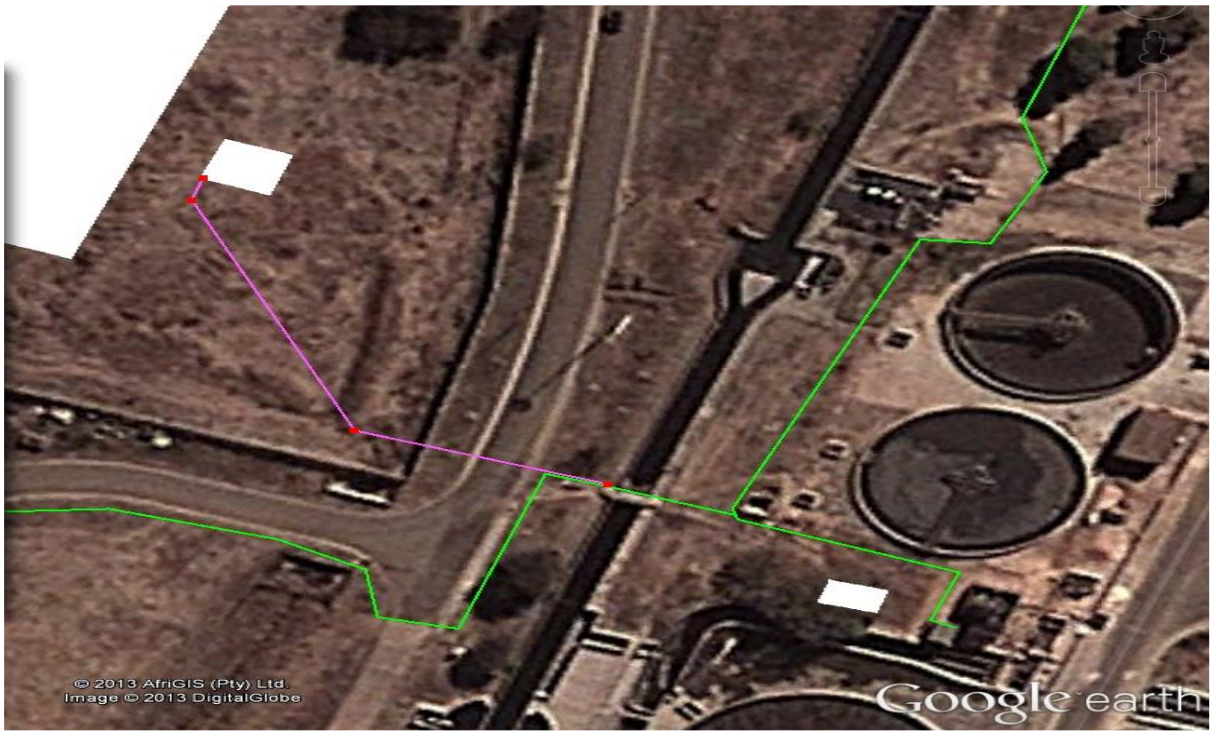
PSX5.7.1 Instrumentation Cables

All cabling must be supplied and installed in accordance with the attached "Automation And Control Standards, Volume 6, Cabling".

PSX5.7.2 Trenching

Under this instrumentation scope of work the tenderer must allow for approximately 80m of trenching from the new Balancing Tank PLC to the rack which crosses the channel, where sleeves to the admin building are accessible and for approximately 30m of trenching from the new Balancing Tank Pump Station PLC to the existing manhole where sleeves to the admin building are accessible. All trenching must be done in accordance with the attached "Automation And Control Standards, Volume 6, Cabling".

The picture below shows the trenching required from the Balancing Tank PLC (See the purple lines). The route must have at least 1 x 110mm sleeve installed. At each change of direction and after every 50m straight length a manhole or stack box must be installed.



The picture below shows the trenching required from the Balancing Tank Pump Station PLC (See the purple lines). The route must have at least 1 x 110mm sleeve installed. At each change of direction and after every 50m straight length a manhole or stack box must be installed.



PSX5.7.3 Cable Racking

All instrumentation cable racking must be manufactured and installed in accordance with the attached "Automation And Control Standards, Volume 6, Cabling". The instrumentation racking will follow the same routes as the electrical racking shown on the attached cable route layout, drawing JW713504-ME-002, but spaced no closer than 500mm from such electrical power racking. The Bill Of Quantities will indicate required lengths and sizes of cable racking. Sizes and quantities indicated in the Bill Of Quantities are there to ensure sufficient funds are available for racking. These quantities must not be used for placing of orders. The contractor must submit cable racking layouts for approval by the Engineer before any racking is ordered.

PSX5.7.4 Data Communication And Networking

All data communication cabling and equipment must comply with the following specifications listed below. The specifications are attached to Volume 2 of the tender.

"Automation and Control Standards, Volume 5, Clean Power And Surge Protection".
"Automation and Control Standards, Volume 6, Cabling".
- "Automation and Control Standards, Volume 7, Networking".

In addition, the Fibre-optic cables in this Contract shall comply with the following minimum requirements:

The fibre-optic cables will be buried within 110mm sleeves.
All fibre-optic cables will 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 Engineer. 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 Engineer. 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 will contain at least 12-cores.
Fibre-optic cables shall be tested on delivery to site as specified in "Automation and Control Standards, Volume 6, Cabling" specifications.

Approximate distances have been measured to each remote location for tender purposes and have been included in the bill of quantities. The contractor shall verify and confirm these cable lengths on site, after the tender has been awarded, before cutting cable lengths to the exact installation size. Cable lengths in the Bill Of Quantities are merely there to ensure the availability of sufficient capital for the project. These quantities must not be used for placing orders. All cable installations shall be re-measured for payment after installation.

All data communications cables (each fibre-optic cable, each patch lead, each copper cable and all equipment) will be named according to the cable block diagram and naming list as provided by the Engineer during construction. All equipment labels, cable markers and cable route markers must comply with the "Automation and Control Standards, Volume 6, Cabling" specification and the "Automation and Control Standards, Volume 3, PLC Panels" specification.

PSX5.7.5 Fibre-Optic Cables.

Supply and install one fibre-optic cable from PLC-18 to the **core switches** at the admin building. Also supply and install one fibre-optic cable from PLC-19 to the **core switches** at the admin building. See the attached cable block diagram ING0014-CI-001.

PSX5.7.6 Fibre-Optic Splicing.

One end of all fibre cores shall be terminated on the existing patch panel located inside the 19" network equipment (data) cabinets at a pair of existing **core switches** in the following arrangement (**core switches** and the 19" patch panel are existing and therefore need not be supplied under this contract):

8 cores (4 pairs) terminated on a patch panel.
The remaining fibres will be neatly coiled in the patch panel as spares.

Connections at the **core switch** include the following equipment for **each** of the two new PLC connections (**i.e. this equipment must be supplied under this contract**):

Install 2 x 1000BASE-LX SFP modules, one on core switch A and one on core switch B.
Install 2 x 3m single mode fibre patch leads between the patch panel and core switches A and B respectively.

Supply and install a 12-way, wall mounted, fibre patch panel within the PLC-18 PLC cabinet. Terminate the cores at the other end of the fibre-optic cable (i.e. not the end at the core switches) on the patch panel.

Supply and install a 12-way, wall mounted, fibre patch panel within the PLC-18 PLC cabinet. Terminate the cores at the other end of fibre-optic cable (i.e. not the end at the core switches) on the patch panel.

PSX5.7.7 Fibre-Optic Area Switches.

Each **area switch** will 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. **Two new area switches** (one for PLC-18 and one for PLC-19) are required under this contract.

The contractor is primarily responsible for all fibre-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 Engineer.

The fibre-optic cables must be tested and commissioned after installation. The commissioning of the data network can commence after the fibre-optic cables are commissioned.

PSX5.8 TRAINING

The tenderer must allow an amount to cover the cost of training of up to two Johannesburg Water personnel by the supplier (not only the contractor) on new instrumentation supplied on this contract. Training will be by the supplier at the supplier's premises or on site. If no training is required then this amount will not be claimed

PSX5.9 MAINTENANCE SPARES

The tenderer will be required to provide a recommended list of instrumentation spares, including PLC equipment and data communications equipment including, but not limited to, at least one type of each PLC I/O module processor and power supply, spare Ethernet Switch etc., for at least the following three years maintenance. The tenderer must allow a corresponding cost for these spares in the BOQ.

PSX5.10 DRAWINGS

The following drawings are supplied to show the extent of cabling, instrumentation, junction boxes, control panels, wiring, etc. required under the instrumentation and control portion of this contract:

- ING0014-CI-PID-LEGEND
- ING0014-CI-PID-001
- ING0014-CI-001-T2
- ING0014-CI-605-1
- ING0014-CI-605-2

- ING0014-CI-610(DI)
- ING0014-CI-611(DO)
- ING0014-CI-612(AI)
- ING0014-CI-613(AO)
- ING0014-CI-640-1
- ING0014-CI-640-2
- ING0014-CI-640-3
- ING0014-CI-640-4

PSX5.11 APPLICABLE SANS STANDARDS

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

II. This Specification is not issued with this volume but is available at the Contractor's expense from: Standards South Africa,

III. Office Address:

IV. 1 Dr Lategan Road, Groenkloof, PRETORIA

V. Postal Address:

VI. Private Bag X191, PRETORIA, 0001

VII. **Telephone:**National: (012) 428-6883

VIII. International: + 27 12 428 6883

IX. Telefax:

X. National: (012) 428-6928

XI. International: + 27 12 428 6928

XII. **Email:** sales@sabs.co.za

PSX5.12 PARTICULAR GENERIC SPECIFICATIONS

XIII. 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.

Electrical Works (Automation And Control Design Standards)	
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 19	Field Junction Boxes And Panels

XV. The listed specifications are included in this tender document.

PSX5.13 Plant and Materials

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

PSX5.14 Data Sheets

All the data sheets required for equipment (such as flow meters, level meters, surge protection devices, power supplies, etc.) as required in the Automation And Control Design Standards must be completed and submitted with the tender. Incomplete or missing data sheets will result in the disqualification of a tenderer.

PSX5.15 Quality Assurance

PSX5.15.1 QA Plans

The contactor must submit a quality assurance plan for approval by the engineer.

PSX5.15.2 Factory Acceptance Tests

Part of the QA plan must include factory acceptance tests of the PLC panels and Field Junction Boxes at the manufacturer's premises. These panels and FJBs must undergo a similar test after delivery on site. The test procedures to be followed during these tests must be submitted for the approval of the engineer. The engineer must be notified no less than 5 working days in advance of such planned inspections.

PSX5.16 C&I PROGRAM

When compiling his program the contractor has to take the following C&I activities and associated durations into account:

PORTION 6: PARTICULARS OF REQUIRED RECTIFICATION OF BALANCING TANK MIXERS AND ASSOCIATED ANCILLARIES.

PSX6 SURFACE MOUNTED MIXERS FOR BALANCING TANK RECTIFICATION

PSX 6.1 DESCRIPTION OF THE WORKS

PSY6.1.1 **Employer's Objectives**

The Bushkoppie Wastewater Treatment Works is a BNR-activated sludge plant with a nominal treatment capacity of 200Ml/d. The plant has a conventional process train for wastewater treatment by the activated sludge process and has a new balancing tank constructed to balance the diurnal variations in the settled wastewater inflow to the activated sludge reactors with the result that process stability is affected with consequential difficulty in complying with the effluent standards.

PSX 6.2 Background

The Contract No. JW 13504 was awarded to Umzinyathi Construction.
The initial Contract No. JW 13504 included the implementation of the following:

- Concrete Balancing Tank (volume of 25000m3)
- MCC Room
- Pump station and various pipelines
- Access roadway
- Mechanical equipment including mixers and pumps.
- Electrical equipment
- Instrumentation equipment
- Alterations to existing channels and pipes

The required details for the design of the surface mounted mixers for the Balancing Tank are provided under PSX1.3 SURFACE MOUNTED MIXERS FOR BALANCING TANK'".

The Balancing Tank design requires a total of fifteen (15) vertical shafts, single speed, dual impeller 11kw surface mounted mixers shall be installed. The balancing tank is necessary to remove the diurnal wastewater flow and load variation and to achieve constant or nearly constant flow and load rates to the biological reactor. The vertical shaft mixers are installed to ensure that the settled sewage is kept in suspension at all times and post power failure.
The finalization of the 'Contract JW 13504 by rectifying the mixers' design and reinstallation.

PSX 6.3 PARTICULARS OF REQUIRED MECHANICAL EQUIPMENT RECTIFICATION AND SERVICING

PSY6.3.1 **Scope of work**

The scope of works entails rectification of the Balancing Tank Mixers through redesign and reinstallation of the mixers in accordance with the Johannesburg Water Particular Specification as incorporated under Contract No. JW 13504. The mechanical scope of works shall include but not be limited to the following:

a). **Balancing Tanks Mixers Redesign**

A software design study such as a computational fluid dynamic study shall be performed on the Balancing Tank. The aim of the study is to evaluate the flow and solids suspension behaviors through the Balancing Tank for several different load scenarios in order to identify and select compliant mixer design sizes to satisfy all the Balancing Tank philosophical operational scenarios in compliant with the Johannesburg Water's Particular Specification.

b). **Surface Mounted Vertical Shaft Mixers**

- Remove the balancing tanks' surface-mounted vertical shaft mixers from their platforms,
- Decommission and store the drive motors, couplings and gearboxes from the disassembled mixer,
- Based on the approved solution with reference to practical site testing or CFD modelling, the Scope will include, but not limited to the following:

c). **Supply of New Mixers, OR**

- Supply, deliver, store (if necessary), install and commission, drive motors, couplings, shafts, impellers, and gearboxes to replace the non-compliant installation.
- Design, supply, deliver, store (if necessary), and install new mounting base plates compatible with existing holding-down bolts for vertical shaft mixers.

d). **Modifying existing Mixer assembly**

- Inspect and redesign balancing tank mixer shafts and impellers of the existing installation,
- Service / Maintenance Overhaul of 11kW SEW Euro drive Electric Motor for over 10,000 operating hrs.
- Service / Maintenance Overhaul of 11kW SEW Euro drive RF137 Speed Reducer (Gearbox)Inspect and reinstall the holding down bolts, where necessary.
- Reinstallation of mixers shall include inspection of the based plate, hold down bolts and re-grouting where required.

e). **Pump Station**

- Remove the pump station ' pump set from their baseplate,
- Decommission and store the drive motors, couplings and pump from the disassembled pump set,
- Major Service / Maintenance Overhaul for pump assembly with a Cornell 12NHTM-F18DB- Pump and WEG 280SM-55kW-6P-380V Motor.
- Inspect and remedy any defect on the pump station,
- Inspect and reinstall the hold down bolts, where necessary.
- Reinstallation of pump set shall include inspection of the based plate and re-grouting where required and
- Installation, testing and commissioning of the pump station to acceptable quality standards.

PSX 6.4 DETAILS OF BALANCING TANK

PSY6.4.1 **Surface Mounted Vertical Shaft Mixers**

Fifteen (15) surface-mounted vertical shaft mixers are installed in the balancing tank to ensure that the settled sewage inside the tanks is kept in suspension at all times.

PSY6.4.2 **Particular Specifications**

This specification shall be read in conjunction with the Particular Specification, M05, of specific interest is the following:

The mixing energy required for the radial flow type impellor shall be 4-5 W/m^3. Mixing energy shall be defined as the actual power imparted into the mixed liquor via the impellor through the drive unit (motor and gearbox assembly).

The tip speed of the radial flow impellor shall not exceed 2,5m/s.

PSY6.4.3 **Drawing References**

The drawings listed are bound here after the Project Specification in this Document, Volume 4.

PSY6.4.4 **Detail General Requirements for the Modification and Servicing of Mixers**

- The surface-mounted vertical shaft mixers shall be removed from their mounting bases and disassembled into their main components and parts, such as the drive unit (motor and gearbox), mounting base plate, mixer shaft and mixer impeller.
- Each of the disassembled mixer components and parts to be re-used shall be physically inspected for surface wear, corrosion, and other forms of physical damage.
- The existing equipment shall be taken apart, cleaned, shot blast and repainted to ‘original condition’. Where excessive damage is found, the Contractor shall replace the parts with new parts. The Contractor shall supply and install the replacement parts.
- Rate-only items have been included in the BOQ for spares and replacement items.
- The welds on the impeller blades of the mixers shall be inspected for fatigue and damage. Cracks, corrosion, or any physical damages or welds damages shall be removed by grinding and new welding shall be performed to repair the blades.
- The mixers shall be assembled and rebuilt to comply with Johannesburg Water’s particular specifications using the repaired and replacement parts.
- The mixer impeller assemblies shall be statically balanced before re-installation as per particular specification requirements.

- The rectified mixer assemblies shall be so that maintenance and disassembly can be performed with standard shop tools. Any special tools or fixtures required shall be listed in the Contractor's proposal , and be provided as part of mixer supply.
- The mixers shall be reinstalled to their respective positions. The Contractor shall take cognizance of the direction of rotation of the mixers as detailed in the design drawings.

PSY6.4.5 Electric Motors – Balancing Tank

- The existing balancing tank drive motors shall be removed and placed in storage.
- The Contractor shall place the removed equipment in the designated storage area specified by the Client.
- The Contractor shall supply, deliver, store (if required) and install new drive motors in accordance with Johannesburg Water's Particular Specification for Electrical Infrastructure.
- The motors shall be refurbished / new and comply with JW's particular specifications for the balancing tank.
- The new/refurbished motors for the balancing tank mixers shall be motors with a rated installed power of 11 kW/ as per selection to ensure compliance with Johannesburg Water's Particular Specification.
- The motors shall be vertically flange mounted and shall have whether shields to prevent ingress of rain and fan damage due to sunlight.
- The table below provides detailed items to be considered as part of the scope for refurbishment and reinstallation of the existing motor installation.

Balancing Tanks - 11kW x 3pH, 380 X 4P, 160M4 Motor TEFC	
Item No	**Description**
1	Strip and Re-assemble
2	Clean
3	Bake
4	Rewind
5	Replace Bearings
6	Replace Fan
7	Replace Fan Cover
8	Balance rotor
9	Balance fan
10	Repair to Bearing Journals
11	Repair of End Shield
12	Replace Shaft
13	Repair Shaft keyway
14	Replace Terminal Boxes
15	Replace Terminal Blocks
16	Fasteners
17	Replace V-Rings
18	Replace O-Rings
19	Replace Couplings
20	Replace thermistors
21	Replace heaters
22	Test and Commissioning

PSY6.4.6 **Gearboxes – Balancing Tank**

- The existing balancing tank mixer gearboxes shall be removed from the drive units and placed in storage.
- The Contractor shall place the removed gearboxes in the designated storage area.
- The Contractor shall supply, deliver and install refurbished / new gearboxes in complaint with Johannesburg Water's Particular Specification.
- The refurbished / new gearboxes shall be specifically maintained/designed for mixer service and shall be compliant with Johannesburg Water's Particular Specifications. The gearboxes supplied shall comply with the JW Particular Specification under Mechanical Engineering.

- The gearbox shall be confirmed to withstand all torsion, bending, and thrust loads so that significant deflections are not transmitted to the gears and bearings.
- Gearbox lubrication system shall be reinstated as per the original equipment manufacturer for refurbished gearbox and be designed to operate automatically without operator intervention for new gearboxes.
- Shot blast and re-coat gearbox housing including reinstatement of baseplate, fasteners replacement.
- Gearbox lubrication Oil 100% fill-up compliant with gearbox OEM specification including labour and handling and testing.
- The table below provides detailed items to be considered as part of the scope for refurbishment and reinstallation of the existing gearbox installation.

Balancing Tanks – RF137 SEW GEARBOX, N2 – 24rpm, 550 Flange	
Item No	**Description**
1	Strip and Re-assemble
2	Oil level gauge replacement
3	Drain plug
4	Oil level gauge replacement
5	breather valve
6	valve and pipe replacement
7	External fasteners replacement
8	Gearbox lubrication Oil 100% fill-up
9	Replace Roiling Bearings
10	All perishable seals, rubber buffer, and gaskets to be replacement
11	Corrosion Protection
12	Gearbox lubrication Oil 100% fill-up
13	Test and Commissioning

PSY6.4.7 **Base Plates – Balancing Tank**

- Existing mixer mounting bases shall be inspected and mounted as required or necessitated by the preferred drive unit.
- Refurbished / New base plates shall be designed, supplied, delivered and installed for each mixer. The base plates shall be designed to match the existing holding-down bolts or the requirement of the new mixer installation.

- The Contractor shall supply, deliver, store (if required) and install new holding down bolts to replace the existing holding-down bolts in the event that the new base plates and the existing are not compatible. The new holding-down bolts shall be sized by the Contractor according to the new base plate configuration. The Contractor shall consult with the Employer's Agent before procurement of new holding-down bolts. Rate-only items have been included in the BOQ for new holding-down bolts.
- The base plates shall be designed to withstand the most adverse combination of loading resulting from the equipment operation.
- The contractor shall inform the Employer's Agent in writing should one or more of the holding down bolts be deemed unfit for purpose and upon agreement new holding down bolts shall be sourced, with prior approval of the Employer's Agent.

PSY6.4.8 **Electric Motors – Pump Station**

- The existing pump station drive motors shall be removed and placed in storage.
- The Contractor shall place the removed equipment in the designated storage area specified by the Client.
- The Contractor shall supply, deliver, store (if required) and install new drive motors in accordance with Johannesburg Water's Particular Specification for Electrical Infrastructure.
- The motors shall be refurbished / new and comply with JW's particular specifications for the pump station.
- The refurbished motors for the pump station pump shall be motors with a rated installed power of 55 kW.
- The table below provides detailed items to be considered as part of the scope for refurbishment and reinstallation of the existing motor installation.

Pump Station - 55kW x 3pH, 380 X WEG Motor	
Item No	**Description**
1	Strip and Re-assemble
2	Clean
3	Bake
4	Rewind
5	Replace Bearings
6	Replace Fan
7	Replace Fan Cover
8	Balance rotor
9	Balance fan
10	Repair to Bearing Journals
11	Repair of End Shield
12	Replace Shaft
13	Repair Shaft keyway
14	Replace Terminal Boxes
15	Replace Terminal Blocks
16	Fasteners
17	Replace V-Rings
18	Replace O-Rings
19	Replace Couplings
20	Replace thermistors
21	Replace heaters
22	Test and Commissioning

PSY6.4.9 **Pump for Pump Station**

- The existing Pump Station pumps shall be removed from the drive units and placed in storage.
- The Contractor shall place the removed pumps in the designated storage area.
- The Contractor shall supply, deliver and install the refurbished pump in complaint with Johannesburg Water's Particular Specification.
- The refurbished pumps shall be specifically serviced in accordance with the original manufacturer's recommendation and shall be compliant with Johannesburg Water's Particular Specifications. The pumps supplied spares shall comply with the JW Particular Specification under Mechanical Engineering.

- Shot blast and re-coat pump housing including reinstatement of baseplate, fasteners replacement.
- The pump's lubrication shall be 100% fill-up in compliant with pump OEM specification including labour and handling and testing.
- The table below provides detailed items to be considered as part of the scope for refurbishment and reinstallation of the existing pump installation.

Pump Station – Cornell 12NHTM-F18DB- Pump, Suction 10'' and Discharge 12"	
Item No	**Description**
1	Strip and Re-assemble
2	Replacement of mechanical seal
3	Replacement of rolling bearing
4	Replacement of the lubrication content of the rotating element.
5	Replacement of tyre coupling between motor and pump shaft
6	Corrosion Protection
7	External fasteners replacement
8	Test and Commissioning
	Mechanical Commissioning Spares
9	Cornell 12NHTM-F18DB- Pump - Impeller
10	Cornell 12NHTM-F18DB- Pump - Impeller Lock Screw and Setscrew
11	Cornell 12NHTM-F18DB- Pump - Wearing Rings

PSY6.4.10 **Gantry cranes and hoists**

Testing and Commissioning of Existing Crawl Beam Installation
Perform all the required legislative tests, inspections and re-certification in accordance with the Occupational Health and Safety Act, no 85 of 1993 and Regulation. A crawl beam with a mechanically operated crawl and electrically operated hoist is installed to assist with the loading of pumps as per the following details:

Length of travel:	13.0m
Height (filter floor to bottom of beam):	7 m.
Minimum lift height:	6,5 m
Working load:	2 000 kg
Hoist speeds:	3.0 and 0.5 m/minute

PSY6.4.11 **VENTILATION FANS**

The pump station consists of two (2) ventilation fans, the ventilation unit shall be serviced as per the original equipment manufacturer's recommendation, tested and commissioned as required.

PSY6.4.12 **Testing and Commissioning**

The contractor shall demonstrate the performance of the rebuilt and/or refurbished equipment in each pump station and balancing tanks through:

- A dry commissioning test, witnessed by the Engineer and the Employer's Engineer, whereby the connectivity of all electrical and control cabling is demonstrated prior to the Contractor demonstrating the operation of the system.
- A wet commissioning test which shall be witnessed by the Employer and the Employer's Engineer, followed by the continuous trouble-free operation of the equipment for a period prescribed in section PS 5.7 of this document.

PSX 6.5 PARTICULARS OF REQUIRED RECTIFICATION OF ELECTRICAL WORKS

PSY6.5.1 **Scope of Works**

The electrical work to be carried out at the Bushkoppie Wastewater Treatment Works on Balancing tanks and Pump Station as part of Electrical Works in general shall include, but not be limited to the following:

- Supply, delivery, installation, testing and commissioning of refurbished MCC (motor control centre) faulty components per bucket for the balancing tanks.
- Supply, delivery, installation, testing and commissioning of refurbished MCC (motor control centre) faulty components per bucket for the pump station.
- Supply, delivery and installation of faulty components per start/stop isolator stations at each motor for the balancing tank and pump station.
- Supply, delivery, installation and termination of new low-voltage power and control cables and all accessories where required.
- Supply, delivery and installation of missing earthing for the refurbishment of MCC building earthing and earth bonding refurbishment of all related equipment and metal structures.
- Testing and commissioning of the complete electrical and associated automation installation.

PSX 6.6 DETAIL SPECIFICATION: REFURBISHMENT AND SERVICING

PSY6.6.1 Scope of Work

This specification covers the servicing and repair of an MCCB for 630kVA mini-substation and the refurbishment of two (2) existing MCCs for the Pump Station and Balancing Tank complete with sub-circuit wiring.

The motor sizes indicated in the motor schedule for the Balancing Tank are provisional. The Contractor shall confirm the final sizes of all the motors in order to correctly rate the power circuits (isolator, circuit breaker, overload, etc.) of each of the motor starters the final drive unit for the balancing tank change from the current installation due to the rectification process.

PSX 6.7 Detail Specification: Local Start/Stop Isolator Pushbutton Stations

PSY6.7.1 Scope of work

This specification covers the supply of faulty components for the local start/stop isolator pushbutton stations for both the pump station and balancing tank equipment.

PSX 6.8 Earthing And Earth Bonding

PSY6.8.1 Earth bonding of metal structures and equipment

The earthing and bonding shall be inspected and tested and replaced/ repaired as necessary in all the areas where work is conducted by the Contractor namely the balancing Tank Area, Pump Station and MCC Rooms.

All metal parts, structures and equipment are to be earth bonded to the balancing tanks and pump station earth bar systems to eliminate static build-up.

In general, unless otherwise specified, all bonding shall be done by means of a 16 mm², green PVC insulated, hard drawn, stranded copper conductor and crimping lugs or ferrules.

The earth bonding from steel structures to the main substation earth bar shall be done by means of a 70 mm2, bare copper earth wire (BCEW).

The earth bars of the MCCs shall be connected to the existing Substation earth bars by means of a 70 mm2, bare copper earth wire (BCEW).

PSY6.8.2 **Earthing of buildings**

The earthing and bonding shall be inspected and tested and repaired/ replaced as necessary in all the areas where work is conducted by the Contractor namely: Balancing Tank Area, Pump Station and MCC room.

PSX 6.9 PARTICULARS OF REQUIRED RECTIFICATION OF BALANCING TANK MIXERS'S CONTROL & INSTRUMENTATION WORK

PSY6.9.1 **SCOPE OF WORK**

The scope of works for the instrumentation part of this contract shall be the servicing, repair, delivery; calibration, installation, testing and commissioning of the process monitoring instrumentation systems listed in this tender document and on the relevant drawings. The instrumentation equipment shall include the following:

- The calibration, testing and commissioning of three ultrasonic level meters (18-LIT 001, 18-LIT 002 and 19-LIT 001).
- The calibration, testing and commissioning of one open channel flow meter (19-FIT 001).

PSX 6.10 DETAILED PLC SYSTEM SPECIFICATION

PSY6.10.1 **System Integration and PLC Programming**

The system integration and PLC programming will be carried out by others. However, a provisional sum has been allowed in the bill of quantity to allow the finalisation of installation, testing and commissioning of the system fully.

PSX 6.11 FIELD EQUIPMENT

PSY6.11.1 **Level And Flow Meters**

PSY6.11.2 **Ultrasonic Level Meters**

Service and calibration three ultrasonic level meters, 18-LIT001, 18- LIT002 and 19-LIT001 as installed.

PSY6.11.3 **Open Channel Flow Meter**

Service and calibration open channel ultrasonic venturi flow meter, 19-FIT001 as installed.

PSY6.11.4 **Electrically Actuated Valves**

a). **Modulating Electrically Actuated valves**

Servicing and maintenance of motorised modulating valve, 18-FCV001 as per original equipment manufacturer recommendation.

b). **Open/Close Electrically Actuated Valves**

Servicing and maintenance of motorised on/off valve, 19-CLV001 as per original equipment manufacturer recommendation.

PSX 6.12 QUALITY CONTROL RECORDS

Accurate and detailed quality control records shall be kept by the Contractor for all stages of the work.

All the quality control records shall be available for inspection by the Engineer / Employer' Representative.

The collection of record documents for each item of Plant shall be collated and bound in a logical manner and retained by the Contractor as proof of quality achieved. These shall be available on demand for quality control and part payment releases.

The records shall be neatly filed and handed over to the Engineer / Employer' Representative. on completion of the work in the form of a Data Pack together with all relevant material and test certificates. Only after the Data Pack has been approved and signed off by the Engineer / Employer' Representative. shall Plant be dispatched to Site.

PSY6.12.1 Substandard Quality Control

All material, certification and records of the Contractor shall be subject to examination by the Engineer / 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.

PSY6.12.2 Access for Surveillance

For the purpose of carrying out quality surveillance, the Engineer / 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.

PSY6.12.3 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 or

Representative opportunities to evaluate the equipment for compliance to this specification.

All items of equipment shall be subject to inspections by the Engineer or Representative 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.

PSY6.12.4 **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 Employer's Agent or Representative 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 or Representative's discretion

PSY6.12.5 **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 Engineer and/or Representatives. The duration of the training period shall be advised by the Contractor and agreed with the Engineer and/or Representatives.

The training structure for the equipment and/or system should include both the theory and practical components of the equipment 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 6.13 Operation and Maintenance Manual summary

The Contractor shall hand over to the Engineer 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:

- Brief description of the plant and installation.
- Concise operating instructions including start-up, operating, shutdown and troubleshooting procedures.
- Routine maintenance instruction this shall include failure mode analysis and preventative strategies.
- Precautionary measures, elementary trouble location, rectifying

measures and emergency actions.

- Detailed information on equipment.
- Lists of spare parts including names and addresses of suppliers.
- Schematic Diagram and Drawings
- Risk, Health and Safety Assessment with proposed control measures.

PSX 6.14 Drawings

The drawings included in the Tender Documents are the Engineer or Employer's Representative. 's proposal for the plant layout. Should the Tenderer offer alternative layouts, they 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 or Employer's Representative. . Approval of these drawings does not relieve the Contractor from his responsibility for the correctness of the drawings.

PSX 6.15 Interchangeability

Where two or more similar types of equipment 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.

PSX 6.16 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:

PSY6.16.1 **General**

The following items shall, inter alia, be included in the rates:

- Supply of all design and pre-manufacture documentation and obtaining approval thereof;
- Procurement/manufacture of required equipment with associated equipment items and delivery to Site;
- Installation of complete required equipment with associated equipment items and testing;
- Services required during period of initial use before handover to the Employer.

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 trail operation of the equipment.

PSY6.16.2 **Design and documentation**

Item	**Unit**

Items are provided in the Bill of Quantities for the design of the mixer to Specification.

The rates tendered shall include for full compensation of all costs incurred in the design of the complete installation including full design calculations, detailed working drawings for all items, specifications, schematic diagrams, electrical drawings and wiring diagrams, layout drawings, material schedules, operation and maintenance instructions, programmes of work (manufacture and on-site) and any other work required to complete the design as specified.

Payment will only be effected after the design and associated documentation has been approved by the Engineer.

Measurement and Payment for the preparation and submission of O&M Manuals shall be paid as itemised in the bill of quantity.

PSY6.16.3 **Supply and delivery to site with documentation.**

Item	**Unit**

Supply and delivery to site with documentation.....No

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 cranage 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.

PSY6.16.4 **Installation, Testing and Commissioning of Equipment**

Item	**Unit**

Installation, Testing and Commissioning of the Equipment.....No

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 Engineer / Employer' 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.

Payment will only be effected after full compliance of the equipment items with this Section and associated documentation has been approved by the Engineer / Employer' Representative.

After 600 hours of initial operation the Contractor shall take an oil sample from every aerator gearbox and send it to an approved lab for analyses and submit the results to the Engineer / Employer' Representative. Depending on the lab test results the Employer's Agent / Employer' Representative will instruct the Contractor to take the required actions.

PSY6.16.5 **Trial Operations**

Item	**Unit**
Trial Operations	No

This specification allows for a number of calendar days within which the system Trial Operation can be completed after completion of commissioning process. The Contractor shall programme and price for providing full technical and operational support during trail operation.

PSY6.16.6 **Employer's Operator Training**

Item	**Unit**
Training	No

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.

PSY6.16.7 **Spares Equipment**

Item	**Unit**
Spares	No

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 Engineer/ Employer's representative shall be submited 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.

----------**END**----------

Johannesburg Water (SOC) Ltd

VOLUME 2

DATA SHEET: 11 kW SURFACE MOUNTED MIXERS

M1. DATA SHEET: 11 kW SURFACE MOUNTED MIXERS

Item	Description	Unit	Tenderer's Offer
1.	**MIXER SUPPLIER DETAILS**		Wamechsi group (pty) ltd
1.1	Manufacturer	-	RSA
1.2	Country of Manufacturer	-	CBT
1.3	Type	-	Curve Blade Turbine
1.4	Model	-	
2.	**TECHNICAL DETAILS**		
2.1	Number required	No	15
2.2	Speed of rotation – motor	rpm	1470
2.3	Speed of rotation – mixer	rpm	25
2.4	Direction of rotation	CW/ACW	
2.5	Detail of mixer impellors	-	Curve Blade – Flat Back
2.5.1	Upper impellor diameter	mm	N/A
2.5.2	Lower impellor diameter	mm	2250
2.6	Retreat (back-curved) blade (Yes/No)	-	Yes
2.7	Tip speed	m/s	2.4
2.8	Baffles required (Yes / No)	-	No
2.9	Anti Vortex baffle fitted (Yes/No)	-	No
2.10	Power input per mixer	-	8.3
2.10.1	Upper impellor (Axial flow)	W/m³	N/A
2.10.2	Lower impellor (Radial flow)	W/m³	5
2.11	Absorbed power	kW	8.3
2.12	Impellor blade thickness	mm	8
2.13	Vortex baffle thickness	mm	N/A
2.14	Shaft diameter	mm	168
2.15	Shaft wall thickness	mm	8
2.16	Construction materials	-	LDX
2.17	Corrosion protection	-	Yes
2.18	Fixing of mixer to drive shaft	-	Bolted
2.19	Vertical load of mixer system	kg	1400
2.20	Torsional moment at start-up	kN.m	17 758
2.21	Torsional moment running	kN.m	15 750
2.22	Mass mixer	kg	Total = 1400
2.23	Mass gearbox	kg	
2.24	Mass motor	kg	
2.25	Mass frame	kg	

Item	Description	Unit	Tenderer's Offer
3.	**MOTOR DETAILS**		
3.1	Manufacturer	-	SEW Eurodrive GmbH & Co KG
3.2	Country of Manufacture	-	
3.3	Type	-	DRN 160M4
3.4	Model (frame size)	-	160
3.5	Service factor	-	S1
3.6	Insulation class (H minimum)	-	H
3.7	Temperature use class	-	
3.8	Rotational speed	rpm	1473
3.9	Rated output at Site	kW	11
3.10	Operating voltage	V	400
3.11	Corrosion protection	-	CI Epoxy
3.12	Anti-condensation heaters for motor (Yes / No)	-	Yes
3.13	Temperature detectors in windings (Yes/No)	-	Yes
3.14	Power factor at 75% of rated power	-	0.76
3.15	Efficiency at 75% of rated power	-	91.7
3.16	Full load current	Amps	23
3.17	Starting current	Amps	107
3.18	Type of starter	-	DOL
3.19	Starting time for starting with connected load	Sec	TBC
3.20	Number of consecutive starts at its specified load	No	15
4.	**GEARBOX DETAILS**		
4.1	Manufacturer	-	
4.2	Country of Manufacture	-	
4.3	Type	-	
4.4	Model	-	
4.5	Rating	-	11
4.6	Service factor on installed power	-	2.7
4.7	Efficiency	%	97
4.8	External flow or pressure switch control (Yes/No)		
4.9	Corrosion protection	-	CI-epoxy
5.	**INSTALLATION**		

Item	Description	Unit	Tenderer's Offer
5.2	Holding down bolts	-	
5.3	Number of holding down bolts	No	
5.4	Base plate thickness	mm	
5.5	Base plate corrosion protection	-	
6.	**DELIVERY TIME FOR MIXERS**	weeks	
7.	**INSTALLATION TIME FOR MIXERS**	weeks	
8.	**LOCAL CONTENT OF MIXERS**	%	
9.	**IMPORTED CONTENT OF MIXER COMPONENTS IN RELEVANT CURRENCIES**		
10.	**RECOMMENDED SPARES AND DETAILS OF MAINTENANCE REQUIRED**		

SIGNED ON BEHALF OF TENDERER : .....

NAME (in print) : .....

DATE : .....

BUSHKOPPIE WASTEWATER TREATMENT WORKS

BALANCING TANK MIXER MOTOR

TECHNICAL DATA

1	**Designation**	
1.1	Manufacturer	SEW Eurodrive GmbH & Co KG
1.2	Type	DRN160M4
1.3	Mounting position	B5
1.4	Electrical standard	IEC
1.5	Connection diagram	R13
1.6	Efficiency class	IE3
1.7	Equivalent IEC frame size	160
1.8	Type of motor	three-phase induction motor
1.9	Duty type	S1
1.10	no. of phases	3
2	**Rating**	
2.1	Output power	11kW
2.2	Speed	1473min^{-1}
2.3	Torque	71Nm
2.4	Voltage	400/690V D/Y
2.5	Current	21//12,2A
2.6	Frequency	50Hz
2.7	Power factor	0,81
2.8	Efficiency	91,4%
3	**Design**	
3.1	Degree of protection	IP65
3.2	Method of cooling	IC411 (self ventilated)
3.3	ambient temperature	-20°C to 40°C
4	**Operation characteristics**	
4.1	Starting torque ratio M_A/M_N	2,6
4.2	Pull-up torque ratio M_H/M_N	2,2
4.3	Pull-out torque ratio M_K/M_N	3,0
4.4	Locked rotor current ratio I_A/I_N	7,3
4.5	KVA letter (NEMA)	H
4.6	No load current (without gearbox)	9,1/5,2A
4.7	Perm. no-load starts BGE	900h^{-1}
4.8	max. stalltimes cold/hot	13/10s

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5 Partial load characteristics

5.1

Perc. rated load	25%	50%	75%	100%	125%
Current [A]	10,5//6,07	13,2//7,64	16,8//9,76	21//12,2	25,9//15
Speed [min^{-1}]	1494	1487	1481	1473	1465
Power factor	0,43	0,65	0,76	0,81	0,83
Efficiency [%]	87,1	91,1	91,7	91,4	90,6

6 Winding and insulation

6.1	Connection	D/Y
6.2	Winding resistance cold	0,628Ω @ 20°C (+/-10%)
6.3	Thermal class	H
6.4	Winding temp. rise	40K
6.5	Thermal protection	-

7 Design details

7.1	Direction of rotation	both
7.2	Inertia motor	0,0817kgm²
7.3	Inertia rotor	0,0812kgm²
7.4	motor weight net	115kg

8 Standard bearing sizes

8.1	Bearing A stand-alone motor	6310
8.2	Bearing B stand-alone motor	6212
8.3	Bearing A gearmotor	6312
8.4	Bearing B gearmotor	6212

9 Motor extras

9.1 Thermistors: 3 x PT100

9.2 Heaters: None

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BUSHKOPPIE WASTEWATER TREATMENT WORKS

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1.6	Efficiency class	IE3
1.7	Equivalent IEC frame size	160
1.8	Type of motor	three-phase induction motor
1.9	Duty type	S1
1.10	no. of phases	3
2	**Rating**	
2.1	Output power	11kW
2.2	Speed	1473min^{-1}
2.3	Torque	71Nm
2.4	Voltage	400/690V D/Y
2.5	Current	21//12,2A
2.6	Frequency	50Hz
2.7	Power factor	0,81
2.8	Efficiency	91,4%
3	**Design**	
3.1	Degree of protection	IP65
3.2	Method of cooling	IC411 (self ventilated)
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4	**Operation characteristics**	
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6.5	Thermal protection	-

7 Design details

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8.3	Bearing A gearmotor	6312
8.4	Bearing B gearmotor	6212

9 Motor extras

9.1 Thermistors: 3 x PT100

9.2 Heaters: None

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07/06/2018

Johannesburg Water (Pty) Ltd

VOLUME 2

CONTRACT

PART 4:

SITE INFORMATION

C4 SITE INFORMATION

GENERAL

This section describes the site at the time of tender to enable the tenderer to price his tender and to decide upon his method of working and programming and risks.

CONTENTS

Clause	Description	Page no.
SI 1	SITE LOCATION	SI.3
SI.2	SITE INFORMATION	SI.3
SI.3	ACCESS TO SITE AND RESTRICTIONS	SI.3
SI 4	EXISTING SERVICES, SERVITUDES AND WAYLEAVES	SI.4
SI 5	SECURITY	SI.4
SI 6	HYDROLOGICAL REPORT	SI.4
SI 7	GEOTECHNICAL REPORT	SI.5

SI 1 SITE LOCATION

The Bushkoppie Wastewater Treatment Works is located South of the N12 and West of the N1 Freeways, between Eldorado Park and Soweto.

The following site conditions shall be taken into consideration in the design and selection of equipment:

Altitude above sea level ..... 1562 m

Peak temperature..... 40ºC

Average maximum temperature..... 35ºC

Minimum temperature ..... -5ºC

Relative humidity..... 71% at 13ºC

Lightning .....Severe

Corrosion .....Severe

Atmosphere.....Dusty

SI 2 SITE INFORMATION

The project site lies within the boundary of the existing palisade security fence. The was incorporated into the existing security area during the construction of the balancing tank. The contractor must take all necessary precautions to secure the construction site during construction and control entry thereon.

SI 3 ACCESS TO SITE AND RESTRICTIONS

The Treatment Works is located south of the N12 and west of the N1 Freeways, between Eldorado Park and Soweto, approximately 1 kilometre to the southeast of the N12 and Golden Highway (R553) intersection.
The Treatment Works is a fully functional Plant and as such its operation must not be jeopardised at any time.

The Contractor may not operate any valves, sluice gates or any other equipment currently in use on the works without written permission from the Works Manager.

The Contractor shall provide temporary access to the Works as may be required by him and to the approval of the Engineer.

Access to the Site is by means of existing tarred roads through the main access gate, which is controlled by a security service provider approved by Johannesburg Water (SOC) LTD. No restriction on access to the Site of Works will be placed on persons or vehicles involved with the execution of the Works. All traffic must be restricted to the maximum speed of 40 km/h and vehicles must be driven with extreme caution.

The Contractor shall be required to report daily to Management personnel of the Works. Work permits shall be completed and shall be area specific, i.e. working on the various zones of the Works (Balancing Tank, Pump Station, MCC).

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

The Contractor's staff shall be identified by either clothing bearing the contracting company's name or an identification tag, which shall be displayed when entering the Site of Works.

Movement within the Site of Works is restricted so as to avoid damage to the existing services, structures, trees and, where practical, to the gardens. The making good of any damage caused by non-observance of such restrictions will be for the Contractor's account.

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

SI 4 EXISTING SERVICES, SERVITUDES AND WAYLEAVES

The existing treatment works must remain in operation during the execution of the contract. The Employer must have access to the works at all times. If the work to be done requires the treatment works to be out of operation for a short period, prior arrangements must be made at least one week in advance with the Engineer.

The known existing services are shown on the drawings. The positions of the services cannot be guaranteed. On establishing on Site, the Contractor must determine the positions of all pipelines and cable routes on Site with the assistance of the Engineer's and the Employer's staff on Site. The Contractor must take precautions to prevent any damage to existing services. Damages which might occur will be repaired at the cost of the Contractor.

No permits or wayleaves will be required.

SI 5 SECURITY

A concrete palisade fence has been installed along the entire perimeter boundary of the Works. The Employer has appointed a security company which controls the access through the main access gate to the works and regular patrols within the boundaries of the works.
The Contractor shall remain responsible for the security of his on-site establishment and plant. Upon the appointment of a security service provide, the details of the guards and the grade of such appointed personnel shall be made available to the Employer.

SI 6 HYDROLOGICAL REPORT

No floodline nor hydrological information will be made available

SI 7 GEOTECHNICAL REPORT

No Geotechnical information will be made available

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

VOLUME 6 : CABLING

Johannesburg Water (SOC) Ltd.
PO Box 61542
Marshalltown
2107

Revision 17 August 2019

DOCUMENT CONTROL SHEET

Document Title: **Particular Specification – VOLUME 6 : Cabling**

JW Reference: **BWW523C**

Document Ref. No: **VOLUME 6**

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	09/09/2019	

RECORD OF REVISIONS

Date	Revision	Author	Comments
2019-08-26	17	C. Du Toit	Cover page updated
2019-08-14	16	C. Du Toit	Updated materials for use in corrosive areas (GRP).
2019-06-15	15	C. Du Toit	JW comments included (Trenching under roads, sleeve draw wires, route marker painting, manhole covers and
2018-11-30	14	C. Du Toit	Added maximum losses for OTDR & OLTS testing, standards for data cable testing, protective tiles and
2014-04-17	13	C. Du Toit	Added blown fibre, splicing requirements & laser safety.
2013-10-07	12	C. Du Toit	Updated footer, bends for cable racks, cores in fibre-optic cables, fibre-optic cable type, earthing for theft
2012-07-27	11	C. Du Toit	Updated headers & footers.
2012-03-08	10	C. Du Toit	Updated support material for Ferric Chloride areas.
2012-03-08	9	C. Du Toit	Altered height of cable route markers, added new wiring size requirements and precedence of wiring sizes,
2011-07-11	8	C. Du Toit	Added cable theft prevention measures and removed 2010 logo.

2010-07-27	7	C. Du Toit	Added details of cable route markers and updated materials for cable ladders.
2009-08-18	6	C. Du Toit	Added new logos, cable rack material & colour and warning tape in trenches.
2009-05-08	5	C. Du Toit	Added requirements from client meeting on 04 May 2009.
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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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 0.5mm^2 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:

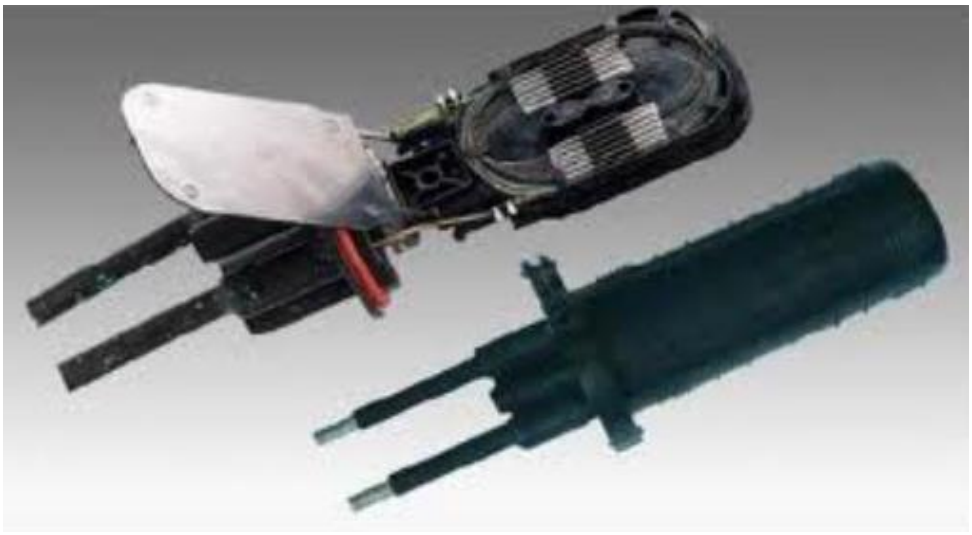
Installation Condition	Blown Fibre Microduct Assembly Requirem
In ceiling of a building	Rodent-proof, low-smoke, fire retardant, halogen
On a cable support against the side of the building	Steel wire or steel tape armoured, UV protected.
Buried in a trench	Suitable for direct burial.
On a rack in the open above ground	Mechanical protection, UV protection (if mechani 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.

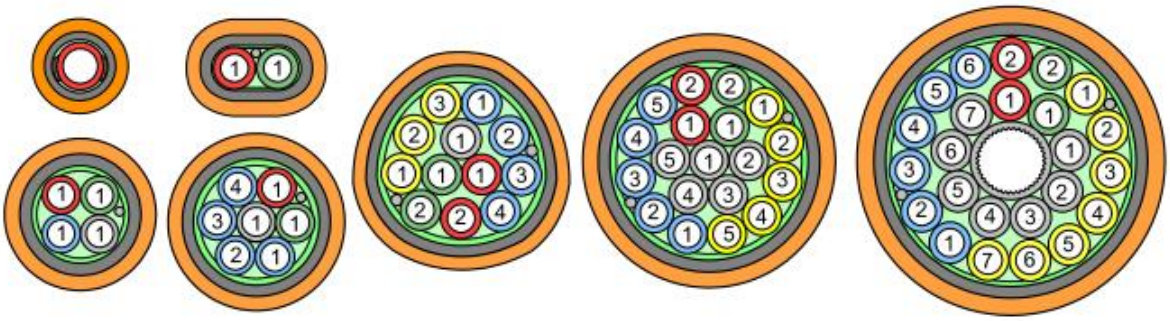
6.4.38 All cable routes, including trenches, cable racks, tunnels, cable supports, etc. must be clearly marked on drawings and submitted for approval by the Engineer. The project will not be regarded as complete until such cable route drawings have been submitted and approved.

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.

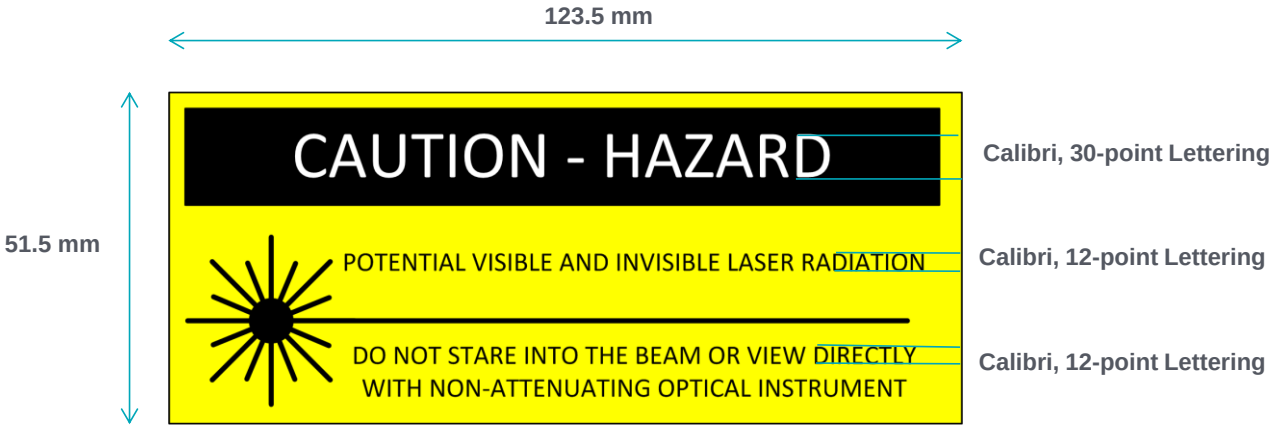
6.4.41 Microducts in microduct assemblies must be available in 1, 2, 4, 7, 12, 19 and 24 microduct assemblies and must be numbered and colour-coded as indicated in the sketch below.



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/ m^2, 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 25mm^2. 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.

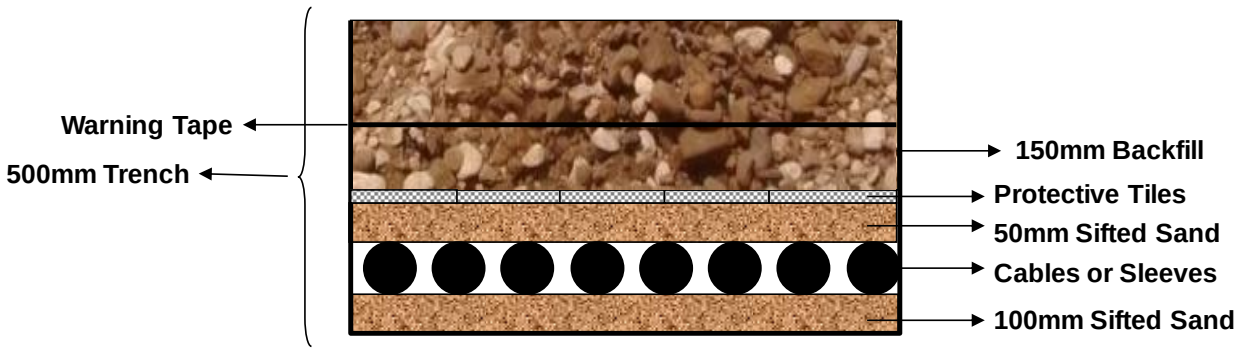
6.6.7 Where cable junction boxes, terminal boxes or terminations in instruments or any other panels in the field take place it must be ensured that such a junction box, termination box, instrument, etc. is not exposed to fire hazards from burning grass or other vegetation. If such a termination point 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 approximately150mm 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.

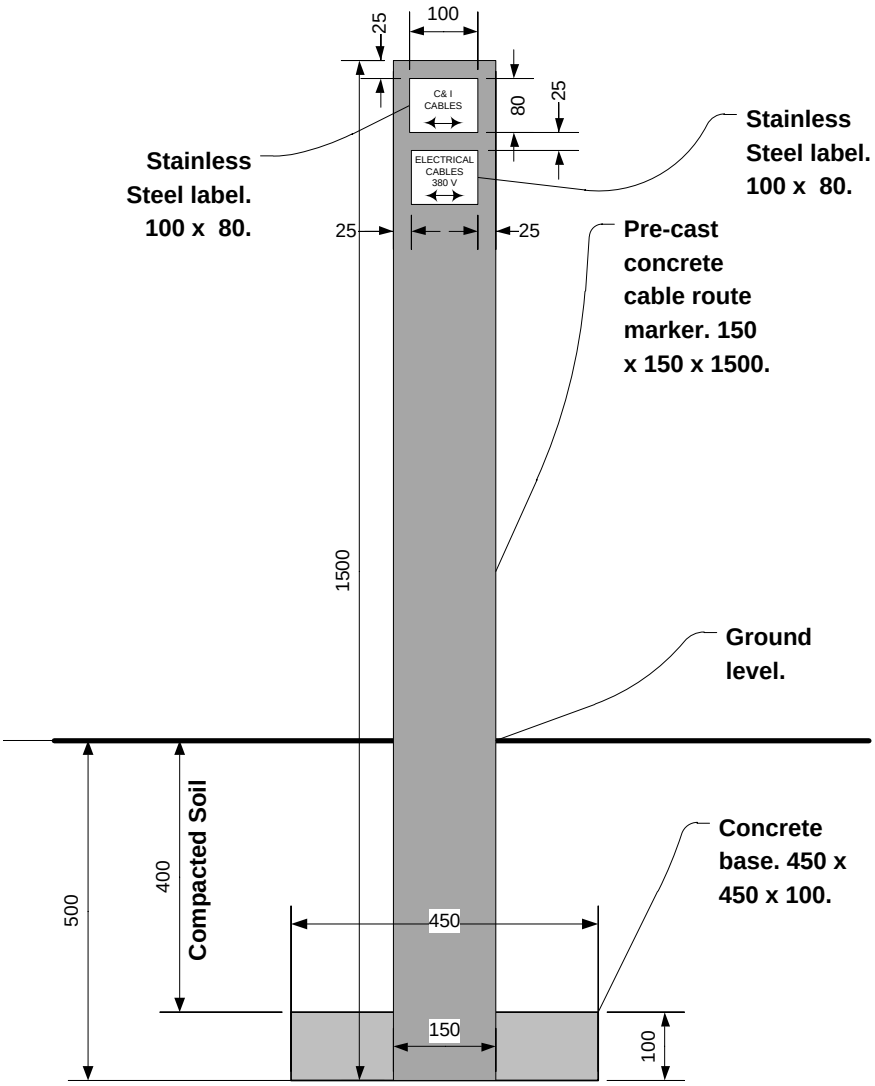
6.7.7 Cable route markers, in the form of concrete pre-cast posts, which stand 1.0m above ground level, secured in the ground, must be installed every 50m on straight runs and at every change in direction of the trench. Movable route markers will not be acceptable. The post must be equipped with a stainless 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 that 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 that 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).



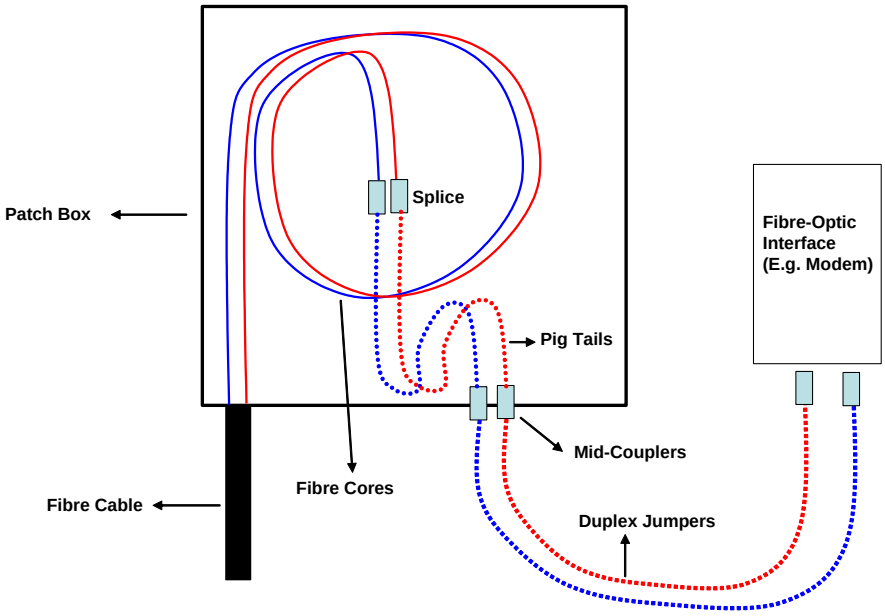
6.7.20 The base of the chamber must be made up of a dry mix of stone and cement so that it forms a hard but porous surface which is free draining for any water which enters the chamber.

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.

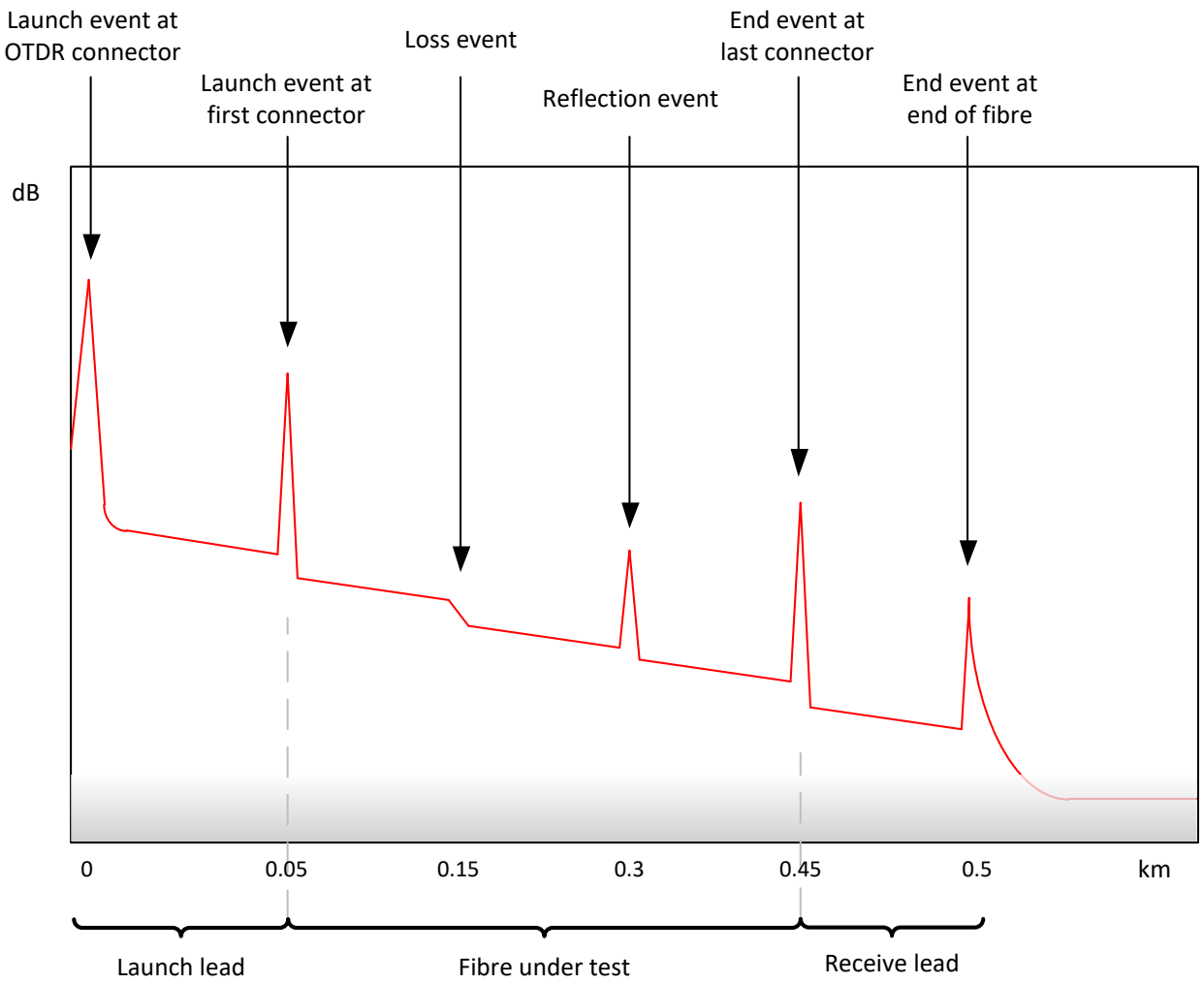
6.8.7 All fibre-optic cables supplied must comply with the relevant parts of SANS 60793/ IEC 60793 and SANS 60794/ IEC 60794 in terms of construction, installation and testing.

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

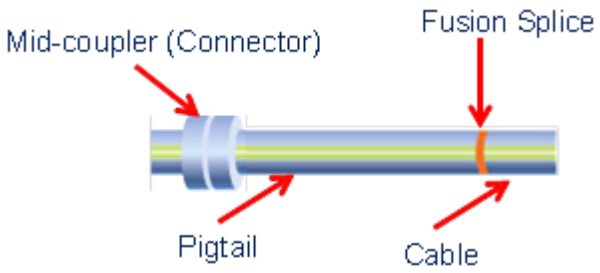


6.8.8.3 OLTS (optical loss test set) analysis with a power source and power meter must be done for all fibres after the installation has been completed. These tests must be done in both directions and the results have to be captured in MS Excel. A typical test report for one fibre is shown below. (P/Loss = Power Loss; ORL = Optical Reflection Loss).

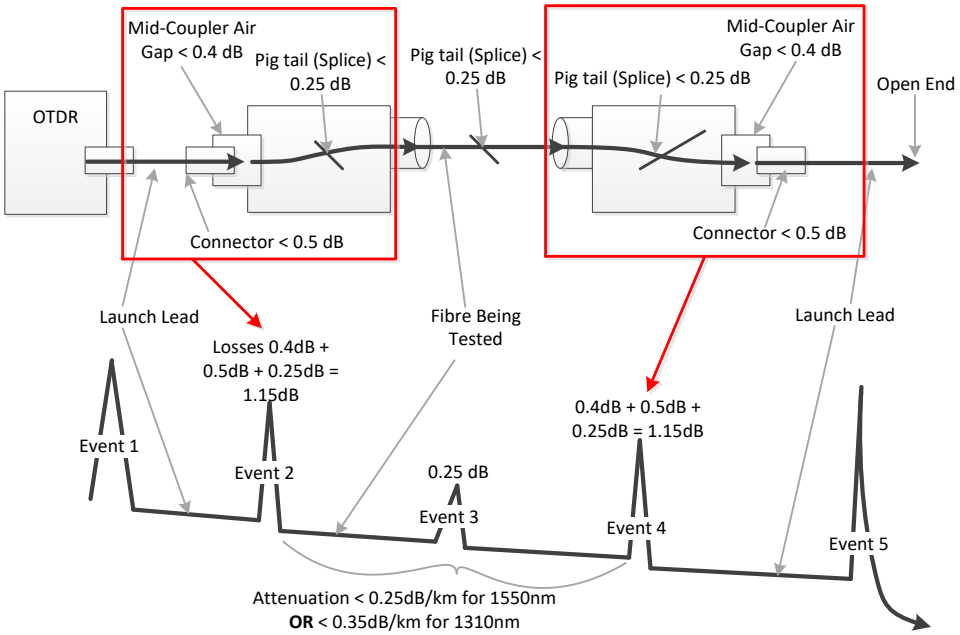
Fibre ID	Wavelength	P/Loss	P/Loss	Average	ORL A	ORL B	Length
		A->B	**B->A**				
	(nm)	(dB)	(dB)	(dB)	(dB)	(dB)	(km)

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 5^{th} 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 18 : CHEMICAL OXYGEN DEMAND MEASUREMENT

Johannesburg Water (SOC) Ltd.
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Prepared	HOD	C. Du Toit	2019-08-26	
Reviewed	Engineer	L. Gobinca	2019-08-26	
Approved	Manager	H. Makola	2019-10-07	

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2018-11-30	11	C. Du Toit	Added reference to Labelling specification and corrected errors.
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2012-03-08	7	C. Du Toit	Changed (Pty) to (SOC) and changed from reagent-using, on-line analyser to probe as per Cydna request.
2011-07-11	6	C. Du Toit	Removed 2010 logo.
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

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18 CHEMICAL OXYGEN DEMAND MEASUREMENT

18.1 Scope

18.1.1 This specification covers the supply and installation of Chemical Oxygen Demand meters, complete with sampling, filtration, indicators, panels, etc. used for process monitoring and control applications at Johannesburg Water wastewater sites.

18.2 Abbreviations

18.2.1 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
mg/l	:	Milligram per litre
O&M	:	Operating And Maintenance
FSD	:	Full Scale Deflection (Also refers to maximum range)
COD	:	Chemical Oxygen Demand
SAC 254:		The Spectral Absorption Coefficient (SAC 254 nm) is a total parameter measuring the dissolved organic material that absorbs UV light at a wavelength of 254 nm.

18.3 Standards

18.3.1 The supply and installation of all COD 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.

18.4 Scope Of Work

18.4.1 The supply, installation testing and commissioning of all fittings, brackets, piping, cabling, etc. required for the complete sampling, analyzing, display and interfacing (e.g. to PLC's) system.

18.4.2 The supply, installation testing and commissioning of all sampling pumps required for sample analyzing.

18.4.3 The supply, installation, testing and commissioning of all Field Junction Boxes (FJB's) with circuit breakers, surge protection, terminals, trunking, etc. required to ensure compliance with this specification.

18.4.4 The supply, installation, testing and commissioning of the analyzer and all required filtration systems to ensure sample analyzing in accordance with this specification.

18.5 General Requirements

18.5.1 This specification must be read in conjunction with the following specifications:-

18.5.1.1 PLC Panels Specification (Volume 3 of the Automation And Control Standards).

18.5.1.2 Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

18.5.1.3 Cabling Specification (Volume 6 of the Automation And Control Standards).

18.5.1.4 Field Junction Boxes And Panels (Volume 19 of the Automation And Control Standards).

18.5.1.5 Labelling (Volume 25 of the Automation And Control Standards).

18.5.2 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.

18.5.3 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).

18.5.4 FJB's and all sampling pumps, filtration units, fittings, displays, etc., 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.

18.5.5 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.

18.5.6 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.

18.5.7 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, solids in liquid, etc.) and to ensure that if there are potential problems, they can be pointed out and rectified before orders for equipment are placed.

18.5.8 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 there are solid particles too large for proper operation, or the analyser 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.

18.5.9 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.

18.5.10 If the instrument requires de-ionised water, the tenderer must ascertain whether this is available on site and provide for the de-ionised water where necessary.

18.5.11 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.

18.5.12 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 analyser and associated equipment for inclusion in a final O&M manual.

18.5.13 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.

18.6 Surge Protection

18.6.1 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).

18.6.2 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).

18.6.3 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).

18.7 COD Measurement – Controller/Transmitter

18.7.1 The transmitter/controller must be a microprocessor based instrument.

18.7.2 All instrument transmitter enclosure must have at least an IP 65 or higher rating.

18.7.3 The transmitter must have an operating temperature range of -20 to 60 degrees C.

18.7.4 The instrument must be equipped with at least two isolated, active, 4 – 20mA outputs which will be connected to a maximum 500 ohm load.

18.7.5 The transmitter must be able to accept two inputs from digital measuring sensors.

18.7.6 The instrument must be equipped with at least three SPDT relays, rated for at least 230V AC, 2A. Two relays for preset COD 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 COD values.

18.7.7 The transmitter must be suitable for use with a 230V AC, 50/60 Hz power supply.

18.7.8 The transmitter/controller must have at least two data logs of not less than 128kB each. The logged data must be downloadable on an SD card in XML format.

18.7.9 The transmitter must have an LCD or LED display, which will show instantaneous nitrate value.

18.8 COD Measurement – Transducer/Sensor

18.8.1 The principle of sensor operation must be based on ultraviolet absorption technology using two beams. The measurement method must be measurement of SAC 254 in accordance with DIN 38404 C3.

18.8.2 No reagents must be used.

18.8.3 The sensor housing material must be stainless steel.

18.8.4 The sensor must be self-cleaning.

18.8.5 The detection range of the sensor must be from 0.1 to 600 m^{-1} absorption units, using a 5mm path and must be suitable for the application (see items 18.5.7 and 18.5.8 of this specification).

18.8.6 The sensor accuracy will be determined by the calibration of the unit after installation. It is therefore essential that the tenderer allows a cost to have the supplier available for a period of approximately 2 weeks to set up and calibrate the

instrument correctly.

18.8.7 The sensor must be suitable for an operating temperature range of 2ºC to +40ºC.

18.8.8 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.

18.9 Spares

18.9.1 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.

18.10 Data Sheets

18.10.1 All data sheets in the attached Appendix 1 must be completed.

APPENDIX 1

DATA SHEET – CHEMICAL OXYGEN DEMAND ANALYSER

DESCRIPTION	DATA
Make/Manufacturer	
Transmitter/Controller type/model	
Transmitter/Controller operating temperature range	
Transmitter/Controller microprocessor based (Y/N)?	
Transmitter/Controller data logs available (Y/N)?	
Power Supply (Voltage)	
Number of sensor inputs to controller and type (e.g. 2 x digital sensor inputs)	
Analogue output	
Digital Output Quantity, Type & Rating (E.g. 3 x SPDT, 230V AC, 5A) & Programmable (Y/N)?	
Transmitter/Controller enclosure rating	
Display data & type (E.g. instantaneous Nitrate, LCD).	
Sensor type/model	
Sensor operating principle	
Sensor range	
Sensor housing material	
Sensor operating temperature range	

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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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.

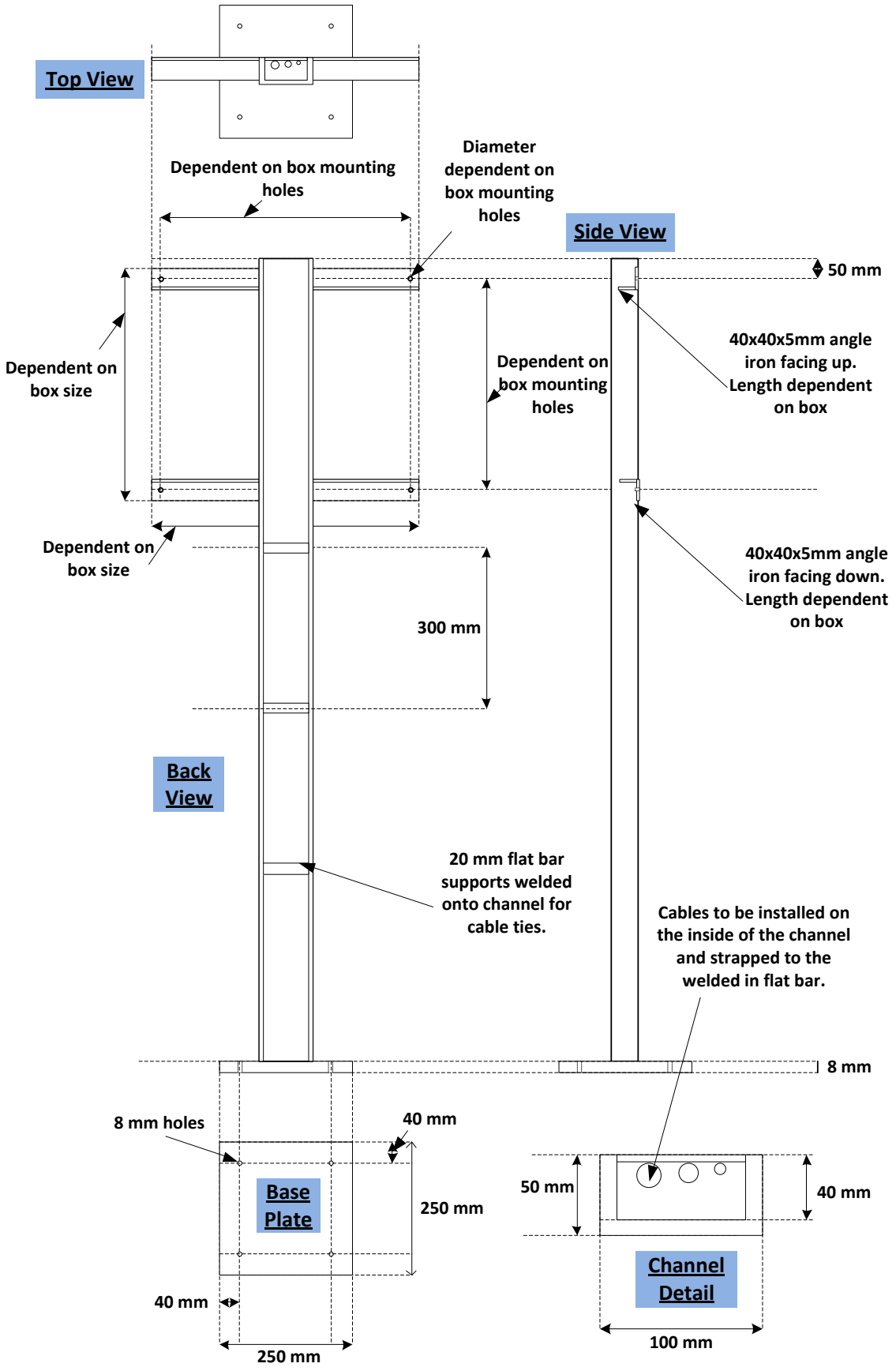
19.4.7 All IJBs should be clearly labelled with labels as specified in the Labelling Specification (Volume 25 of the Automation And Control Standards).

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).


Top View
Dependent on box mounting holes
Diameter dependent on box mounting holes
Side View
50 mm
Dependent on box size
Dependent on box mounting holes
40x40x5mm angle iron facing up. Length dependent on box
Dependent on box size
40x40x5mm angle iron facing down. Length dependent on box
300 mm
Back View
20 mm flat bar supports welded onto channel for cable ties.
Cables to be installed on the inside of the channel and strapped to the welded in flat bar.
8 mm
8 mm holes
40 mm
Base Plate
250 mm
50 mm
40 mm
Channel Detail
40 mm
250 mm
100 mm

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/ m^2, 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).

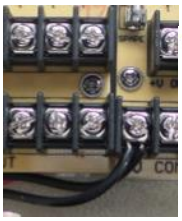


19.6 Wiring and Terminals

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 230V AC Power

Live	Brown
Neutral	Blue
Earth	Green and Yellow

19.6.11.2 24V DC Power

Positive	Red
Negative	Black

19.6.11.3 Digital Inputs

230V AC	Yellow
24V DC	Red

19.6.11.4 Digital Outputs

230V AC	Grey
24V DC	Red

19.6.11.5 Relay Outputs

230V AC	Grey
24V DC	Red

19.6.11.6 Analogue Signals

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:-

Property	Requirement	Test Method
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 185ºC 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:

Treminals - Phoenix SK12, 4mm, white.
MCB's - Merlin Gerin, 5A, 10kA, single-pole.
Etc.

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

VOLUME 8 : FLOW MEASUREMENT

Johannesburg Water (SOC) Ltd.
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Reviewed	Engineer	L. Gobinca	2019-08-26	
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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 -10ºC to +50ºC.

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 ±2% of the full scale for Doppler meters and not less than ±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 -10ºC to +80ºC.

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 -20ºC to +150ºC.

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 suitable for operating in temperatures ranging from minus 15ºC to +60ºC.

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 an 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 15ºC to +65ºC.

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 15ºC to +65ºC.

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 ± 0.2% of full scale for changes in gas composition as high as ±2.5% of CH_4.

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 m^3/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 20ºC to +70ºC and a process temperature operating range of minus20ºC to +120ºC.

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 25 : LABELLING

Johannesburg Water (SOC) Ltd.
PO Box 61542
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Revision 3 August 2019

DOCUMENT CONTROL SHEET

Document Title: **Particular Specification – VOLUME 25 : Labelling**

JW Reference: **BWW523C**

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Approved	Manager	T. Thabeng	09/09/2019	

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2019-08-26	3	C. Du Toit	Cover page updated
2019-07-04	2	C. Du Toit	JW requirements from electrical workshop for wire numbering included.
2019-06-15	1	C. Du Toit	JW requirements included (Arial font on labels and no more than 4 threads showing on bolt ends).
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).

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

VOLUME 9 : LEVEL MEASUREMENT

Johannesburg Water (SOC) Ltd.
PO Box 61542
Marshalltown
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Revision 14 August 2019

DOCUMENT CONTROL SHEET

Document Title: **Particular Specification – VOLUME 9 : Level Measurement**

JW Reference: **BWW523C**

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Approved	Manager	T. Thabeng	04/09/2019	

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2019-08-26	14	C. Du Toit	Cover page updated
2019-06-25	13	C. Du Toit	Revision approved by JW.
2018-11-30	12	C. Du Toit	Added reference to Labelling specification.
2014-04-17	11	C. Du Toit	Added reference to FJB specification.
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).
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 position requirements added.
2009-03-25	4	C. Du Toit	JW Wastewater Partnership deleted & logos altered as per client's requirements.

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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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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 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.

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 -10ºC to +50ºC.

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 21 : LOAD CELLS

Johannesburg Water (SOC) Ltd.
PO Box 61542
Marshalltown
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Revision 11 August 2019

DOCUMENT CONTROL SHEET

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Reviewed	Engineer	L. Gobinca	2019-08-26	
Approved	Manager	T. Thabeng	09/09/2019	

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2019-08-26	11	C. Du Toit	Cover page updated
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2018-11-30	9	C. Du Toit	Added reference to Labelling specification.
2014-04-17	8	C. Du Toit	Added reference to FJB specification.
2013-10-07	7	C. Du Toit	Updated footer
2012-07-27	6	C. Du Toit	Updated headers & footers.
2012-03-08	5	C. Du Toit	Changed (Pty) to (SOC).
2011-07-11	4	C. Du Toit	Removed 2010 logo.
2009-08-18	3	C. Du Toit	New logos and transmitter position requirements added.
2009-03-25	2	C. Du Toit	JW Wastewater Partnership deleted & logos altered as per client's requirements.
2009-03-12	1	C. Du Toit	Included comments from JW. Approved revision.

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21 LOAD CELLS

21.1 Scope

21.1.1 This specification covers the supply and installation of Load Cells, complete with sensors, transmitters, indicators, panels, etc. used for process monitoring and control applications at Johannesburg Water wastewater sites.

21.2 Abbreviations

21.2.1 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

21.3 Standards

21.3.1 The supply and installation of all Load cells 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.

21.4 General Requirements

21.4.1 This specification must be read in conjunction with the following specifications:-

21.4.1.1 PLC Panels Specification (Volume 3 of the Automation And Control Standards).

21.4.1.2 Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).

21.4.1.3 Cabling Specification (Volume 6 of the Automation And Control Standards).

21.4.1.4 Field Junction Boxes And Panels (Volume 19 of the Automation And Control Standards).

21.4.1.5 Labelling (Volume 25 of the Automation And Control Standards).

21.4.2 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.

21.4.3 All power supply cables to instruments must have a black outer sheath, while all control cables (such as digital and analogue signals to PLCs) must have an orange outer sheath as specified in the Cabling Specification (Volume 6 of the Automation And Control Standards).

21.4.4 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.

21.4.5 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.).

21.4.6 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.

21.4.7 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.

21.4.8 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.

21.4.9 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 lifting equipment cannot be inserted to fit the instrument, or the instrument is interfered with by mechanical structures, or the safe loading capacity of the instrument is exceeded, or there is incorrect eccentric or concentric loading on a load cell, 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.

21.4.10 It is the express responsibility of the tenderer to guarantee that this instrument will work correctly for this application and that it will not require regular maintenance (i.e. more frequently than once in 6 months) under normal operation conditions. If the instrument does not work correctly or if regular maintenance is required for it to work properly, the tenderer will be required to replace the instrument with one that does work correctly, and the cost of such replacement (including the cost for another instrument, labour and material) will be for the tenderer's account.

21.4.11 Each instrument which is a 2-wired, 24V DC, loop powered device must be equipped with a suitably sized fuse in a latched fuse holder, connected to the power supply of the instrument, to enable local isolation in case of repairs or replacement.

21.4.12 Each instrument which is a 230V AC powered device must be equipped with a 2-pole circuit breaker, connected to the power supply of the instrument, to enable local isolation in case of repairs or replacement.

21.4.13 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.

21.4.14 The tenderer must supply a complete and detailed set of documentation for the installation, connections, terminations, power supply, technical details, setting up, calibration, testing, etc. of the instrument for inclusion in a final O&M manual.

21.4.15 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.

21.5 Screening, Earthing And Surge Protection

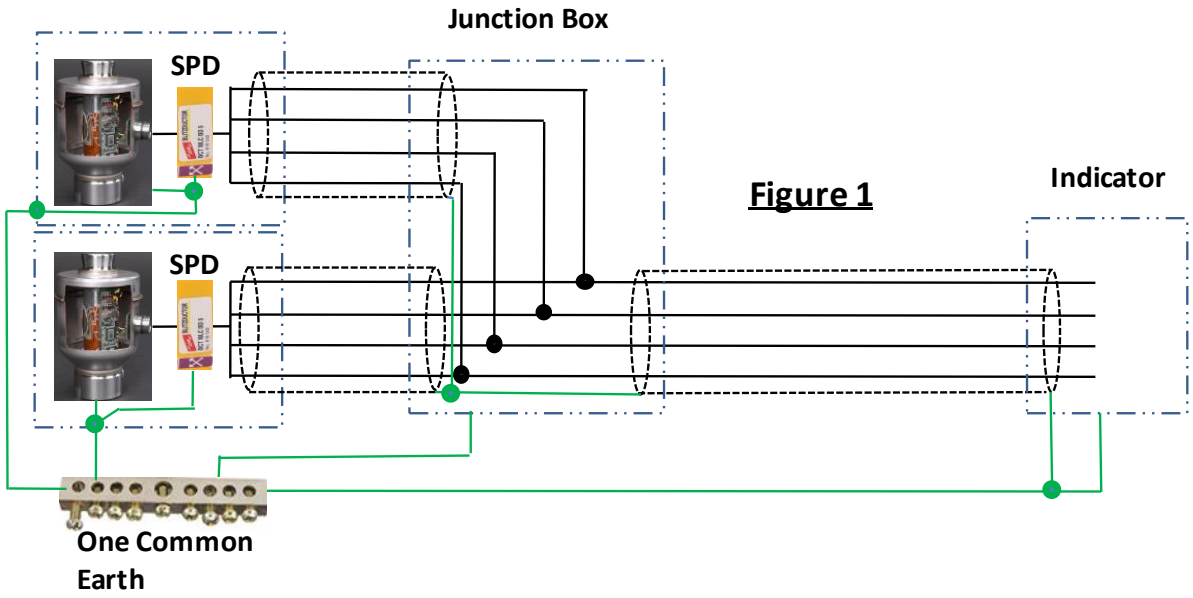


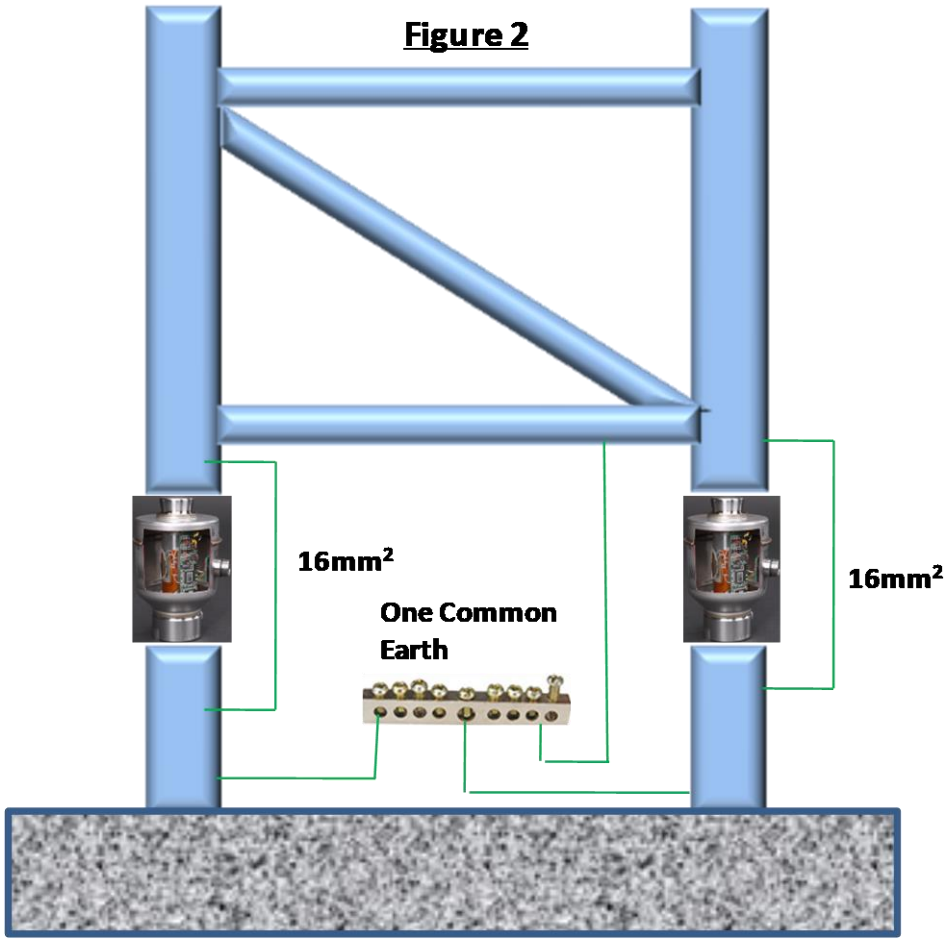
Figure 1

21.5.1 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).

21.5.2 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).

21.5.3 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).

21.5.4 All load cells, junction boxes, SPDs, indicators, etc. must be equipped with good earthing connections.



21.5.5 Avoid earth current loops by:

- Earthing cable screens at one end only (see Figure 1)
- Using one common earth point, instead of multiple earths (see Figure 1 and Figure 2)
- Grounding the load cell and the SPD at the same point (see Figure 1)

21.5.6 When welding is done, put the earth clamp as close as possible to the point of welding and avoid high currents running through the load cell.

21.5.7 When welding is done, and the load cell cannot be removed, at least disconnect the load cell cables.

21.6 Load Cells And Their Installation

21.6.1 The design and manufacturing of the vessel to be weighed by load cells must be done in conjunction with the supplier of the load cells to ensure that all factors such as wind forces, asymmetrical loading, maintenance, number of load cells, brackets for load cells, etc. have been taken into consideration. Where wind forces, asymmetrical loading, etc. can cause the vessel to be lifted from one or more of the load cells, it has to be ensured that the brackets used provide protection against the

vessel being lifted off a load cell.

21.6.2 It must be ensured that the load cell can move freely, without obstruction from external systems or devices such as chutes, brackets, supports, pipes, cables, etc.

21.6.3 The vessel must be designed to avoid impact forces which can lead to overloading and subsequent damage to the load cells.

21.6.4 Pipe connections, cable connections, etc. must be done via extremely flexible connections to avoid interference with mass measurement.

21.6.5 A flexible, multi-strand, copper conductor of not less than 16mm^2 must be connected to the structure on either side of the load cell to ensure that harmful currents from surges, welding, etc. are diverted across the load cell.

21.6.6 The structure design and load cell selection must be such that load cells can be removed for maintenance or replacement, without overloading other load cells on the same vessel. Dummy load cells must be provided for fitting during construction (before the actual load cells are installed) or for fitting during replacement.

21.6.7 The number and location of load cells must be such that each load cell will bear the same amount of weight. I.e. situations where one load cell can bear virtually no weight must be avoided by proper installation measures (such as shimming) during commissioning and setting up.

21.6.8 Pivot weighing (i.e. where half the vessel is weighed by load cells while the other half is supported on dummy load cells or flexure beams acting as pivots) can only be done where symmetrical vessels containing liquids are weighed and where it can be ensured that the pivot system will not introduce friction which can lead to false weight readings.

21.7 Load Cells Measuring Criteria

21.7.1 The measuring range of the load cell must be suitable for the application (see items 21.4.8 and 21.4.9 of this specification).

21.7.2 Each load cell must be manufactured from stainless steel or from tool steel which is Electroless Nickel (“EN”) plated and painted to SANS 1274-2005, and must be hermetically sealed to IP68.

21.7.3 Since these load cells are not used in “Scales For Trade”, only medium accuracy load cells are required. Each load cell must have a combined error of no greater than 0.2% of the measured range. The overall system error (including the mechanical installation) must not be greater than 0.5% of the measured range.

21.7.4 Each load cell must have a temperature operating range of at least -10ºC to +45 ºC.

21.8 Load Cell Junction Box And Indicator

21.8.1 Each system must be supplied, complete with a local junction box where all the load cell cables are connected in parallel to provide a single output related to the weight being measured.

21.8.2 Each system must also be supplied, complete with a local indicator. There must be a

single multi-core cable wired from the local junction box to the local indicator.

21.8.3 Each local indicating unit must be equipped with a means of calibrating and performing tare functions. These functions however must only be available to suitably qualified personnel. I.e. there must be a means of preventing unauthorised people from performing these functions (such as password protection, a lock-out key, etc.).

21.8.4 The local indicating unit must be equipped with an isolated, active, 4 – 20mA output for mass, which will be connected to a maximum 500 ohm load.

21.8.5 The local indicating unit must have a potential-free relay contact for a collective failure on the system as well as change-over relay contacts for at least three programmable threshold limits. Each contact must be suitable for switching 500mA at 230V AC,

21.8.6 The local indicating unit must be suitable for a 230V AC, ±10%, power supply.

21.8.7 The local indicating unit must have at least a 5-digit display.

21.8.8 The local indicating unit and the local junction box must have a protection rating of not less than IP 65 and it must comply with the requirements of the Field Junction Boxes Specification (Volume 19 of the Automation And Control Standards) if it is a free-standing enclosure. If it (the local junction box and/or the local indicator) is mounted inside another field junction box (i.e. the field junction box containing the cabling to the PLC and/or the MCC), it can be manufactured of poly-carbonate or similar material and need only have a protection rating of not less than IP 54.

21.8.9 The local indicating unit and the local junction box, with all electronic and indicating instrumentation, must have a temperature operating range of at least -10ºC to +45 ºC.

21.9 Spares And Manufacturer/Authorised Distributor Requirements

21.9.1 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.

21.10 Data Sheets

21.10.1 All data sheets in the attached Appendix 1 must be completed.

21.10.2 Where terms and conditions apply to warranties or guarantees, these should be clearly stated in the data sheets in the section where “Guarantee period” is requested.

APPENDIX 1

DATA SHEET – LOAD CELLS

DESCRIPTION	DATA
Load Cell	
Load Cell Make/Manufacturer	
Type/Model	
Material Of Construction	
IP Rating	
Measuring range	
Manufacturer/authorised distributor (Y/N)?	
Manufacturer/authorised distributor contact details.	
Guarantee period	
Combined Accuracy (% of measured range)	
Local Indicator	
Power Supply (Voltage)	
Analogue Output Type	
Change-over relay contacts for programmable limits (Y/N)?	
Self-diagnostics with failure alarming (Y/N)?	
Local Indicator Enclosure Rating	
Guarantee period	
Local Junction Box	
Local Junction Box Enclosure Rating	

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

VOLUME 7 : NETWORKING

Johannesburg Water (SOC) Ltd.
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Revision 15 August 2019

DOCUMENT CONTROL SHEET

Document Title: **Particular Specification – VOLUME 7 : Networking**

JW Reference: **BWW523C**

Document Ref. No: **VOLUME 7**

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	09/09/2019	

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Date	Revision	Author	Comments
2019-08-26	15	C. Du Toit	Cover page updated
2019-06-25	14	C. Du Toit	Revision approved by JW.
2018-11-30	13	C. Du Toit	Added reference to Labelling specification.
2014-04-17	12	C. Du Toit	Added use of blown fibre.
2013-10-07	11	C. Du Toit	Updated footer.
2012-07-27	10	C. Du Toit	Updated headers & footers.
2012-03-08	9	C. Du Toit	Changed (Pty) to (SOC), updated core switch port requirements, core switch power supply requirements,
2011-07-11	8	C. Du Toit	Removed 2010 logo.
2010-07-27	7	C. Du Toit	Area and core switch requirements clarified, data irrelevant to tenderers deleted and data sheets
2010-03-12	6	C. Du Toit	Fibre core switch requirements updated to specify Gigabit uplinks and to include a data sheet.

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.
2009-02-24	3	C. Du Toit	Switch requirements from specialist added plus "Joburg" & "JW" Logos added to top & partnership
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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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:-

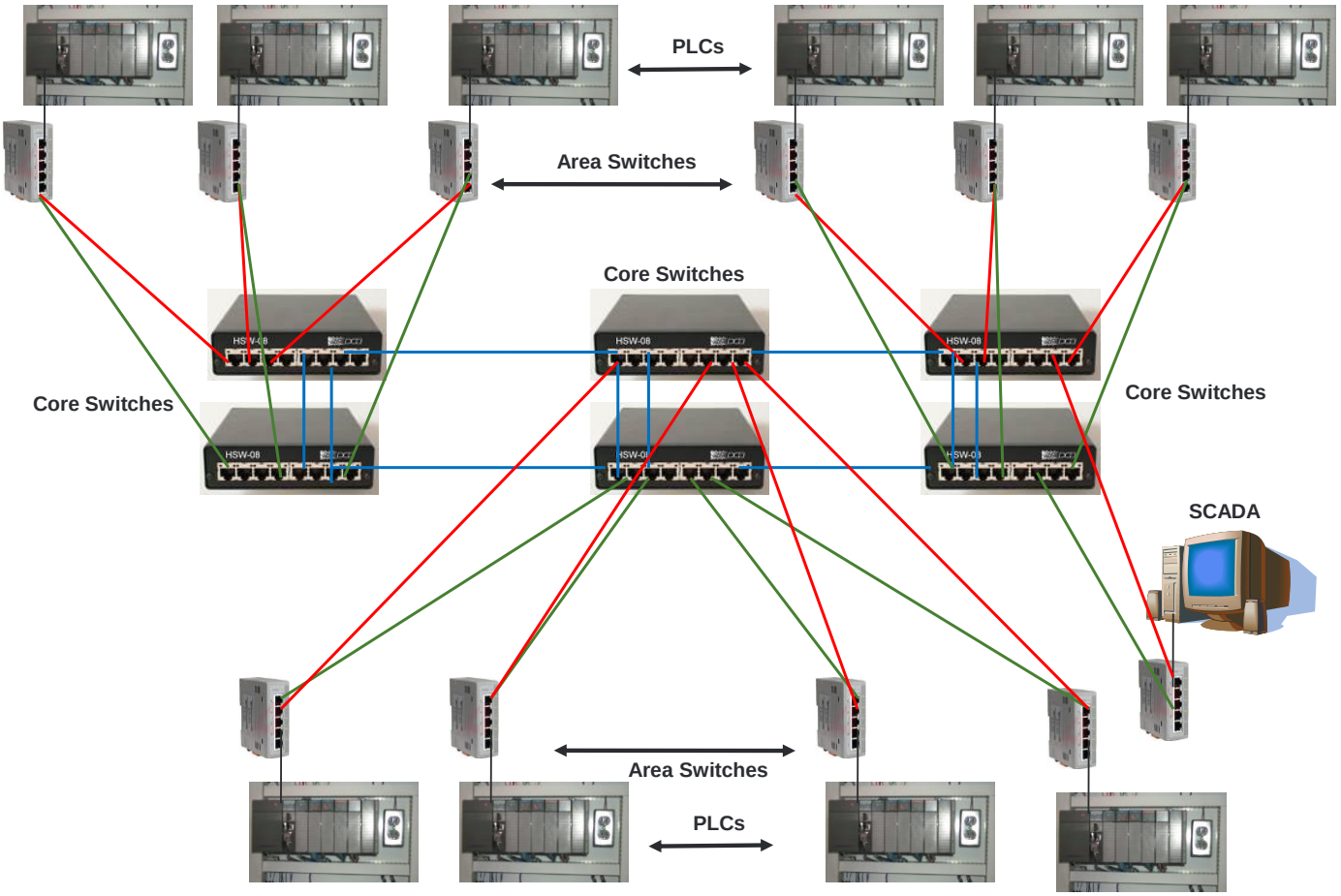
SANS 10142-1	:	National Standards for the wiring of premises
IEEE 802.3-2005	:	Carrier Sense Multiple Access with Collision Detection (CSMA/CD) access method and physical layer specifications
IEEE 802.3ad (Now IEEE 802.1AX)	:	Link Aggregation
IEEE 802.1d	:	MAC Bridges
IEEE 802.1p	:	Quality of service
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 55ºC, 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 55ºC, 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 form 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 form 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 3 : PROGRAMMABLE LOGIC CONTROLLER (PLC) PANELS

Johannesburg Water (SOC) Ltd.
PO Box 61542
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Revision 15 August 2019

DOCUMENT CONTROL SHEET

Document Title: **Particular Specification – VOLUME 3 : Programmable Logic Controller (PLC) Panels**

JW Reference: **BWW523C**

Document Ref. No: **VOLUME 3**

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	09/09/2019	

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2019-08-26	15	C. Du Toit	Cover page updated
2019-06-25	14	C. Du Toit	Added stopper plugs, fan terminations, panel light and PLC panel earthing.
2018-11-30	13	C. Du Toit	Added spare space requirements, PLC fan position, terminal requirements, use of bolts, fused terminal
2014-04-17	12	C. Du Toit	PLC fan position and reference to SANS 10142 updated.
2013-10-07	11	C. Du Toit	Updated footer, screws in backing plates and PLC fan requirements.
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.
2010-07-27	7	C. Du Toit	Altered I/O card terminal requirements and minimum panel powder coating thickness.
2010-03-12	6	C. Du Toit	Altered submission time of PLC panel drawings.

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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.

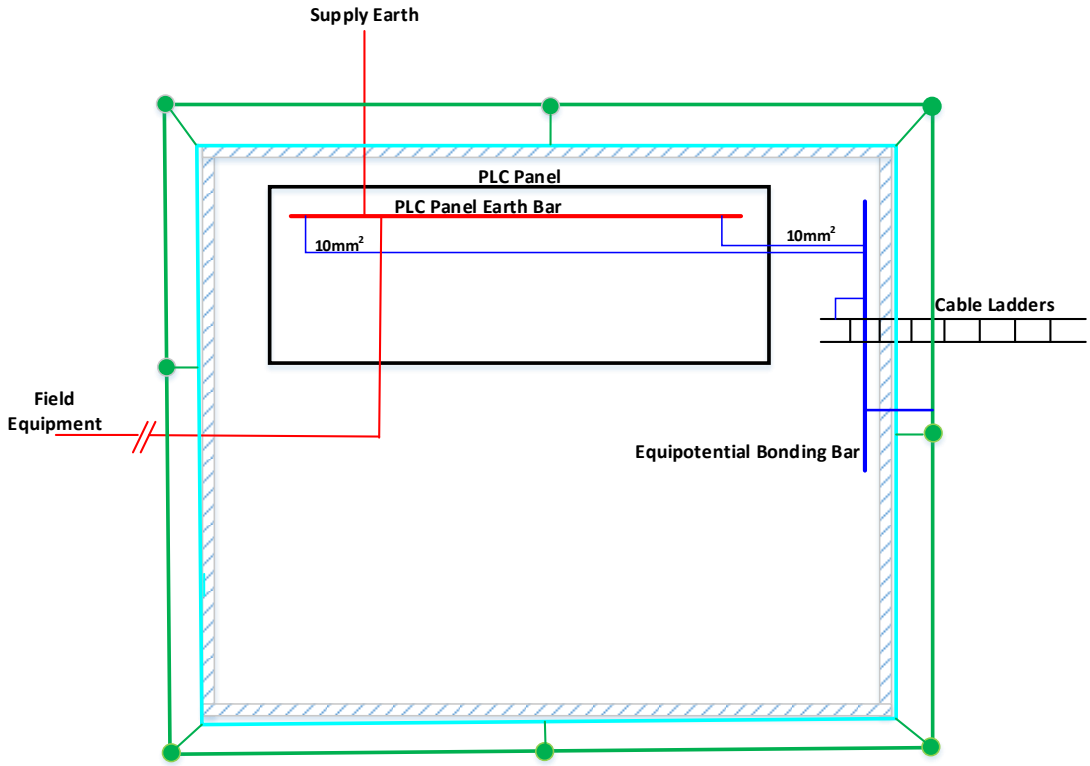
3.5.1.7 No holes may be drilled for tapping, riveting, bolts & nuts, etc. in any section of the panel where it will compromise the protection rating of the panel. I.e. only in the backing plate or in the glanding plate may holes be drilled. Where drilling is unavoidable, e.g. to affix labels, the holes 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 $10mm^2$ 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 230V AC Power

Live	Brown
Neutral	Blue
Earth	Green and Yellow

3.6.14.2 24V DC Power

Positive	Red
Negative	Black

3.6.14.3 Digital Inputs

230V AC	Yellow
24V DC	Red

3.6.14.4 Digital Outputs

230V AC	Grey
24V DC	Red

3.6.14.5 Relay Outputs

230V AC	Grey
24V DC	Red

3.6.14.6 Analogue Signals

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:-

Property	Requirement	Test Method
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 185ºC 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.

PARTICULAR SPECIFICATION

E01 :ELECTRICAL MOTORS

2	2012-05-30	Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance		
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**

City of Johannesburg
Johannesburg Water (SOC) Ltd

PARTICULARSPECIFICATION : VOLUME E01 : ELECTRICAL MOTORS

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E01.1 SCOPE

This specification shall cover all electric motors tobe 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)	SABS 948-1	Three-Phase Induction Motors
(b)	SANS 1222	Enclosures for electrical equipment (classified according to the degree of protection that the enclosure provides)
(c)	BS 4999	General requirements for rotating electrical machines
(d)	BS 1486: Part 2	Heavy duty lubrication nipples
(e)	ISO281/1	Rolling bearings - dynamic load ratings and rating life

E01.2.3 Particular Specifications to be read in conjunction with this specifications

The following particular specifications shall be read in conjunction with the Project Specification:

G01: PARTICULAR SPECIFICATION FOR COLOUR CODES

G02: PARTICULAR SPECIFICATION FOR CORROSION PROTECTION

E01.3 GENERAL REQUIREMENTS

(a) Electric motors shall be manufactured in South Africa and shall comply with the requirements of SABS948-1.

(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 SABS 948-1.

(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 which comply with the requirements of SABS 948-1.

(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, shall 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 ± 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 ± 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 plus and minus 5 percent of the nominal supply voltage.

(c) The slip-in speed of any motor at 80 percent of the nominal voltage at 50 Hz 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) The efficiency of all motors shall be guaranteed by the contractor. Deviations from the guaranteed efficiency shall be within the limits specified in SABS 948.-1.

(b) The guaranteed efficiency of each size and rating of motor shall be as determined in accordance with BS 4999: Part 102. 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.

(c) 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 inadvertentvibration without load, and at full rated voltage at the manufacturer's works, and the vibration amplitude as measured shall be in accordance with BS 4999: Part 142, quality grade 'Special'.

(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 BS 4999.

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 1222, or alternatively specified. Motors shall preferably be of the totally enclosed fan-cooled (TEFC) type.

(c) 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.

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, however, not exceed 120% of the required capacity without prior approval having been obtained 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 BS 4999 Part 112, 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 BS 4999: Part 143 will not be accepted and shall be limited to 10%.

(g) Documentation shall include performance curves to suit the designedworking 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: Part 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 281/1.

E01.13 EARTHING

All motors shall be provided with a machined or spot-faced boss tapped to receive a bolt of not less than 10 mm in diameter for earthing purposes, which is located on one side between the mounting feet.

E01.14 HEATERS AND DRAINAGE

Non-submersible motors which 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.

Where specified in the project specifications, motors shall be supplied with anti-condensation heaters to keep the motor temperature at 23°C when the motor is not operational to prevent moisture from condensing in the motor.

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) 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.

(b) 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 SABS 948. 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.

(c) Winding termination in the motor terminal boxes shall be properly secured or fastened to avoid hot connections during operation.

(d) 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.

(e) Terminals shall be of a substantial design and shall be suited to receive cable lugs. Pinch-screw connections will not be accepted.

(f) 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.

(g) The electrical clearance and creepage distances, with the correct cable terminations in position, shall comply with the requirements of BS 4999.

(h) Terminal markings shall be clear and permanent and shall comply with BS 4999. 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.

(i) 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.

(j) 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 948-1the following shall also be marked on the nameplates:

- Year of manufacture,
- The order number,
- Total mass of motor in kilogram,
- Diagram indicating the number, type and positions of heaters and temperature detectors if applicable,
- Bearing types and sizes, and
- 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 SABS 948-1.

(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 submerging, 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 1,0 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 result 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 to be 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 55kW shall have no thermistor and heater protection devices installed on them. Motor rated 55kW 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 thisspecification.

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 BS 170, SABS 948-1 or BS 4999.

(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 BS 170 and BS 4999.

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 SABS 948-1, BS 170 or BS 4999.

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 high 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 oil 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 ERECTION AND COMMISSIONING

E01.24.1 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.

E01.24.2 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 brineling during the guarantee period, the Contractor, free of charge, without delay, shall change them.

E01.24.3 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.

E01.24.4 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 megaohms, 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 placingthe motor in a heating oven.

Sufficient heat shall be applied to produce a temperature of 60ºC but not greater than 80ºC for a Class A or 90ºC 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 100 kW 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.

E01.24.5 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.

E01.25 COLOUR CODING

The standard final colour codes for equipment supplied under this Contract shall be in accordance with Particular Specification G01.

E01.26 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 to be included in the rates tendered for the equipment.

Where separate payment is required for electric motors and specified as such in the detail specifications, the following payment items shall be applicable:

Item	**Unit**
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.

Item	**Unit**
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.

PARTICULAR SPECIFICATION

E02: ELECTRICAL CABLE RACKS

3	2012-05-30	Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance		
2	2010-05-03	Review Electrical Standards		
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**

City of Johannesburg
Johannesburg Water (Pty) Ltd

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:

- SANS 10044 : Welding
- SANS 10064 : Preparation of steel surfaces for coating
- SANS 10158 : Glossary of terms for quality assurance and quality control
- SANS 10214 : The design, fabrication and inspection of articles for hot-dip glavanising
- SANS 1274 : Coatings applied by the powder process
- SANS 10044 : Welding Part 3: The fusion of steel (including stainless steel): Tests for the approval welding procedures and production welds
- SANS 10044 : Welding Part 4: The fusion of steel (including stainless steel): Tests for the approval of welders working to approved welding procedures
- SANS 10044 : Welding Part 5: The fusion of steel (including stainless steel): Tests for approval of welders where weld procedure approval is not required
- SANS 10162-1 : The structural use of steel Part 1: Limit-states design of hot-rolled steelwork
- SANS 10162-2 : The structural use of steel Part 2: Limit-states design of cold-formed steelwork
- SANS 10162-4 : The structural use of steel Part 4: The design of cold-formed stainless steel structural members
- 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:-

G01: PARTICULAR SPECIFICATION FOR COLOUR CODES

G02: PARTICULAR SPECIFICATION FOR CORROSION PROTECTION

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. Metal cable ladders shall be manufactured from corrosion resistant Stainless Steel 304 L. For severe corrosion areas GRP material should be used

All metal cable ladders shall consist of a 76 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 interval of 250 mm. Where cables of 10mm² or smaller are installed on cable ladders, the spacing of the cross rungs shall be a maximum of 125 mm.

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 is not exceeded. Sharp angles shall be 45º 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 unistrut section securely fixed to the wall. The corrosion protection shall be of the same system as that of the cable ladder.

Cable ladders shall be supported with the struts, channels, brackets, clamps, cantilever arms and nuts/bolts/washers.

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, springwashers, etc shall be stainless steel 316.

E02.5 EARTH BONDING OF CABLE RACKING

All joints must be continuously electrically bonded with earth bonding. The ends of the racking must be connected to a network earth using bare earthwire conductor.

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

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 cable rack protected.

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 MEASUREMENT AND PAYMENT

Item **Unit**

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.

Item **Unit**

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.

Item **Unit**

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.

Item **Unit**

Install deliver 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.

Item **Unit**

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.

Item **Unit**

Install deliver 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.

Item **Unit**

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.

Item **Unit**

Install deliver 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.

Item **Unit**

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.

Item **Unit**

Install deliver 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.

Item **Unit**

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.

Item **Unit**

Install deliver 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.

Item **Unit**

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.

Item **Unit**

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.

Item **Unit**

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.

Item Unit

Install deliver 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.

PARTICULAR SPECIFICATION

E03: ELECTRICAL ISOLATOR PUSHBUTTON STATION (LOCAL START/STOP) EQUIPMENT

2	2012-05-30	Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance		
2	2010-05-03	Review Electrical Standards		
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**

City of Johannesburg
Johannesburg Water (Pty) Ltd

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	Enclosures for electrical equipment classified by IP code
(b)	SANS 10142-1	The Wring of Premises Part 1 – Low-voltage Installations
(c)	SANS 60439	Low-voltage Switchgear and Control gear Assemblies
(d)	IEC 60529	Degrees of Protection of Enclosures for Low Voltage Switchgear and Control gear
(e)	BSCP 1014	Protection of Electrical Power Equipment against Climatic Conditions
(f)	SANS 60947	Low-voltage Switchgear and Control gear:
		Pt 1 General rules
		Pt 2 Circuit breakers
		Pt 3 Switches/Isolators/Switch Isolators and Combination Fuse Switch Units
(g)	BSS 3858	Binding/Identification Sleeves for Cables and Wires
(h)	BSS 152	Electric Power Switchgear and Associated Apparatus
(i)	BSS 158	Marking and Arrangement for Switchgear Busbars Main Connections of Auxiliary Wiring
(j)	SANS 1091	National Colour Standards for Paint
(k)	BSS1767	Grommets
(l)	Occupational Health and Safety Act 85 of 1993 (as amended)	

E03.3 GENERAL REQUIREMENTS

E03.3.1 Particular specifications to read in conjunction with this specification

This specification shall be read in conjunction with the following specifications:-

G01: PARTICULAR SPECIFICATION FOR COLOUR CODES
G02: PARTICULAR SPECIFICATION FOR CORROSION PROTECTION
E08: WIRING

E03.3.2 General Requirements

(a) The enclosure shall be of a 3CR12 material equipped with a motor isolator to match each motor rating as specified in the motor equipment schedules. Where the station is to be placed in highly corrosive areas, a tougher material like GRP is preferred.

(b) The Start/Stop pushbutton or control station shall be mounted adjacent to the motor which it shall control. and shall be located at a radius of 1000mm at the most from the equipment it controls.

(c) The station shall be pedestal mounted at least 1100mm above floor level. The pedestal design shall be approved by the Engineer.

(d) The pedestal base plate shall be installed on 10mm of epoxy grout to prevent crack corrosion.

(e) The pedestal material shall be mild steel and have minimum thickness of 6mm. The pedestal shall be painted, B26 electric orange.

(f) All START pushbuttons shall be GREEN and flush mounted with the bezel.

(g) A mushroom head latching push button suitable to serve as an EMERGENCY STOP shall be fitted to each of the enclosure provided under the contract.

(h) The EMERGENCY STOP button shall be a “twist to release” type.

(i) The EMERGENCY STOP button shall be lockable for added protection for maintenance staff.

(j) The station enclosure shall be designed to provide adequate space for the following:

- The required switches, indicating lights and their 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 individual motor, as per the cable schedule, terminated at an isolator in the panel. The isolator shall be rated for off-load conditions.

E03.4 DIMENSION FOR ISOLATOR STATION

The start/stop isolator pushbutton station shall be of IP65 rating to SANS 1222 and shall be fitted with a canopy. The minimum dimensions of the start/stop isolator pushbutton stations shall be 300 mm (L) x 250 mm (H) x 200 mm (D).

The junction box including the canopy and the support stand shall be painted B26 – Electric Orange.

E03.5 FASTENERS

All fasteners in concrete shall be 316 SS and 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

Item **Unit**

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.

PARTICULAR SPECIFICATION

E04: ELECTRICAL LOW VOLTAGE SWITCHBOARDS AND MOTOR CONTROL CENTRES

4	2012-05-30	Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance		
3	2011-08-30	Omit Fifa Logo		
2	2010-05-03	Review Electrical Standards		
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Rev	**Date**	**Description**	**Signature: JW Wastewater Partnership**	**Signature: Approval from Johannesburg Water**

City of Johannesburg
Johannesburg Water (SOC) Ltd

PARTICULAR SPECIFICATION : VOLUME E04 : ELECTRICAL LOW VOLTAGE SWITCHBOARDS AND MOTOR CONTROL CENTRES

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E04.1 INTRODUCTION

This specification is for the supply of low voltage (380V) distribution switchgear.

All equipment and services shall comply with the mandatory requirements of the Occupational Health and Safety Act 85 of 1993 and regulations (as amended).

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 Motor control centre 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 prices of same.

(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:

SANS 10142-1	The Wring of Premises Part 1 – Low-voltage Installations
SANS 60439	Low-voltage Switchgear and Control gear Assemblies
SANS 1973-1	Low-voltage Switchgear and Control gear Assemblies
IEC 60529	Degrees of Protection of Enclosures for Low Voltage Switchgear and Control gear
BSCP 1014	Protection of Electrical Power Equipment against Climatic Conditions
SANS 60947	Low-voltage Switchgear and Control gear: Pt 1 General rules Pt 2 Circuit breakers Pt 3 Switches/Isolators/Switch Isolators and Combination Fuse Switch Units Pt 4 Contactors Pt 5 Relays

IEC 60337	Low Voltage Control Switches
IEC 60228/BSS 159	Busbars, Main Connections and Small Wiring for Switchgear
BSS 3858	Binding/Identification Sleeves for Cables and Wires
SANS 1507	Electric Cables with Extruded Solid Dielectric Insulation For Fixed Installations (300/500V to 1900/3300V)
SANS 1574	Electric Cables – Flexible Cords and Flexible Cables
SANS 1619	Small Power Distribution Units (Ready Boards) for Single-phase 230V Service Connections
SANS 61643	Surge Protective Devices Connected to Low-voltage Power Distribution Systems
SANS 61238-1	Compression and Mechanical Connectors for Power Cables with Copper or Aluminium Conductors, Part 1: Test Methods and Requirements
IEC 60730-2-7	Timer Switches
SANS 61036	Alternating Current Static Watt-hour Meters for Active Energy (Classes 1 and 2)
BSS 1322	Aminoplastic Moulding Materials
BSS 152	Electric Power Switchgear and Associated Apparatus
BSS 158	Marking and Arrangement for Switchgear Busbars Main Connections of Auxiliary Wiring
SANS 60076/BSS 3535	Transformers
SANS 1091	National Colour Standards for Paint
IEC 60185/BSS 3938	Current Transformers
IEC 60186/BSS 3941	Voltage Transformers
IEC 6043/BSS 37	Meters
IEC 6051/BSS 89	Indicating Instruments
BSS 142	Protective Relays
SANS 156	MCB's and MCCB's
SANS 1195	Busbars
BSS 1767	Grommets

E04.3.1 Particular specifications to read inconjuction with this specification

This specification shall be read in conjunction with the following specifications:-

G01: PARTICULAR SPECIFICATION FOR COLOUR CODES

G02: PARTICULAR SPECIFICATION FOR CORROSION PROTECTION

E06: ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE INSTALLATION

E08: WIRING

E04.4 CODES

All equipment and services shall comply with the mandatory requirements of:

(a) Mine Health and Safety Act 29 of 1996 and Regulations (as amended).

(b) Occupational Health and Safety Act 85 of 1993 (as amended).

(c) Road Traffic Act, Act No 29 of 1989 (as amended).

(d) The SANS Standard and Regulations for the wiring of premises (SANS 10142-1) (as amended).

(e) The South African Minerals Act 50 of 1991 (as amended).

E04.5 DESIGN CRITERIA AND MATERIAL OF CONSTRUCTION

E04.5.1 System Details

Busbar voltage	380V ±10%
Phases	3

Frequency	50 Hz
Phase rotation	R-Y-B-R

Note:

The fault levels as indicated on drawings shall be deemed to be the maximum current occurring at the Motor control centres 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 to be a minimum of one second. Evidence (in the form of Certificates from testing authorities recognised by Johannesburg Water) of the ability of the 380V distribution switchgear boards offered to withstand satisfactorily the prospective fault conditions shall be furnished with the tender.

E04.6 MANUFACTURING AND CONSTRUCTION DETAILS

E04.6.1 Mechanical Construction - General

(a) The Motor control centres shall be fixed pattern, comprising one or more fully interchangeable modular, rigid, free standing sections, bolted together to form an extensible, composite, rigid, free standing and vermin proof Motor control centre of uniform appearance. Each section shall be divided vertically into panels. Each panel shall be divided into one or two cubicles one above the other.

(b) A channel iron frame (minimum 100mm x 50mm) shall be provided under each completed section of transportable length which shall be so constructed that it can be used for lifting the transportable section without distortion taking place. The maximum length of the transportable sections shall not exceed 3000mm.

(c) All completed sections shall be provided with lifting lugs and shall have sufficient strength to withstand all stresses occurring during transportation, installation and operation without distortion or damage.

(d) The Motor control centre shall be compartmentalised to segregate busbar, cable, circuit-breaker and instrument zones, in such a manner that prospective damage resulting from electrical faults will be minimised and confined to the zone cubicle or compartments in which the fault occurs. Power busbars shall be completely separated from any other compartment by means of suitably earthed metallic barriers.

(e) Separate compartments shall be provided for each moulded case circuit breaker and instrument section.

(f) Access to all power busbar compartments shall be by removable bolted covers. Removable covers shall be provided with captive screws.

(g) Incoming feeder, outgoing feeder, relay, control transformer and metering and instrumentation cubicles shall have doors suitably constructed to ensure rigidity. Doors shall be fitted with robust steel or brass (Barker Nelson 41200 EMB or equivalent) hinges with at least two 6mm square recessed quick close/open latches (Barker Nelson 26013 Dinlock or equivalent).

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 padlockable.

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.

(h) 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.

(i) All hinged doors shall open to a minimum of 135° from the closed position, to facilitate easy access for maintenance.

(j) Under no circumstances should rear doors have a width exceeding 750mm.

(k) Attention shall be given to ventilation to prevent the accumulation of ionised gases. Suitable drip proof, fine mesh screened, vermin proof openings shall be provided to facilitate air movement by convection. These openings shall be arranged such that the hot gasses or other materials cannot be discharged in a manner injurious to operating personnel.

(l) 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. Cable entry shall be at the bottom of the board. 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. Gland plates for three-core cable of cross-sectional area 70mm^2 and above shall be minimum 5mm plate.

Gland plates shall be galvanised. Where single core cables are used, gland plates are to be of non-magnetic material or slit to mitigate effect of eddy currents. The cable gland compartments shall have removable covers attached with standard 6mm square recessed quick close/open latches.

(m) 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". 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 cores after glanding off.

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.

(n) Flash barriers shall be furnished to increase creepage distance between phases and shall be furnished on all circuit breaker cradles between the phases on the busbar riser section.

(o) Spare compartments shall be equipped generally as detailed on the single line diagram, 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.

(p) The general structure of the board 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.

(q) 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. "Avdel Burnside" 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.

(r) The switchboard steelwork shall be a minimum of 2mm thick, irrespective of the type of steel used.

(s) Each cubicle/compartment door shall be labelled 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 being the tier, numbered from A, left to right and the second the cubicle, numbered from A top to bottom.

(t) Every door and/or removable cover giving access to a cubicle shall bear a durable designation label suitably inscribed with the description and the equipment number where applicable, using engraved black characters at least 6mm high on white background. Incomers shall be labelled as indicated on the single line diagrams.

(u) The Motor control centre shall be provided with an identity label, engraved with 30mm high black on white characters and shall be mounted on top of the switchgear.

(v) All removable covers/doors protecting live equipment shall be fitted with warning labels. Warning labels shall be engraved red characters 6mm high on a white background.

Each circuit shall be provided with a blank white/black white traffolyte type label (or engraved in accordance with designations on drawings).

All electrical components/equipment shall be labelled ((with designations corresponding to those of the Purchaser's schematic diagrams) to facilitate recognition. Engraving shall be left to the discretion of the manufacturer but shall be legible and durable. The component labels shall be affixed adjacent the component they refer to.

All labels and label brackets shall be affixed by machine screws. Adhesive labels are not acceptable.

(w) Incomers shall be labelled "Incomer from ……..." and the standby bus coupler (where applicable) shall be labelled "Standby Bus Coupler".

(x) Over and above labelling requirements of this specification, the labelling requirements of SANS 10142-1 must also be met.

(y) Doors to compartments shall be so arranged that normally they cannot be opened whilst the apparatus contained is live, unless this apparatus is fully shrouded or screened to IP20 to prevent inadvertent contact. Doors shall be designed to ensure rigidity and shall be a neat fit in the framework and around the circuit breaker escutcheon plate.

(z) Circuit breakers shall be interlocked with the panel door to prevent opening of the door when the circuit breaker is in the "ON" position.

A non-apparent 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 the attaching of three padlocks to each operating handle in the "OFF" position, which prevent the circuit breaker from being operated.

All access doors are to be effectively and permanently earthed to the main panel enclosure of the switchgear, by means of a suitable braided copper earth strap, not less

than 16mm^2, crimped with lugs and bolted at each end to the door and enclosure.

E04.6.2 Mechanical Construction - Busbar Ducts (where required)

(a) Busbar ducts shall be furnished for the interconnection of the standby bus between the various Motor control centres.

(b) The bus ducting shall have suitable sealing at each end, between the bus duct and switchgear, and shall be constructed so as to ensure that any fire or other fault cannot spread between the various sections.

(c) Busbar ducts shall utilise copper complying with this Specification and shall be designed for a maximum current density of 1.6A/mm^2. The bus ducts shall be metal enclosed, non-segregated phase type, suitable for indoor use and positively vermin proof. Ventilation slots if any shall be suitably screened with a fine mesh.

(d) If necessary, provision shall be made for expansion or contraction of the busbars and the housing due to loadings, temperature changes and short circuit conditions.

(e) Busbars, insulators and supports shall be braced so as to withstand the mechanical and thermal effects of the fault current.

(f) Bus duct housing shall have bolted covers for access to busbars, insulators and joints.

(g) Insulators shall be mounted on their supports in such a way that they can be easily removed and replaced.

E04.6.3 Electrical Construction

The electrical requirements for each Motor control centre shall be as detailed in the drawings.

E04.6.3.1 Cooling

Artificial cooling of any component will not be acceptable. All design and construction shall be based on natural cooling by convection or radiation. Forced cooling will only be acceptable where power electronic components are contained.

E04.6.3.2 Busbars and Connections

Busbars and connections shall generally comply with BS 158, BS 159 and BS 162 for air clearances. Notwithstanding the contents of the above-mentioned specifications, all solid copperwork 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/mm^2.

Notwithstanding the requirements of BS 159, the following minimum air clearances shall be observed for busbars and other current carrying or live parts:

- Phase – Earth : 30mm
- Phase – Phase : 45mm

Where these clearances cannot be attained, suitable insulating barriers shall be employed.

In addition, all copperwork (including connections to, from and between equipment) shall have applied solid insulation suitable for the rated voltages. Heat shrink insulation shall be used wherever possible.

Main busbars shall be rated for 2000 amps. Busbar droppers shall be manufactured from solid copper bar and rated for the maximum possible current (determined by the breaker frame size) in that section with a minimum rating of 1000 amps.

The use of flexible conductors as droppers from the main busbars to circuit breakers shall not be permitted.

Note:

- Busbars and droppers shall be housed in separate metal enclosures.
- 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.
- 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.

- All insulation used on electrical conductors/connections and wiring shall be flame retardant types, constructed of low toxicity materials.
- Power wiring on the "live" side of the circuit breakers (busbar dropper to circuit breaker) shall be **as short as** possible, sized to carry the maximum current continuously of the frame size of the respective breakers and shall be a flexible conductor. The flexible connection shall be provided on all such connections and shall be designed so as 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 to be a fault free zone and the design and use of the flexibles shall in no manner compromise this zone.
- This connection may be by way of insulated stranded conductor, laminated, insulated conductor or multistrand braid.

Notwithstanding the foregoing the minimum power wiring size shall be 25mm². Power wiring terminations shall use an appropriate crimped accessory. The pressed tubular type of accessories is preferred. **Stamped**, **folded, split-barrel** type accessories are **not** acceptable.

In addition, hexagonal die type hydraulic crimping shall be used for all wiring greater than 16mm².

E04.6.3.3 Earth Bar

A continuous copper main earth bar or minimum cross sectional area 70mm² shall extend the whole length of each Motor control centre. This earth bar shall, at least, be bolted to the switchgear housing at each vertical section. Crimp type terminals for 70mm² stranded copper shall be provided at both ends of the earth bar for connection of Johannesburg Water earthing.

E04.6.3.4 Wiring

Each Motor control centre shall be equipped and completely wired at the factory and, only after satisfactory testing, be split, if necessary, for transport.

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 link.
General Control Wiring	(AC) 2.5mm^2 red (DC) 2.5mm^2 (positive – red, negative – black)
LED's and PLC Inputs	(AC) 0.75mm^2 red (DC) 0.75mm^2 (positive – red, negative – black)
Control Neutral	(AC) 2.5mm^2 black
Terminal Links	2.5mm^2 yellow

Notwithstanding the above mentioned requirements, the vendor shall ensure wire size used is amply rated for the applicable current, under ambient conditions. 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). Control and instrumentation shall not be coloured yellow or blue, yellow or blue being restricted for use as bridge wires and interlocking wires respectively.

All control/instrument panel wiring shall terminate by means of suitably sized compression crimp lugs unless terminals of the pressure pad type are employed. The minimum voltage rating of the control wiring shall be 600/1000V grade to SANS 1507 and SANS 1411 Pt I and III.

All wiring shall be of the stranded type. 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.

E04.6.3.5 Wire Numbering

Cable/wire marking ferrules shall be to the codes laid down in BSS 158 and shall correlate to the appropriate schematic or wiring diagrams.

Split or open type marking ferrules shall not be used.

E04.6.3.6 Terminals

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. 10% additional spare terminals shall be furnished.

Terminals are to be provided for all door mounted components, diodes, etc.

E04.6.3.7 Circuit Breakers

Circuit breakers shall be either fixed pattern moulded case circuit breakers or withdrawable pattern air circuit breakers complying with the following requirements:

(a) Air Circuit Breakers (ACBs)

- 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.

  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 “380V – LIVE/LEWENDIG”. ACBs shall be equipped with inter-phase barriers.
- Each bus section ACB shall be equipped with three appropriate direct acting non-adjustable over-current trip devices.
- Each incoming ACB from a transformer shall be equipped with three direct acting, thermal inverse time over-current trip devices with adjustable current set point and three direct acting magnetic short time delay over-current trip devices with adjustable current set point and short time delay.
- The Johannesburg Water Project Engineer shall take particular care to ensure that the ACB protection is correctly co-ordinated with the upstream and down stream protective devices.
- Where current and time delay set points on ACBs are adjustable these 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.
- Interlocks shall be provided to ensure the following:
  - that the main circuit breaker cannot be removed from or to the fully connected position unless the ACB is open.
  - that the compartment doors cannot be opened should any accessible portion of the ACB frame be energised.
  - that the breaker cannot be closed unless in the fully connected, test or fully disconnected positions.
- Mechanical deterrents shall be provided to inhibit mismatch of ACBs of different ratings.
- 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.
- ACBs employed as incomers and bus-section switches shall incorporate mechanical interlocks to prevent paralleling of incoming supplies.
- 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.

- The ACB control/protection unit shall be fitted with a transparent cover that can be sealed in the closed position to prevent tampering with the settings.

(b) Moulded Case Circuit Breakers (MCCBs)

- MCCBs shall be of the manually operated trip free type with thermal and instantaneous magnetic trips in each pole. Trip functions shall be resetable via the MCCB toggle.

  Generally these MCCBs will be used for the incoming circuit breakers and outgoing feeders up to a maximum rating of 800 amps.
- Each MCCB shall be fitted with a varidepth type operating handle.
- The thermal trip elements of each MCCB shall be calibrated for the maximum ambient temperature at 40°C
- Current ratings of MCCBs shall be detailed in the drawings.
- MCCBs shall be selected according to rating and fault level.
- The name of the manufacturer shall be furnished by the tenderer at tender stage.
- 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.
- Where interlocking is called for between the MCCBs this shall be effected using captive keys in the breaker or Lowe & Fletcher type keys.
- Miniature circuit breakers (MCBs) shall be confined to auxiliary circuits such as control and indication in which the prospective let through fault current will not exceed 2,5kA. They shall be of the thermal and magnetic trip free type.
- All outgoing circuits shall be equipped with individual core balance earth leakage units arranged to shunt trip each respective outgoing circuit.
- 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.
- All circuit breakers, except bus couplers and incomers, shall be connected with the switched side to the load, i.e. with reference to power flow incoming to "LINE" and outgoing to "LOAD".
- **The incoming terminals/shutters of all 380V circuit breakers shall be effectively shrouded and marked "380V LIVE - LEWENDIG" with white characters on a red ground**.

(c) 380V Power Connections

Power connections on any equipment shall **not** use "Philips"/Star type screw/socket heads. Allen type socket heads are preferred.

(d) Insulation Materials

Any insulation, filling putty, etc, used shall be selected such that it can withstand without injurious effect (mechanically or electrically), all temperatures encountered within the switchboard. All ACB boards shall have an surge arrestor fitted to the incoming ACB. This surge arrestor shall be fitted to the LIVE side of the breaker.

(e) Instruments and Meters

In general voltmeters and ammeters are a minimum requirement and shall be included as follows:

Incoming Feeders shall be equipped with 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.

In addition incoming feeders shall have 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.

Outgoing feeders shall be equipped with a suitably sized 5A CT operated 96mm x 96mm 90° movement suppressed maximum demand ammeter having an overload rating of 40 x rated current for one second.

CTs shall be rated as follows:

MCCB Current Rating	Ratio
800	800/5
700	700/5
600	600/5
500	500/5
400	400/5
300	300/5
250	250/5
225	250/5
200	200/5
150	150/5
100	100/5
75	75/5
60	60/5
40	40/5
30	30/5

All current transformers shall conform to BS 3938 and IEC 285. For protection purposes class 10P CTs are to be used: for indicating purposes class 1 CTs are to be used and for metering purposes class 0,5 CTs are to be used. In general current transformer mechanical and thermal ratings shall be co-ordinated with the short circuit ratings of the equipment.

E04.6.4 Specific Notes

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 were 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.

Fuse protection shall be used in cases were capacitive loads are switched i.e. Power factor correction or static capacitors panels.

E04.6.5 Labelling 5mm^2

All components shall be clearly labelled with suitable inscriptions indicating their function. All labels shall be affixed by screws and have black lettering on a white ground, except danger labels which shall be white on a red ground.

To prevent confusion, identification labelling must be placed on all removable panels as well as the fixed portion of the respective enclosures.

Only safety related labelling must be fixed to removable panels.

E04.6.6 Types of motor starting

The following are the types of motor starters that available on the market:

- Direct-on-line (DOL) type motor starting
- Star/Delta (S/D) type motor starting

- Soft starting (SS) type motor starting
- Variable Frequency(Speed) Drive (VFD/VFD) type motor starting

The type of motor starting required shall be project specific and shall be indicated in the motor control centre schedule/s to be issued by the Engineer.

E04.6.7 Mechanical equipment protection devices

All the protection devices, i.e. overloads, circuit breakers, motor thermistors, motor heaters, gearbox oil flow switches etc on mechanical equipment shall be accommodated onto the individual motor starter circuits.

E04.6.8 Limit Switches

Limit switches shall be metal encapsulated precision switches with robust and compact explosion-proof structures.
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.

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 JW wastewater treatment plants.

The limit switch shall meet the following minimum requirements:

Operating ambient temperature
- -20 °C to +90 °C

Equipotential bonding
- External Ex terminals

Switching capacity
- 6.5 A at 250V AC
- 0.16 A at 230 V DC

Mechanical data
Switching point tolerance
- +/-0.5 mm depending on the actuator

Switching force tolerance
- +/-1 N

Repeat accuracy
- +/-1 mm

Protection class
- IP 67 according to DIN 40050

Mechanical life
10^6 switching cycles

Vibration resistance
10 g at 10 to 2 000 Hz

Shock resistance/shock stability
50 g at a shock duration of 6 ms

E04.7 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 EACH)	QUALITY CONTROL PLAN	YES	ORDER + 3 WEEKS
	MANUFACTURING PROGRAM	YES	ORDER + 3 WEEKS
MATERIAL CERTIFICATES		YES	MANUFACTURE
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 (5 SETS OF EACH)	OPERATING / MAINTENANCE MANUAL	YES	COMPLETION
	DATA BOOK	YES	DELIVERY – 1 WEEK
	DRAWINGS	YES	COMPLETION
	WARRANTY/GUARANTEES CERTIFICATES	YES	COMPLETION

E04.8 DRAWINGS AND DATA

The vendor / contractor will supply 5 copies of the equipment data book including all items as specified in the Vendor QA and document requirement list.

(a) All drawings and documentation shall be in accordance with Johannesburg Water specifications.

(b) 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 same.

E04.9 PAINTING AND PROTECTIVE COATING

All chassis plates shall be painted white.

Specific external colours will be provided by Johannesburg Water.

All gland plates shall be galvanised for improved cable earthing.

E04.10 PERFORMANCE AND GUARANTEE

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.

The vendor shall not be specifically required to conduct a performance test on site.

A minimum guarantee period of 12 months is required.

E04.11 INSPECTION AND TESTING

The Johannesburg Water Representative shall have access, at all reasonable times, to those parts of the manufacturing facilities engaged in the manufacture of items in terms of this specification. He is authorised to witness any stage of manufacture, tests and inspect documentation.

The Johannesburg Water Representative is authorised to reject any items not manufactured to the requirements of the specification.

All equipment shall be inspected at the vendor's works prior to delivery, to ensure compliance with the specification.

No unit shall be considered complete until acceptance by Johannesburg Water.

The minimum testing / pre delivery check list shall be as follows:

- The Johannesburg Water representative must carry out a clause by clause check of each MCC or switchboard, prior to delivery.
- This DB 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

		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.)**	
Busbars		
□	**Correct cross-section**	
□	**Correct phasing with incomer/outgoers**	
□	**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 70mm²**	
□	**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**	

		Comments
	plate	
□	**Air clearances correct throughout**	
	Incomer status signal to PLC	
	Interlocks	
Pressure and Injection Tests		
□	**2kV pressure test on all 550 volt parts of the board, with contactors de-energised and circuit breakers closed, excluding control supply**	
□	**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**	
□	**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**	

Specific testing and inspection requirements relating to switchgear boards are as follows:

- 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.
- 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.
- 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.

E04.12 PAINTING AND PROTECTIVE COATING

Powder Coating Systems

Paint system 1: Powder Coating, 7 Stage zinc, Phosphate pre-treatment, Pure epoxy primer, Polyester finishing coat, 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

On completion of the paint job, the powder manufacturer must carry out the following tests on the test panels:

- SABS 6J impact test
- Cross hatch adhesion test
- Bend test

The powder manufacturer must issue a Certificate of Compliance for each paint job, which should be included in the contract documentation.

The preferred corrosion protection systems are applied onto cold rolled mild steel plate with a thickness of 2.0mm.

Epoxy Powder Coat Products

Item	Product Type	Powder - Lak
1	Epoxy Primer	23-007
2	Pure Epoxy / Polyester Finishing Coat.	Series 3000

E04.13 MEASUREMENT AND PAYMENT

E04.13.1 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.

E04.13.2 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.

E04.13.3 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.

E04.13.4 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).

E04.13.5 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.

E04.13.6 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.

E04.13.7 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.

E04.13.8 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.

PARTICULAR SPECIFICATION

E05: ELECTRICAL LOW VOLTAGE POWER AND CONTROL CABLES

3	2012-05-30	Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance		
2	2010-05-03	Review Electrical Standards		
1	2010-05-03	Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance		
Rev	**Date**	**Description**	**Signature: JW Wastewater Partnership**	**Signature: Approval from Johannesburg Water**

City of Johannesburg
Johannesburg Water (SOC) Ltd

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 the purpose of 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:

SANS 1507	:	Electrical cables with extruded solid dielectric insulation for fixed installations
SANS 1411	:	Materials of insulated electric cables and flexible cords
SANS 1520	:	Flexible electrical cables for use in mines
SANS 10142-1	:	The Wiring of Premises Part 1 – Low Voltage Installations
IEC 173	:	Flexible cords
IEC 245	:	Rubber insulated cables
IEC 287	:	Current rating calculations
IEC 540	:	Insulation tests
VDE 0250	:	Standard for insulated wires and flexible cables

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 together, 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.
P.V.C.	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 2.5mm^2.

(b) The minimum conductor size for instrument supply shall be 1.5mm^2 and the outer sheath of the cable shall be electric orange, to distinguish it from other supplies.

(c) Conductor material

Aluminium conductor cables are not acceptable unless 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.

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

E05.3.4 Bedding

The bedding shall consist of a continuous P.V.C. 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.

E05.3.7 Cable for Industrial Control Circuit Wiring

For general purposes this shall be a flexible P.V.C. insulated cable with a minimum of 21 finely stranded copper conductors having minimum cross sectional area of 2.5mm^2 and a rated insulation voltage of 600/1000V, manufactured to SANS 1507 or equivalent specifications.

E05.4 CABLE MARKINGS

The cables shall be legibly marked in accordance with the requirements of the latest edition of SANS 1507, and shall also 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.

E05.5 PARKAGING

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 so as 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.

E05.7 TESTING OF CABLES

The cables shall be tested in accordance with the requirements of the latest edition of SANS 1507. Routine test certificates shall be supplied for each drum of cable supplied under the Contract.

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 SANS ISO 9000 series.

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.

PARTICULAR SPECIFICATION

E06 : ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE INSTALLATION

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City of Johannesburg
Johannesburg Water (SOC) Ltd

PARTICULAR SPECIFICATION : VOLUME E06 : ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE INSTALLATION

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E06.1 SCOPE

This section covers the procurement and 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.

E06.2 PARTICULAR SPECIFICATIONS

This specification shall be read in conjunction with the following specifications:-

SANS 1507 : Electrical cables with extruded solid dielectric insulation for fixed installations

SANS 10142-1 : The wiring of premises Part 1 – Low Voltage installations

SABS 1213: Mechanical Cable Glands

VDE 0278 : Electric cables - Accessories - Material characterisation

G01: PARTICULAR SPECIFICATION FOR COLOUR CODES

G02: PARTICULAR SPECIFICATION FOR CORROSION PROTECTION

E02: ELECTRICAL CABLE RACKS

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E04: MOTOR CONTROL CENTRES

E05: ELECTRICAL LOW VOLTAGE POWER AND CONTROL CABLES

E07: ELECTRICAL INDUSTRIAL WELDING PLUGS, COUPLERS AND SOCKET OUTLETS

E08: WIRING

E06.3 COMPETENCE OF PERSONNEL

It is a definite requirement that the Contractor shall only employ personnel fully conversant with the cable manufacturer's recommendations to lay, joint and terminate cables. When contractors are working on medium voltage equipment they shall be conversant with the medium voltage regulations and operating procedures. There shall be direct supervision at all times when working in the HT substations. Only competent persons who have the relevant qualifications and experience to work with 6.6 & 11 kV systems shall be allowed to work on the HT network.

Cables, cable jointings, cable terminations and cable accessories shall be installed in accordance with the manufacturer’s installation instructions by competent personnel. Where cables are installed but not terminated onto equipment, the cable end shall be fitted with end-caps to prevent the ingress of moisture or other undesirable elements into the cables.

E06.4 MATERIALS

E06.4.1 Medium Voltage Cable Joints and Terminations

The medium voltage cable joints and terminations shall be of the heat shrink type.

E06.4.2 Low Voltage Cable Joints and Terminations

Low voltage joints shall be of the epoxy-resin type.

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 offer a minimum degree of protection according to SANS 1222 of IP 66, shall be suitable for type " EXe " equipment, shall be corrosion proof and shall 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.

Bi-metallic aluminium-copper lugs, shall be used according to the manufacturer's specifications, where solid aluminium conductors are terminated onto copper busbars.

E06.4.3 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.

E06.4.4 Earth Continuity Conductors

Earth continuity conductors shall comprise of stranded copper conductors of cross-section indicated in the detailed specification. Alternative materials or combination of materials can be considered for running of earth continuity conductors to reduce risk of cable theft.

A single earth conductor may be used where two or more cables run together, providing the earth conductor cross-sectional area is based on the largest size cable in the run.

E06.4.5 Cable Route Markers

Cable route markers shall be constructed of reinforced concrete and shall be of dimensions to be approved by the engineer.

E06.4.6 Cable Warning Tape

The plastic cable warning tape shall 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".

The plastic warning tape shall be installed on all cable routes (LV and MV) at 200 mm above the top cable layer. Where a cable route exceeds 600 mm in with multiple warning tapes shall be run in such a way that the space between adjacent warning tapes does not exceed 185 mm.

E06.4.7 Concrete Protective Slabs

Concrete protective slabs shall have the following dimensions:

Length 1 000 mm

Width 350 mm

Thickness 50 mm

The slabs shall be constructed of 20 MPa concrete and each slab shall be reinforced with one longitudinal and three transverse mild steel rod of minimum diameter 8 mm. The slabs shall be manufactured in such a way that the slabs interlock with each other thus avoiding shifting of the slabs after installation.

E06.4.8 Cable Sleeves

Cable sleeves shall be installed were necessary. The sizes of the sleeves to be installed shall as detailed in the specifications. Where the sleeves are used at road crossings, where there is possibility of heavy trucks crossing or heavy structures may be placed, the sleeves shall be of a minimum 6kPa pressure handling capacity.

E06.5 EXCAVATIONS

E06.5.1 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.

Where surplus material has to be disposed of the Contractor shall dump the material in the area

provided by him.

The Contractor shall load and transport to the above-mentioned site all surplus material, unsuitable material for backfilling etc.

E06.5.2 Trench Routes

The cable trench shall be excavated along the routes indicated on the relevant drawings. The routing should preferably traverse through the lowest theft risk areas as much as is possible.

The trench shall be absolutely straight and shall comply with all requirements. The Engineer shall determine the length of the trench to be excavated, which shall not exceed 400 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 of the engineer.

E06.5.3 Cable Trench

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:

For MV cables 1, 0 m and for all LV cables the trench shall be deep enough so that the top layer of LV cables is buried a minimum of 500 mm below final ground levels.

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 trim the trenches and clean up the bottom of the trenches after he has completed the required excavation. Bedding and cables shall not be laid until the trench has been approved by the engineer. 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.

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. A bedding of soft sand shall be laid below the cable. Where this material is not available the contractor shall import suitable material for such purposes. The contractor must ensure that all backfill material if free from sharp objects and rocks and is soft material. Where this material is not available, the contractor should import suitable material for such use.

E06.5.4 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:

- one joint : 2,5 m long x 1,25 m wide
- two joints : 3,0 m long x 1,5 m wide

E06.5.5 Excavated Material

No excavated material shall be left closer than 300 mm from the side of the excavation. The excavated material which is considered by the Engineer to be suitable for bedding material for the cable shall be placed separately on one side of the trench so that it is available when required. The excavated material shall take up as small an area as possible with the safety of the workmen and Works taken into consideration.

E06.5.6 Inspection and Measurement of Excavations

Once the excavations for cable trenches and joint pits have been completed, the Contractor shall give the Engineer 24 hours notice to inspect the trench and to be present when the measurements are made. No inspections shall be undertaken on Saturdays, Sundays and

public holidays.

Full detail of the cable trench dimensions and classification of the type of excavation shall be recorded and signed by the Contractors representative and the engineers representative as the final quantities for such excavations.

Inspections and recordings shall be completed before the installation of any bedding or backfilling. The Contractor shall be responsible to keep all records as proof of progress and as basis for claims for payment.

E06.5.7 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.

E06.6 CABLE TERMINATIONS

E06.6.1 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:-

- conductor no 1 : left (red)
- conductor no 2 : centre (white)
- conductor no 3 : right (blue)

Exposed armouring is not acceptable. Glands will be properly fitted with shrouds so as to cover any bare armouring.

All cable ends shall be supplied with the necessary earth connection.

A P4000 channel 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 clause 5.2.1 (d) of 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 employed.

E06.6.2 Cable Terminations with Heat-Shrinkable Materials

The complete 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 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 kits shall include suitable boots for the covering of the terminal studs on the Equipment. The ends shall be terminated strictly in accordance with the termination manufacturer's specification and shall withstand the same test voltage as the rest of 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 flash-over under wet or contaminated conditions and to ensure additional mechanical strength. This shall be achieved with shrunk- on insulating spacers and rain sheds.

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.

E06.7 CONNECTION OF CABLE CONDUCTORS

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.

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.

Suitable 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.

Contact surfaces shall be thoroughly cleaned and smoothed and fixing bolts shall match the hole size of the lug and shall be manufactured of cadmium plated high tensile steel.

E06.8 CABLE JOINTS INSTALLATION

E06.8.1 General

Joints in cable runs will not be allowed unless authorized by the Engineer.

Jointing shall only be carried out by personnel competent in jointing the types of cable used and shall be carried out strictly in accordance with the manufacturer's instructions.

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.

During outdoor jointing operations, the joint bays shall be adequately covered by tents of waterproof material suitable supported. When necessary, a trench shall be excavated around the bay to prevent the ingress of moisture. The sides of the hole shall be draped with small tarpaulin or plastic sheeting to prevent loose earth from falling in during jointing operations.

Joints shall be fully waterproof and airtight and shall be free of voids and airpockets.

The joint shall not impair the anti-electrolysis characteristics of the cable.

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. The joints shall be completely covered by a watertight sheath to prevent corrosion.

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.

Low voltage cable joints shall be of the epoxy resin type.

High voltage cable joints shall be of the heat shrinkable type.

E06.8.2 Cable Joints with Heat Shrinkable Materials

The complete joint 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 kit.

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.

Heat-shrinkable joints kits shall be used for all high voltage (above 1 kV) joints.

Where cable joints are required to be made in the course of a cable run, a joint hole shall be excavated of sufficient size to enable the cable jointer to work efficiently and unimpeded.

E06.9 CABLE AND CABLE ROUTE 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, Clause 7.1.3(c).

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 which 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.

Cable route markers shall be constructed of reinforced concrete and shall be of dimensions as specified and approved by the engineer.

Aluminium plates shall be cast into the top of the blocks in such a manner that they cannot be pried loose. The wording "ELECTRICAL CABLE" shall be stamped on the plates as well as direction arrows and the cable voltage rating. Additional information may be required on the plate to assist in cable location and identification.

Cable markers shall be installed on the surface along all the underground routes and shall project 1000 mm above normal ground level unless the projected markers could be a hazard to pedestrian or other traffic in which case they shall be installed flush with the surface.

Cable markers shall be installed at the beginning and ending of a cable run (e.g. where a cable enters a substation or building), at all changes of direction, above all Joints, above cable sleeve entries and exits and at intervals not exceeding 50 m along the cable route.. The position of cable markers shall be indicated on the "as built" drawings.

Where the cable runs across around, minimum 6kPA pressure sleeves shall be used and a 20MPa concrete slab laid on top. The cable shall be protected by means of 20MPa concrete where it runs across paving.

E06.10 GENERAL INSTALLATION OF CABLES

E06.10.1 Sand Bed for Cables

A sand bed layer of soft soil shall be installed and levelled at the bottom of each trench after the trench has been approved by the engineer, and prior to cable laying.

The minimum thickness of the sand bed layer is 50 mm.

If the material that has been excavated is not suitable for the sand bed layer then suitable soil shall be imported for this purpose. The cost thereof shall be included in the unit price for the excavation unless otherwise specified.

An adequate quantity of soil similar to the sand bed material shall be available next to the excavation for the sand bed cover before an inspection of the cables is called for. The sand bed cover for MV cables shall be a minimum of 150 mm thick and for LV cables shall be 100 mm thick and shall be placed directly after the cable(s) has been inspected.

If the soil for the sand bed and sand cover has to be sifted, a sieve with holes not larger than 6 mm shall be used.

E06.10.2 Laying of Cables

The cable shall, after the completion of the trench, 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 the cables which are already installed are not damaged.

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 1 m, but not more than 1,5 m 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 heatshrink 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:-

- Cable drum number
- Size of cable
- Laid from where to where
- Length of cable
- Date laid

The Contractor shall be liable for the repair of the cable due to the faulty manufacture of the cable, should this information not be recorded directly after the cable has been laid.

Every cable shall be marked by means of a aluminium label on which the size of cable and its source or destination and cable number is punched. The label shall be installed around the inner PVC sheath immediately above the cable gland.

E06.10.3 Verification 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.

The engineer's representative shall inspect all cable trenches before backfilling to ensure that the laying of cables complies with the specification.

During this inspection the Contractor's and engineer's representative shall record the lengths for all cables and all such records shall be signed by both representatives as the final quantities. The Contractor shall be responsible to keep the records as proof of progress and as basis for claims for payment.

E06.10.4 Road Crossings

The cable sleeves shall be installed 1,5 m 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.

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.

E06.10.5 Crossing of Other 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**
GPO Cables	0,3	0,3
Water pipes	0,3	0,3
Sewer pipes	0,3	0,8
Stormwater pipes	0,3	0,6
Other electrical cables	0,15	0,15 (other than LV cables in same route)
LV cables on same route	0,100	One cable diameter or larger cable

E06.10.6 Backfilling of Trenches

When the cable has been laid, inspected and approved and the sand bed cover as specified in the clause on "Sandbed for cables" has been 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.

E06.11 INSTALLATION OF CABLES IN PURPOSE-BUILT TRENCHES (CABLE DUCTS)

E06.11.1 General

This paragraph covers the installation of cables in build-up trenches, service ducts, etc. 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. The trenches, ducts, etc. inside buildings will be constructed and installed by others.

E06.11.2 Installation

Cables shall be installed in one of the following ways:-

- on horizontal cable trays;
- on horizontal metal supports with suitable clamps;
- on vertical cable trays or metal supports fixed to the side of the trench. Cables shall be clamped in position.

Cables shall not be bunched and laid on the floor of purpose built trenches.

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.

E06.11.3 Covers

The covering of concrete trenches shall as a rule fall outside the scope of the electrical installation. The Contractor shall, however, 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.

E06.11.4 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:-

- Reinforced concrete covers;
- 100mm of 20MPa concrete;
- 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.

E06.12 INSTALLATION OF CABLE LADDERS

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 motor control centre station, on site

reticulation, and on access platforms to the mechanical equipment.

Cable ladders shall be installed within accessible cable duct and 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.

Cable ladders shall be supported with the struts, channels, brackets, clamps, cantilever arms and nuts/bolts/washers.

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.

In highly corrosive environments such as chemical dosing stations, the use of GRP material is preferred.

Unless otherwise agreed, all screws, bolts and nuts shall be hexagonal to ISO Metric commercial standards. All bolts, nuts, springwashers, etc shall be stainless steel 316.

To minimise cable theft, long cable runs on cable ladders should be avoided. Wherever cable ladder is used, a securely welded or bolted boxing cover should used to protect the cables.

E06.13 INSTALLATION OF CABLES ON LADDERS AND STRUCTURES

E06.13.1 Installation

Cables may be installed in one of the following ways:-

- on horizontal cable ladders with stainless steel strapping;
- against vertical cable ladders with stainless steel strapping;
- against horizontal or vertical metal supports or brackets with stainless steel strapping;
- with stainless steel strapping when fixed to structures.

E06.13.2 Spacing of Supports

E06.13.2.1 General

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. Unless otherwise specified herein, this method shall apply to all cable installations.

E06.13.2.2 Spacing of Supports of Restrained Cables

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 off-set 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

FOR RESTRAINED CABLE				
Cross-sectional area of Cable	**Wire Armoured Cables**		**Other than Wire Armoured Cables and Unarmoured Cables**	
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

E06.13.3 Grouping and Spacing of Cables

Cables with a cross-sectional area of more than 16 mm² shall, as a rule, 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.

High voltage cables shall be separated from other cables and services throughout the installation and shall as far as possible be installed in separate floor trenches, pipes or metal channels. 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 1 m 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.

E06.14 INSTALLATION OF MCC'S

Unless other otherwise stated, each MCC shall be installed on a cable duct within an MCC room. Purpose made MCC supports shall be manufactured and installed to support the MCC. The contractor shall design and submit the details of the supports to Engineer for approval prior to the manufacturing of the MCC supports.

E06.15 TESTING

Each cable shall be tested after installation in accordance with SABS 150 (up to 1 kV), SANS 97 and SANS 1339 (up to 11 kV), as well as the requirements of the Local and Supply Authorities.

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.

LV cables shall be tested by means of a suitable megger at 1 kV and the insulation resistance shall be tabulated and certified.

HT cables shall be pressure-tested in accordance with Table 2 and the exact leakage current shall be tabulated and certified.

Table 2

Cable Rating (kV)	**TEST VOLTAGE (kV applied for 15 minutes)**		
	Paper-insulated Cables		**XLPE-insulated Cables**
	Between Conductors	**Conductors to Sheath**	**Conductors to Screen**

	AC (rms)	DC	AC (rms)	DC	DC
6,6	12	18	12	18	11
11	20	30	20	30	18

On completion of the tests on any cable, the Contractor shall without delay, submit 3 copies of the certified test reports to the Engineer.

E06.16 COMPLETION

The Engineer reserves the right to inspect the installation at any stage during the course of construction. Such inspections will, however, 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:-

- overall length of each cable.
- 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 to each joint, shall be used.
- the location of all cable markers in relation to permanent reference points.
- identification numbers of all cables.

The Works will be deemed to be incomplete until all tests have been conducted and certified successfully and all "as built" drawings and schedules have been handed to the Engineer.

E06.17 MEASUREMENT AND PAYMENT

Excavation

Item **Unit**

Excavate in all materials for trenches, backfill, compact and dispose of surplus material ..... m^3

This rate shall apply to all the excavations.

The unit of measurement shall be the cubic metre of material excavated in trenches, classified according to the depth and width specified listed. The width classification shall be in accordance with the authorised dimensions and the depth classification in accordance with the total depth of the trench and not with the depth range in which the material is situated before excavation. The depth of excavation shall be measured to the underside of the bedding.

The tendered rate shall include full compensation for clearing and grubbing the trench areas and the temporary removal of improvements from the line of the trench, for excavating the trench, preparing the bottom of the trench, separating material unsuitable for backfill, keeping the excavations safe, dealing with any surface or subsurface water, measuring, classification and keeping of all records and for separating topsoil and selected backfill material where necessary.

The rate shall furthermore cover the costs of installing the sand bed and sand cover, backfilling, compacting and disposing of the surplus material.

Item **Unit**

Extra over for excavating in hard material ..... m^3

The unit of measurement shall be the cubic metre of material excavated and classified as hard, in accordance with the classification set out hereunder.

The tendered rate shall be paid over and above the rate tendered for excavation in full compensation for the additional cost of excavating in hard material instead of soft.

The tendered rate shall include full compensation for any overbreak as well as the additional

backfilling required, reinstating the trench bottom, and for any other incidentals resulting from overbreak.

The materials excavated shall be classified as follows for payment purposes:

Hard Material

Material which cannot be excavated efficiently except with the use of pneumatic tools, blasting or wedging and splitting, and shall include boulders exceeding 0,15 m^3 in volume.

Soft Material

All material not classified as hard material.

Notwithstanding the above classification, all material excavated from previously constructed fills, embankments, pavement layers and from above existing services shall be classified as soft material.

The decision of the Engineer as to the classification of the material shall be final and binding and any objection as to the classification shall be made before the excavation has been backfilled.

Item **Unit**

Extra over for excavating by hand in all materials ..... m^3

The unit of measurement shall be the cubic metre of trench material excavated by means of hand tools as instructed or authorised in writing by the Engineer where the use of conventional excavating equipment is either impractical or likely to cause damage to services, trees or property or where the electrical Contractor has to excavate by hand where he cannot excavate by machine.

The volumes of the trench excavation will be computed from the length and the depth to the bottom of the specified bedding layer and the minimum base widths specified in the drawings. The rate shall cover the cost of complying with the safety and protection requirements specified except where particular items are scheduled to cover particular costs for the excavation.

The tendered rate shall be paid extra over the rates in full compensation for the additional expense of excavating by means of hand labour instead of conventional trenching equipment.

Item **Unit**

Extra over for using backfill material obtained from:

(a) borrow areas ..... m^3

(b) sources provided by the Contractor ..... m^3

The unit of measurement shall be the cubic metre of imported backfill material.

The tendered rate for paid extra over and shall be in full compensation for the additional cost of excavating and selecting of suitable material and the moving of the material to the backfilling site.

The above items will not be measured for payment unless importation has been ordered in writing. The volume will be computed from the trench width and the depth from ground level to the top of the sand bed cover as shown on the tender drawings. The rate for material from designated borrow pits shall cover the cost of excavation and selection of suitable material, the moving of the material to the backfilling site, and the disposal of the material that becomes surplus as a result of the importation, all within 0,5km.

The tendered rate for sources provided by the Contract paid extra over jointing and termination of MV cable shall cover the cost of the acquisition of the material and of the disposal of the surplus material resulting from the importation together with all the costs of transporting the material to the site regardless of distance.

Item **Unit**

Backfill inverted culvert cable trench ..... m^3

The tendered rate shall be the cubic meter of cable trench backfilled.

The tendered rate shall include full compensation for importing and separating material suitable for backfilling, providing the bedding material, keeping the cable trench safe, dealing with any surface of subsurface water, measuring classification and keeping of all records.

The rate shall furthermore cover the cost of installing the sand bed and sand cover, backfilling and installing covers of the trench route. The covers will be provided by others.

Item **Unit**

Lay MV cable ..... m

The unit of measurement shall be the linear length in meter of MV cable installed.

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. No extra will be allowed for jointing, overlaps and termination.

Item **Unit**

Jointing and termination of MV cable ..... No

The unit of measurement shall be the number of MV cable joints or terminations.

The tendered rate shall include full compensation for the cost of providing the kits, complete with compound, ferrules and cable lugs, the cost of cutting the cable, handling and fitting the kits and the cost of testing the joints and terminations.

Item **Unit**

Lay LV cable ..... m

The unit of measurement shall be the linear length in meter of LV cable installed.

The tendered rate shall include full compensation for the handling, inspecting, laying, cutting and testing the cable. Cables shall be measured linearly over all lengths laid. Separate items shall be scheduled for each size and each type of cable laid.

Item **Unit**

Install LV and MV cable on cable ladder ..... m

The unit of measurement shall be the length of LV and MV cable installed on cable ladder.

The tendered rate shall include full compensation for the handling, inspection, laying, cutting and testing the cable. Cables shall be measured linearly over all lengths laid. Separate items shall be scheduled for each size and each type of cable laid.

Item **Unit**

Termination of LV cables ..... No

The unit of measurement shall be the number of LV cable terminations.

The tendered rate shall include full compensation for providing the cable glands and shrouds, the cost of handling, fitting and cutting the cable. Separate items shall be scheduled for each size and type of cable.

Item **Unit**

Jointing of low voltage cable ..... No

The unit of measurement shall be the number of LV cables joints.

The tendered rate shall include full compensation for the cost of providing the kits, the cost of cutting the cable, handling and fitting the kits and the cost of testing the joints.

Item **Unit**

Supply earth continuity conductor ..... m

The unit of measurement shall be the length in meter of earth continuity conductor supplied.

The tendered rate shall include full compensation for procuring, furnishing and laying the specified earth continuity conductor.

Item **Unit**

Lay earth continuity conductor ..... m

The unit of measurement shall be the length in meter of earth continuity conductor installed.

The tendered rate shall include full compensation for procuring, furnishing and laying the specified earth continuity conductor.

Item **Unit**

Terminate and connect earth continuity conductor ..... No

The unit of measurement shall be the number of earth continuity conductors terminated and connected.

The tendered rate shall include full compensation for supplying all the material required to terminate and connect the earth continuity conductors and the connecting thereof to the earth bars.

Item **Unit**

Supply plastic warning tape ..... m

The unit of measurement shall be the length in meter of plastic warning tape supplied.

The tendered rate shall include full compensation for the supplying, handling and laying the plastic warning tape.

Item **Unit**

Lay plastic warning tape ..... m

The unit of measurement shall be the length in meter of plastic warning tape installed.

The tendered rate shall include full compensation for the supplying, handling and laying the plastic warning tape.

Item **Unit**

Cable record drawings ..... Sum

The unit of measurement shall be the sum.

The tendered rate shall cover the cost of preparing and furnishing the drawings as specified in sub-clause "Information regarding the completed network".

Item **Unit**

Supply and construct plinths for the distribution or junction kiosks ..... No

The unit of measurement shall be the number of plinths supplied and constructed.

The tendered rate shall include full compensation for the supply and delivery of all material required for the plinth, the excavation of the foundation for the plinth and the construction of the plinth.

Item **Unit**

Install distribution or junction kiosks ..... No

The unit of measurement shall be the number of distribution or junction kiosks installed.

The tendered rate shall include full compensation for the installing and fastening of the distribution or junction kiosk on the plinth and the casting of a 50 mm floor at the bottom of the plinth.

Item **Unit**

Substation building accessories..... Sum

The unit of measurement shall be the sum.

The tendered rate shall include full compensation for the supply and installing of the substation building accessories specified in the detailed specification.

Item **Unit**

Removal of existing medium voltage cable from existing switchgear ..... No

The unit of measurement shall be the number of existing MV cable removed from existing switchgear.

The tendered rate shall include full compensation for the disconnection and removal of existing medium voltage cables from existing switchgear.

Item **Unit**

Supply cable markers ..... No

The unit of measurement shall be the number of cable markers supplied.

The tendered rate shall include full compensation for the provision of the cable markers and the cost of handling and installing them.

Item **Unit**

Erect cable markers ..... No

The unit of measurement shall be the number of cable markers installed.

The tendered rate shall include full compensation for the provision of the cable markers and the cost of handling and installing them.

Item **Unit**

Supply cable slabs ..... No

The unit of measurement shall be the number of cable slabs supplied.

The tendered rate shall include full compensation for the supplying, handling and installing of the concrete protective slabs where specified.

Item **Unit**

Install cable slabs..... No

The unit of measurement shall be the number of cable slabs installed.

The tendered rate shall include full compensation for the supplying, handling and installing of the concrete protective slabs where specified.

Item **Unit**

Expose, cut and relocate existing cable ..... Sum

The unit of measurement shall be the sum to expose, cut and relocate existing cable.

The tendered sum shall include full compensation to expose the length of cable as specified in the detail specification by hand, taking all the necessary precautions not to damage the cable, cutting the cable and relocating the cable into the existing substation.

Item **Unit**

Install LV cable in protective sleeve pipes ..... m

The unit of measurement shall be the length in meter of LV cable installed in sleeve pipes.

The tendered rate shall include full compensation for the installation of LV cable in protective sleeve pipes.

SPECIFICATION

E07 : ELECTRICAL INDUSTRIAL WELDING PLUGS, COUPLERS AND SOCKET OUTLETS

2	2012-05-30	Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance		
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**

City of Johannesburg
Johannesburg Water (SOC) Ltd

PARTICULAR SPECIFICATION : VOLUME 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 10142-1 The Wiring of Premises Part 1 – Low Voltage Installations

E07.2.2 Particular specifications to be read in conjunction with this specification

This specification shall be read in conjunction with the following specifications:-

G01: PARTICULAR SPECIFICATION FOR COLOUR CODES

G02: PARTICULAR SPECIFICATION FOR CORROSION PROTECTION

E06: ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE INSTALLATION

E08: WIRING

E07.3 GENERAL REQUIREMENTS

Switched 380V, 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 5-core cable shall be used with a neutral and earth included in the supply cable. The neutral is required for the 220 VAC control of submersible pumps when supplying the submersible pump via a welding plug.

Where pilot 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. All sockets shall be constructed of corrosive resistant materials.

Both 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 mm^2, the cable core size from the junction box terminals to the socket outlet shall be 16mm^2, 4-core. The 16A single phase socket shall have its own dedicated supply.

The junction box including the canopy, the welding socket stand and the sockets shall be painted B26 – Electric Orange.

E07.4 MEASUREMENT AND PAYMENT

Measurement and payment will distinguish between supply / delivery and installation / commissioning of industrial welding plugs, sockets ec..

Item	**Unit**
Supply and deliver of 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 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 the plug to the employer and obtaining a receipt therefore.

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
(c) SANS 1507 : Electric Cables with extruded solid dielectric insulation for fixed installations

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 MEASUREMENT AND PAYMENT

Item **Unit**

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.

Item **Unit**

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.

Item **Unit**

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.

Item **Unit**

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.

Item **Unit**

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. Were 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.

Item **Unit**

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.

Item **Unit**

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.

Item **Unit**

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.

Item **Unit**

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.

Item **Unit**

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.

PARTICULAR SPECIFICATION

E09 :ELECTRICAL BUILDING INSTALLATION

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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) The SANS 10142-1 Code of Practice for the Wiring of Premises as amended;

(b) The Machinery and Occupational Safety Act as amended;

(c) The local Municipal & Supply Authority By-Laws and Regulations;

(d) The local Fire Regulations;

(e) The Regulations of Telkom;

(f) The Standard Regulations of any Government Department of public service company where applicable;

(g) The factory-built assemblies of low voltage switchgear and control gear IEC 439, as amended;

(h) The degrees of protection of enclosures for low voltage switchgear and control gear IEC 144, as amended.

(i) Occupational Healthy and Safety Act (1993)(Act 85 of 1993), as amended.

(j) SANS 10400 National Building Regulations and Building Standards Act (Act 103 of 1977), as amended.

E09.2.2 Particular Specifications to be read in conjunction with this specification

This specification shall also be read in conjunction with the following specifications:-

G01: PARTICULAR SPECIFICATION FOR COLOUR CODES

G02: PARTICULAR SPECIFICATION FOR CORROSION PROTECTION

E02: ELECTRICALCABLE RACKS

E06: ELECTRICAL MEDIUM AND LOW VOLTAGECABLE INSTALLATION

E08: WIRING

In addition, the Sub-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 which may arise as a result of the Sub-Contractor's negligence to comply with the requirements of the regulations enumerated in paragraph 9.2.

It shall be assumed that the Sub-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 Sub-

Contractor shall immediately inform the Engineer of such a contradiction. Under no circumstances shall the Sub-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 Sub-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 Sub-Contractor shall be substantiated with official receipts.

It shall be the responsibility of the Sub-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 Sub-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 Sub-Contractor to position and securely fix conduits, ducts, cables and cable channels, switchboards, fittings and all other equipment or accessories as required for the installation. The Sub-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.

(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 proprietary products such as UNISTRUT, or failing this, shall be of mild steel sections, purpose fabricated for their application. Under no circumstances whatsoever will sheet metal straps bej accepted as a supporting method. All supports shall cradle the item to be supported; supports shall not be rivetted 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 iron supports shall be of 38 x 5mm minimum section.

(g) REDHEAD or RAWLBOLT anchor bolts, or their equivalent, shall be used for fixing supports to the building structure, it not being permissible to utilise gunpowder shot-driven bolts for this purpose unless prior permission has been obtained.

(h) 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.

(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) Brass screws, bolts and nuts shall be used to fix galvanised equipment.

(l) Materials as sheet metal cable ducts or channels may be fixed against walls and concrete slabs by means of the shot-fired method designed for this purpose.

(m) The Sub-Contractor shall ascertain whether this method of fixing will carry the weight of the material including conductors, cables and other items of equipment to be installed later.

Should it be found that the method of fixing is inadequate and joints tend to loosen, the Sub-Contractor will be required to fix the material by an alternative method to the satisfaction of the Engineer. Where the shot-fired method is used, warning signs shall be placed at all entrances leading to the area where this work is in progress. The Sub-Contractor shall take all reasonable precautions to prevent accidents. Only nails recommended by the manufacturer of the shot-fired equipment shall be used.

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 this is unavoidable, cathodic protection shall be provided. Where doubtful situations of this nature occur or where there are installation incompatibilities, the matter shall be reported to the Engineer without delay.

E09.5.3 Galvanised Conduit

Galvanised conduit and accessories shall be used in the following circumstances:

(a) In damp areas and areas exposed to the weather

(b) For all installations within 30 kilometres of the coast

(c) For surface mounted conduit installations

(d) In conduit used for future extensions where 'free ends' exist

(e) For connections to galvanised equipment.

Conduit & accessories for the above applications shall be hot-dipped galvanised to SANS32 and SANS 121.

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 Sub-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 (Steel)

All joints shall be painted with red lead to prevent them from rusting in damp areas, areas within 30km of the coast, and in cases where the installation is exposed to the weather for any length of time. Where the galvanising or black paint has been damaged, the area shall first be cleaned and a coat of zinc base paint applied subsequently. Additional coats of paint shall only be applied after the undercoat has been completed.

E09.5.9 Continuity (Steel)

Mechanical and electrical continuity shall be maintained throughout the conduit installation. Conduits may not be relied upon for earth continuity.

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 Sub-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 Sub-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 90º 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 Sub-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 Sub-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 is permitted in most cases and 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 shall 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 ceilings of concrete, shall 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 Sub-Contractor to ensure close liaison with the Main Contractor in connection with the work.

E09.5.22.2 Fixing

All conduits is 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

Cross-Overs in conduit routes shall be minimised. Where cross-overs are unavoidable one conduit only shall be offset 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

Draw boxes with metal cover plates shall be installed where required. Draw boxes shall as far as possible be installed near gangplanks. Socket and switch boxes will not be accepted as draw boxes in open roof spaces.

E09.5.22.5 Positions of Accessories

In open roof spaces which afford access after completion of the building, conduit accessories shall be installed to allow wiring or inspection from above. In ceiling voids with less than 900mm clear space between the ceiling and the roof, conduits shall be installed to permit wiring and inspection from below. In the latter case, the shortest route may be followed i.e. conduits need not be installed parallel or perpendicular to roof members. Conduits shall be looped 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 which 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

In order not to delay building operations, the Sub-Contractor shall ensure that all conduits and accessories which are to be cast in concrete are placed in position in good time. The Sub-Contractor or his representative shall be in attendance when the concrete is cast.

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

Draw boxes and/or inspection boxes shall, where possible, 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 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 Sub-Contractor's account.

E09.5.24 Surface Installation (steel)

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 Sub-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 Sub-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. 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 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 2,5mm^2 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.

E09.5.27 Chases and Builder's Work

Except where otherwise specified, the Sub-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 Sub-Contractor shall notify the Main Contractor of his requirements and the responsibility lies with the Sub-Contractor to ensure that these requirements are met.

Electrical materials to be built in must be supplied, placed and fixed in position by the Sub-Contractor when required by the Main Contractor. The Sub-Contractor shall also ensure that these materials are installed in the correct positions.

Where no Main Contractor is on site the Sub-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 Sub-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 Sub-Contractor shall maintain close co-operation with the Main Contractor and all his Sub-Contractors throughout the course of the contract. Should the Sub-Contractor not comply with this requirements, any additional costs resulting from lack of his co-operation will be recovered from him.

E09.5.28 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.

E09.5.28.1 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.

E09.5.28.2 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

E09.6.1 Responsibility of the Sub-Contractor

The Sub-Contractor shall supply and install all cable trays or ladders as specified or as required by the cable routes including the necessary supports, clamps, hangers, fixing materials, bends, angles, junctions, reducers, T-pieces, etc.

E09.6.2 Cable Trays

Metal cable trays shall be manufactured from perforated rolled steel or an approved steel wire mesh type. Only the following metal cable tray types may be used:

(a)	Less than 200mm wide	1,6mm minimum thickness with 12mm minimum return
(b)	200mm and 350mm	trays shall be manufactured from 2mm thick steel with folded over returns and a minimum up-stand of 50mm.
(c)	350mm and wider	2,4mm minimum thickness with 76mm return as alternative to (b) above.

The return of trays shall not be perforated and the top of the return shall be smooth. The same cable tray type shall be used in long parallel tray runs.

E09.6.3 Cable Ladders

Metal cable ladders shall consist of 76mm high side rail of 2mm minimum thickness. Cross pieces consisting of channel sections shall be spaced at maximum intervals of 250mm.

Where cables of 10mm dia. or smaller are installed on cable ladders, the spacing of the cross pieces shall be 125mm. Cables shall be clamped in position by means of purpose made cable clamps that fit into the cross pieces. Cross pieces consisting of slotted metal rails which accommodate plastic or metal cable binding bands, may be used in vertical cable runs against walls, etc, where the prior approval of the Engineer has been obtained. These cross pieces are not acceptable in horizontal cable runs.

E09.6.4 Plastic Cable Trays

Rigid PVC cable trays are acceptable. Only the following tray types may be used:

(a) Less than 250mm wide 3,0mm minimum thickness and 40mm minimum return.

(b) 250mm and wider 4,0mm minimum thickness and 60mm minimum return.

E09.6.5 Finishes

Metal cable trays and ladders shall be finished as follows:

(a) In coastal areashot-dip galvanised to SANS 32 and SANS 121 or epoxy power coated

(b) False ceiling voidselectro-galvanised or epoxy power coated

(c) Vertical building ductshot-dip galvanised to SANS 32 and SANS 121 or epoxy power coated

(d) Plant rooms, substations,service tunnels, basements electro-galvanising or epoxy powder coated

(e) Damp areas, exposedhot-dip galvanised to SANS 32 and SANS 121 or epoxy powderto weathercoated

(f) Undercover industrial hot-dip galvanised to SANS 32 and SANS 121 or epoxy powderapplicationcoated

The abovementioned finishes shall apply unless specified to the contrary in the Detailed Technical Specification. Hot-dipped galvanised or electro-galvanised trays and ladders shall be cold galvanised at all joints, sections that have been cut and at places where the galvanising has been damaged. Powder coated trays and ladders shall likewise be touched up at joints, cuts and damaged portions.

E09.6.6 Supports

Trays shall be supported at the following maximum intervals:

(a) 1,6mm thick metal trays 1.5m maximum spacing

(b) 2,4mm thick metal trays 1,5m spacing and 75mm return

(c) Metal cable ladders 1,5m spacing

(d) 3,0mm thick PVC trays, 1,5m maximum spacing with 40mm return

(e) 4,0mm thick PVC trays, 1,5m maximum spacing with 60mm return

In addition, trays and ladders shall be supported at each bend, offset and T-junction.

E09.6.7 Joints

Joints shall be smooth without projections or rough edges that may damage the cables. The Sub-Contractor will be required to cover joints with rubber cement or other hardening rubberised or plastic compounds if in the opinion of the Engineer joints may damage cables. Joints shall as far as possible be arranged to fall on supports.

Where joints do not coincide with supports, joints shall in the case of trays with single returns (items (a) and (c) of paragraph E09.6.2) be made by means of wrap-around splices of the same thickness as the tray and at least 450mm long.

The two cable tray ends shall butt tightly at the centre of the splice and the splice shall be bolted to each cable tray by means of at least 8 round head bolts, nuts and washers. Splices shall have the same finish as the rest of the tray. Where joints which do not coincide with supports occurring in trays with folded over returns, tight fitting metal guide pieces, at least 450mm long, shall be inserted in the folded returns to provide the necessary support to the two cable tray ends. Splices as described above shall be provided if trays sag.

E09.6.8 Fixing

Trays shall be bolted to supports by at least two hexagon headed bolts and nuts per support. Bolts shall be securely tightened to avoid cables being damaged during installation. The use of square nuts is not permitted.

E09.6.9 Fixing to the Structure

The supports for cable trays and ladders shall in all cases be securely fixed to the structure by means of heavy duty, expansion type anchor bolts. It is the responsibility of the Sub-Contractor to ensure that adequate fixing is provided since cable trays and ladders that work loose shall be rectified at his expense.

E09.6.10 Accessories

Horizontal and vertical bends, T-junctions and cross connections shall be supplied by the Sub-Contractor. The dimensions of these connections shall correspond to the dimensions of the linear sections to which they are connected. The radius of all bends shall be 450mm minimum. The inside dimensions of horizontal angles or connections shall be large enough to ensure that the allowable bending radius of the cables is not exceeded. Sharp angles shall have a 45º gusset.

All accessories shall be manufactured by the supplier of the ladder / tray, site fabricated accessories shall not be permitted unless prior written approval has been given by the Engineer.

E09.6.11 Installation of Cables

Cables shall be installed adjacent and parallel to each other on the trays with spacings as determined by the current ratings. Horizontal trays and ladders shall in general be installed 450mm below slabs, ceilings, etc, to facilitate access during installation.

E09.6.12 Earthing

Metal trays and ladders shall be bonded to the earth bar of the switchboard to which the cables are connected. Additional bare copper stranded conductors or copper tape shall be bolted to the tray or ladder where the electrical continuity cannot be guaranteed.

E09.7 CABLE CHANNELS

E09.7.1 Responsibility of the Sub-Contractor

The Sub-Contractor shall supply and install all cable channels 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

Cable ducts shall be of the "Cabstrut" type or similar. The ducts shall be rolled from 1,2mm minimum sheet steel and shall be finished as follows:

(a)	In coastal areas (under all circumstances)	Hot dipped galvanised to SANS 32 and SANS 121 or epoxy powder coated
(b)	Cast in concrete	Pre-galvanised
(c)	False ceiling voids	Pre-galvanised
(d)	Vertical building ducts	Hot-dipped galvanised to SANS 32 and SANS 121 or epoxy powder coated
(e)	Surface mounted in plant, rooms, substations, service tunnels, basements	Epoxy powder coated or electro-galvanised
(f)	Damp areas, exposed to weather,underground	Hot-dipped galvanised to SANS 32 and SANS 121 or epoxy powder coated.
(g)	Undercover industrial applications	Hot-dipped galvanised to SANS 32 and SANS 121 or epoxy powder coated.

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 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 channels shall have metal snap-in cover plates. Cover plates for wider channels shall be fixed by means of screws which 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-rivetted 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 cable channels shall be retained by means of metal clips or metal spacer bars at not less than 1m centres.

E09.7.6 Vermin Proofing

All cable channels 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-rivetted 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 channel installation. A tinned copper bonding strip shall be installed across each joint and secured to both adjoining channels by means of brass bolts, nuts and washers. The channel 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 45º 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

Channels 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 channel.

E09.7.12 Fixing

The Sub-Contractor shall supply and install all hangers, supports or fixings for the channels. Channels up to 75 x 75mm shall be supported at maximum intervals of 1m and larger channels at maximum intervals of 2m. Channel 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 channels or supports to the structure shall comply with paragraph E09.4 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

Where channels are cast into concrete, the reinforced type shall be used. Additional spacer blocks shall be used where necessary to prevent ducts from being bent while the concrete is cast. Channels shall be filled with polystyrene or other suitable fillers to prevent the ingress of cement and shall be securely fixed in position to the shuttering.

E09.7.14 Fire Barrier

Where channels 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 Sub-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 Sub-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 Sub-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 Sub-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 Sub-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 Sub-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 Sub-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 Sub-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 MountingHeights

Unless otherwise specified outlets shall be installed at the following heights above finished floor level:

Flush mounted socket outlets in general	300mm
Surface mounted socket outlets in general	1200mm
Kitchens and prep area, surface or flush mounted	1200mm
Shops - surface or flush mounted	300mm
Offices - surface or flush mounted	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 Sub-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 Sub-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 Sub-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

E09.12.1 Design and Construction of Free Standing Switchboards

Switchboards shall be factory built assemblies of switchgear and control gear (FBAs) of the multi-cubicle type and shall comply with IEC 439.

Switchboards shall be floor mounted with exterior panelling including doors and covers presenting a flush and uniform appearance. A channel section base-frame shall be provided.

(a) Switchboard operation on cable access shall be as follows:

- front operation with rear cable access
- front operation with front cable access
- back to back switchboards with front and rear operation and cable access
- cable entry from above and below

(b) Compartments shall be provided for:

- main busbars
- auxiliary busbars, if applicable
- cabling
- incoming and outgoing functional units

(c) Segregation in the base-frame shall be provided to correspond with divisions in the switchboard sections when cable entry is from below. Access for sealing the cable slot with vermiculite cement shall be provided from the front or rear of the section to:

- reduce the danger of fire spreading
- prevent vermin entering

The base-frame shall be sealed with a cover plate when cable entry is from above.

(d) Increase in depth of certain sections of switchboards for high current ratings shall be subject to the Engineer's approval.

(e) Switchboards shall be designed to confine internal arcing faults and to direct arcs and gases arising from these away from the operator.

The arrangement of functional units and spacing between them shall be such that forced cooling is not necessary.

(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) Measures shall be taken to prevent electrolytic corrosion where dissimilar metals are in contact with each other.

(h) 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.

(i) Switchboards shall be designed to permit the addition of identical sections.

E09.12.1.1 Barriers

Functional units other than fuse switches within their own enclosures, shall be located in their own compartments, separated from each other and the busbars. Barriers shall be provided to prevent accidental contact with live conducting parts of the circuit and to protect the unit from falling objects.

Fused switches, moulded case circuit breakers, etc, within their own enclosures, shall be barrier protected from falling objects and accidental contact with live conducting parts of the circuit and adjacent switches.

Barriers shall be robust with high impact strength and made of material which is self-extinguishing or resistant to flame propagation.

E09.12.1.2 Doors and Covers

Each functional unit compartment and cable compartment shall be provided with individual hinged doors for easy access except where flush mounted equipment prevents this. Power and control busbar compartments shall be provided with removable covers requiring the use of a tool for their removal.

Doors shall have adequate points of hinging and latching and shall be reinforced to prevent distortion when open. Non-ferrous fasteners shall be of the type detailed in Part 2 with four keys being supplied per switchboard. A release mechanism shall be provided on the cable compartment door hinges to allow the doors to be removed.

All removable doors and covers shall be identified to enable replacement in the correct position.

Doors shall have stops to prevent over swing of the door when opening and to avoid interference with adjacent compartments. Dust-proof seals shall be provided on all doors.

E09.12.1.3 Gland Plates

When cables enter a switchboard from below, a cable gland plate shall be provided at a minimum height of 300mm above the point of entry. In case of cables entering from above, the cable gland plate shall be mounted at the point of entry.

The gland plate shall be removable and shall be supported to prevent movement of the cables.

When cables enter a switchboard from below, adequate access shall be provided beneath the gland plate to ensure that once the cables have been installed, the floor slot can be sealed from above using vermiculite cement. The arrangement shall be such that once this slot is sealed level with the floor, each base frame sub-section shall be sealed from the adjacent base frame sub-section.

When cables enter from above, the gland plates shall effectively seal the switchboard opening.

E09.12.1.4 Degree of Protection

The switchboards shall be designed and manufactured to the degree of protection specified in Part 2 in accordance with IEC 144.

The minimum degree of protection shall apply when all functional units are connected. In the test, disconnected and removed positions, adequate protection shall be provided against contact with live parts.

E09.12.1.5 Busbars

Busbars shall be made of hard drawn copper of suitable dimensions and in accordance with IEC 439 with regard to temperature rise at the specified altitude and mechanical strength for the rated fault conditions. Busbars shall be housed in their own compartment. The neutral busbar shall have a current carrying capacity of half that of the phase busbar unless otherwise specified.

Busbars shall be rated in accordance with the requirements as previously detailed in this specification.

Small leads connected directly to the busbars, shall be provided with a 20 amp HBC fuse mounted at the busbar.

Conductors between the busbars and the supply side of a single functional unit shall be rated for the same fault level as the busbars. Where the conductors to the components included in the unit are phase segregated, braced and substantially fault free, they shall be capable of withstanding the let-through current of the protection device in the unit.

Busbars and connections shall be air insulated and shall be taped and/or shrouded on all sections where accidental contact is possible. Insulating materials shall be resistant to flame propagation, non-hygroscopic and resistant to tracking.

Joints and tees in busbar connections shall be made with sherardised bolts, nuts and washers of not less than 12mm diameter. High tensile (black) bolts of not less than 10mm diameter and having a reference symbol 'R' for the tensile range in accordance with BS 970 will be accepted as an alternative.

Joints shall be made with at least two bolts and the overlap shall be sufficient to ensure ample mechanical strength and joint conductivity. Unless otherwise approved, the overlap shall not be less than six times the thickness or shall equal the width of the busbar material, whichever is the greater.

E09.12.1.6 Identification of Busbars

AC or DC busbars and functional unit conductors and connections shall be clearly marked to indicate the supply phase or pole they are connected to. The phases shall be coloured red, white and blue, with the neutral colour black and the protective conductor (earth bar) green and yellow. DC busbars shall be coloured red for positive and black for negative.

E09.12.1.7 Protective Conductor (Earth Bar)

A separate copper protective conductor to which all metal parts are connected shall be installed in the inside rear of each switchboard along the entire length. The bar shall be in an accessible position to allow for the earthing of cables.

The protective conductor shall have a current carrying capacity sufficient to withstand the earth fault current that may occur in the switchboard. The cross-section shall be calculated with the aid of the formula in Appendix B of IEC 439 but shall not be less than 200mm^2.

The neutral busbar shall be connected to the protective conductor by means of a removable bolted link on the cable side of each incoming functional unit. The link shall be easily accessible from the front of the switchboard for removal and testing.

Non-current carrying parts, including relays, metres, etc, shall be effectively connected to the protective conductor by means of their mounting arrangement on the panel or by a separate earthing conductor connected to the protective conductor. This shall include the earth terminals provided on equipment.

All parts of the protective circuit within the switchboard shall be designed to withstand the highest thermal and dynamic stresses that may occur.

E09.12.2 <u>Construction of Flush Mounted Switchboard</u>

E09.12.2.1 Bonding Tray

Bonding trays for flush mounted switchboards shall be of rigidly constructed 1,6mm thick galvanised steel, braced and reinforced. 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.

E09.12.2.2 Expanded Metal

Where switchboards are to be built into 116mm thick walls, expanded metal shall be spot welded to the rear of the bonding trays. The expanded metal shall protrude at least 150mm on each side to prevent plaster from cracking.

E09.12.2.3 Knock-Outs

Ample knock-outs 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. Knock-outs shall be allowed for any size of specified conduit. 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.

E09.12.2.4 Architrave Frame

The architrave frame shall be of 2,0mm thick sheet steel with bevelled edges. The architrave frame shall accommodate the chassis, panels and doors. The architrave shall overlap the bonding tray by at least 25mm on each side. The architrave frame shall be fixed to the tray in such a fashion to allow for depth adjustment and irregularities of the wall.

E09.12.2.5 Extension Frames

Semi-flush mounted switchboards shall be equipped with extension frames. Generally the frame depths shall be 50mm but may be altered to suit each application.

E09.12.2.6 Chassis

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. The chassis position shall be adjustable in the horizontal plane.

E09.12.2.7 Panel (Faceplate)

A suitably stiffened panel manufactured of 2,0mm thick sheet steel shall be installed in the architrave frame for flush mounting of switchgear. 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. Blanking plates shall be provided in positions where future switchgear will be installed. The distance between the inside of the closed doors and the panels shall be not less than 40mm. No equipment may be mounted on the panel (faceplate) unless it is permanently hinged to the switchboard frame.

E09.12.2.8 Fixing of Panels

The panel for each switchboard shall be secured to the architrave frame by means of captive fasteners such as "DZUS" or "CAMLOC". 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. Where it is required that equipment be mounted on the panel, the panel shall be securely hinged to the switchboard frame.

E09.12.2.9 Panel Handles

Two chromium plated handles shall be provided on each front cover. The handles shall be mounted at the top and bottom of each panel. Handles can be omitted if "DZUS" or "CAMLOC" fasteners are used.

E09.12.2.10 Hinged Panels

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. The panel shall be removable when it is in the open position.

E09.12.3 Construction of Surface Mounted Switchboards

NB This section refers to surface mounted sub-switchboards and not to floor standing main switchboards in substations or sub-main switchboards.

E09.12.3.1 Switchboard Tray

Surface mounted switchboards shall be equipped with a 1,6mm sheet steel reinforced tray. Securing lugs shall be provided to fix the tray to walls or any other structure. A solid brass or cadmium plated steel earth connection stud and nut shall be provided.

E09.12.3.2 Construction

All joints shall be welded or securely bolted. The tray shall be square and neatly finished without protrusions. The front tray sides shall be rounded with an edge of at least 20mm to accommodate flush doors.

The requirements for chassis, panels and doors shall be as specified for flush mounted switchboards. The doors shall be hinged and shall fit flush in the frame in the closed position. Knock-outs shall not be provided unless specifically called for.

E09.12.4 Power and Control Wiring

(a) Power circuit wiring and connections in a switchboard shall be rated to the full rating of the associated equipment, i.e. fused switch, contactor, circuit-breaker, etc, and not to the circuit or fuse rating.

(b) Neutral connections shall have the same rating as the phase connections unless otherwise approved.

(c) Control circuits shall be wired using a minimum of 2,5mm² conductors. Current and voltage transformer circuits shall be wired using a minimum of 2.5mm².

(d) Conductors shall be general purpose 600/1000V grade PVC-insulated wire to SANS 1507 and SANS 1574.

(e) Wiring for circuits up to 50V shall be in 0,5mm² flexible 300/500V grade PVC-insulated wire in accordance with SANS 1507 and SANS 1574.

(f) Single or solid conductor wire shall not be used.

(g) Joints or splices in any wiring are not acceptable.

(h) Panel and equipment terminals, labels, etc, shall be accessible after the wiring has been completed.

(i) Terminals which are on the live side of fuses and isolating switches shall be completely shrouded to prevent accidental contact.

(j) Aluminium conductors are not acceptable.

E09.12.4.1 Wiring Supports

Wiring shall present a neat appearance and shall be braced, clipped and/or laced to prevent vibration and to ensure that it shall not deform under fault conditions. Connections to equipment on swing doors shall be arranged so as to give a twisting motion and not a bending motion to the conductor.

E09.12.4.2 Wiring Identification

Power wires shall bear the colour along their entire length of the phase to which they are connected.

Control wire sheaths shall be coloured grey for AC circuits.

Control wiring leads shall be marked at both ends with an interlocking type of ferrule with permanent black letters impressed on a white background.

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.

E09.12.4.3 Wiring of Moulded-Case Circuit Breakers

Single pole and double pole moulded-case circuit breakers shall be wired in a way that the supply to the switchboard is equally balanced.

E09.12.4.4 Control Wiring and Cable Terminations

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 preset. 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.

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.

Not more than two conductors shall be connected to any side of a terminal.

Each terminal strip shall be provided with not less than 10% spare terminals, with a minimum of two, unless otherwise approved.

E09.12.4.5 Power Wiring and Cable Terminations

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.

An undrilled 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 630mm^2.

E09.12.4.6 Cable Terminal Arrangements

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 for fixing the cable leads to prevent

vibration.

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.

Terminals shall be provided for all cores of external control cable as indicated on the drawings whether internally connected or not.

E09.12.5 Testing

Electrical switch panels shall be inspected by the Engineer at their place of manufacture, prior to delivery to site. At such inspection and testing, the Sub-Contractor shall demonstrate the functioning of the switch panel to the Engineer. Any defects in materials, finishes and operation of the switch panels shall be corrected at their place of manufacture prior to delivery to site.

Type and routine tests shall be carried out on either a complete switchboard or a representative portion thereof to verify its characteristics.

Type tests shall be performed in accordance with IEC 439:

- verification of temperature rise limits
- verification of dielectric properties
- verification of the short circuit strength
- verification of the effectiveness of the protective circuit
- verification of clearances and creepage distances
- verification of mechanical operation
- verification of degree of protection

If evidence is available of type tests already made on similar equipment, this may, subject to the Engineer's approval, be acceptable in lieu of these tests,

Copies of test certificates shall be submitted to the Engineer.

Routine test shall be performed in accordance with IEC 439:

- inspection of the switchboard including inspection of wiring and electrical operation tests
- dielectric test. This test shall have a duration of 60 seconds
- checking of protective measures and of the electrical continuity of the protective circuits.

E09.12.6 Construction of LV Switch Cubicles (Kiosks)

Switch cubicles shall be of sufficient size to accommodate all the specified equipment. All equipment shall be installed as described in paragraph E09.12.7.

E09.12.6.1 Framework

Switch cubicles 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 reinforced or other corrosion proof material (e.g. glass fibre) may also be used if adequately reinforced.

E09.12.6.2 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.

E09.12.6.3 Doors

Doors shall be provided in the front and back panels and shall swivel through 180º. 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.

E09.12.6.4 Warning Sign

Warning & danger signs shall be mounted on each door in compliance with the requirements.

E09.12.6.5 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.

E09.12.6.6 Panel

All equipment shall be mounted flush behind a single front panel with the exception of metres and time switches. The panel shall be fixed by means of captive fasteners. Chromed handles shall be provided on the panel. Metres and time switches may be installed on the surface of the flush panels.

E09.12.7 Mounting of Equipment

E09.12.7.1 Clearance and Access

A minimum clearance of 50mm shall be maintained between items of equipment and the side of the compartment. Where extra equipment is specified after the design has been finalised, this clearance requirement may be altered subject to the Engineer's approval.

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.

E09.12.7.2 Mounting of Circuit Breakers

All moulded case circuit breakers shall be flush mounted with only toggles pro-truding. Miniature circuit breakers may be installed in clip-in trays mounted on the frame. Special provision shall be made for large main switches. Circuit breakers shall be installed so that the toggles are in the up position when "ON" and down when "OFF".

E09.12.7.3 Mounting of Contactors

Contactors shall only protrude through the panel in special cases. Plastic covers or other coverings will not be required.

E09.12.7.4 Instrumentation

All metering instruments shall be mounted flush in the front panel unless otherwise specified. 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. 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.

E09.12.7.5 Fuse-Links and Carriers

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.

DC circuits shall have fuses in the positive and negative leads.

Fuses shall be so positioned that they are readily accessible to a person standing on the floor.

Fuses for instrumentation shall be mounted on the outside of the compartment door adjacent to or below the instrument.

Fuses shall be provided with labels giving their rating and duty.

Solid link holders shall be coloured white.

E09.12.7.6 Spare Fuses

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.

E09.12.7.7 Control Equipment

All equipment performing control functions, e.g. control relays, transducers, and time relays not requiring adjustment, shall be mounted behind the front panel.

E09.12.7.8 Current Transformers

Current transformers shall comply with SABS 3939.

Current transformers shall be accessible and easily removable.

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).

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.

E09.12.7.9 Main Circuit Breakers

(a) Rack-out type air circuit breakers shall be mounted in a separate compartment with the handle or operating mechanism only protruding. A positive device shall be provided to ensure that the circuit breaker is secured in the:

- connected position
- test position
- disconnected position

It shall be possible to remove the circuit breaker from its compartment. It shall not be possible to insert a circuit breaker into a circuit of higher rating.

Automatically-operated shutters shall be provided so that on racking out the circuit breaker, these shutters cover the isolating sockets to prevent inadvertent contact with live busbars and circuits. Busbar shutters shall be labelled with the word BUSBARS in letters of at least 50mm high.

Mechanical interlocks shall be provide to ensure that:

- the circuit breaker main contacts cannot be engaged and disengaged unless the circuit breaker contacts are fully open
- the circuit breaker cannot be closed unless it is in the connected, disconnected or test position
- the action of disengaging the circuit breaker from the connected, disconnected or test position shall automatically trip the circuit breaker.

Circuit breakers shall be capable of carrying continuously the load current stated in the drawings at site altitude when mounted within the compartment specified without forced ventilation.

(b) If the main switch is a moulded case circuit breaker or isolator, it shall be installed flush in a separate compartment.

Contactors controlling the supply shall be installed behind separate front panels.

(c) All metering, protection and indicating equipment shall be clearly visible from the front of the board. Where doors are specified the equipment shall be installed flush in the doors and covered as described in 'Instrumentation' above.

(d) Fuses or control gear providing back-up protection for circuit breakers shall be installed behind separate front panels.

E09.12.7.10 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 switchboard, the switchboard shall be divided into electrically separate sections with sheet metal division plates to isolate power and mains power sections.

(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 may be used. Electrical interlocking alone is not sufficient. Rotary switches may only be used on boards where the fault level does not exceed 10kA.

(c) A separate 3-pole isolator, fuse switch or 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.

E09.12.8 General

E09.12.8.1 Size

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. The clearance between adjoining switchgear or switchgear openings shall be as specified in paragraph E09.12.7 of this specification.

E09.12.8.2 External Dimensions

All specified external dimensions for switchboards shall be strictly adhered to. If the clearances specified in paragraph E09.12.7 cannot be adhered to as a result of restricting external dimensions, the Sub-Contractor or Manufacturer shall obtain the opinion of the Engineer before manufacturing the switchboards.

E09.12.8.3 Positions

The Sub-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.

E09.12.8.4 MountingHeights

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 2,1m above finished floor level.

E09.12.8.5 Labels

In addition to paragraph E09.15 of this specification, the following labels shall be provided for switchboards:

(a) Main labels: A white traffolite label shall be provided to clearly identify each switchboard and subsections of switchboards.

The fixing of main labels shall be done as per paragraph E09.15. Lettering shall be black with a maximum height of 20mm letters.

(b) Compartment labels : Front panels shall be identified with white traffolite labels fixed to the doors or front panel respectively. The function of the equipment and circuits shall be clearly identified.

The fixing of compartment labels shall be done as per paragraph E09.15.

Lettering shall be black with a maximum height of 8mm letters.

(c) Equipment labels : All equipment shall be identified with the necessary labels. The labels for equipment mounted on doors shall be identified with white traffolite labels having black lettering engraved on them, with a maximum height of 3mm letters.

The equipment labels shall be secured by means of high quality double sided tape.

The labels for all equipment, installed behind panels, shall be fixed to the chassis

close to the equipment.

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.

The types of labels for equipment behind the doors or covers shall be subject to the Engineer's approval.

E09.12.8.6 Drawings

(a) A set of three prints of the shop drawings for the switchboards shall be submitted to the Engineer for approval before the boards are manufactured. The following information shall be presented:

(i) A complete wiring diagram of the equipment on the boards, and the internal wiring of such equipment.

(ii) A complete layout of the arrangement of the switchboards indicating all equipment dimensions and the construction of the boards. The positions and method of fixing of busbars shall be shown.

(iii) All labelling information on a separate sheet.

(iv) The make, catalogue number and capacity of all equipment such as isolators, circuit breakers, fuses, contractors, etc.

The approval of drawings shall not relieve the Sub-Contractor of his responsibility to the Employer to supply the switchboards according to the requirements of this specification or to the requirements of the Detailed Technical Specification.

(b) A complete set of "Record" transparent 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.

Where such transparent drawings as called for above are modified during the execution of the contract, the Sub-Contractor shall at his own expense modify or replace such drawings. Accurate drawings of the equipment shall be forwarded to the Employer.

E09.12.9 Paint Finish

E09.12.9.1 Finish Required

Metal components of the framework, panels and chassis shall be finished with a high quality paint applied according to the best available method. Baked enamel, electrostatically applied powder coating or similar proven methods may be used. Care shall be taken to ensure that all edges and corners are properly covered. Whichever finishing method is employed, it shall be backed up by written certification that the quality of finish complies with the relevant SABS standard.

E09.12.9.2 Baked Enamel Finish

Prior to painting, all metal parts shall be thoroughly cleaned of rust, mill scale, grease and foreign matter to a continuous metallic finish. Sand or shot blasting, or acid pickling and washing may be employed for this purpose. Immediately after cleaning all surfaces shall be covered by an electrolytically applied rust inhibiting, tough, unbroken metal phosphate film and then thoroughly dried.

Within forty-eight (48) hours after phosphatising, a passivating layer consisting of a high quality zinc chromate primer shall be applied, followed by two (2) coats of high quality baked enamel to SABS 783 type 1. The minimum paint thickness after baking shall be 0.06mm. The paint shall have a shock resistance of 25kg / cm on 0,9mm soft steel plate and a scratch resistance of 2000 grams.

E09.12.9.3 Powder Coated Finish

Prior to painting, all metal parts shall be thoroughly cleaned of rust, mill scale, grease and foreign matter to a continuous metal finish. Sand or shot blasting, or acid pickling and washing may be employed for this purpose. The metal parts shall be pre-heated and then covered by a microstructured paint powder applied electrostatically. The paint shall be baked on and shall harden within 10 minutes at a temperature of 190°C. The minimum paint thickness after baking shall be 0,5mm and shall have a shock resistance of 25kg / cm on 0,9mm soft steel plate and a scratch resistance of 2000 grams.

E09.12.9.4 Colour

The colour coding shall be as per the following specification:-

G01: PARTICULAR SPECIFICATION FOR COLOUR CODES

Before the installation is handed over, the Sub-Contractor shall ensure that all paint surfaces are clean and undamaged.

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 Sub-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 Sub-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 Sub-Contractor's expense, making good included.

It is in the interest of the Sub-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 Sub-Contractor's account.

The Sub-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 Sub-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 Sub-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 Sub-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 Sub-Contractor shall record all motor running currents and set overload protection devices to correct values.

(b) The Sub-Contractor shall adjust and set all time clocks, time delay relays, automatic control devices and check their function for correctness and response.

(c) The Sub-Contractor shall remedy any defects apparent on the installation prior to calling upon the Engineer to accept the plants.

E09.15 LABELLING AND IDENTIFICATION

All equipment shall be labelled and identified using white traffolite 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 manufacturers information concerning correct operation, etc, based on commissioning results.
- A description of the mode of operation of all systems.
- Diagrammic 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 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 plantroom and switchroom 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 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.

E09.18 MEASUREMENT AND PAYMENT

Item ..... **Unit**

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.

Item ..... **Unit**

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.

Item ..... **Unit**

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.

Item ..... **Unit**

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.

Item ..... **Unit**

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.

Item ..... **Unit**

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**

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

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.

Item ..... **Unit**

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.

Item ..... **Unit**

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.

Item ..... **Unit**

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.

Item ..... **Unit**

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.

Item ..... **Unit**

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.

Item ..... **Unit**

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.

Item ..... **Unit**

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.

Item ..... **Unit**

Terminate service connection cable ..... No

The unit of measurement shall be the number of service connection cable terminated.

The tendered rate shall include full compensation for the termination cable including all material and labour to render complete terminations of the cables.

Item ..... **Unit**

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.

Item ..... **Unit**

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.

Item ..... **Unit**

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.

Item ..... **Unit**

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.

Item ..... **Unit**

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.

Item ..... **Unit**

Supply and install connections to heaters, stoves, fans and airconditioners 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.

Item ..... **Unit**

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.

Item ..... **Unit**

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.

Item ..... **Unit**

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.

Item ..... **Unit**

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.

Item ..... **Unit**

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 conducts. Separate items shall be scheduled for the different types of conduit specified.

Item ..... **Unit**

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.

Item ..... **Unit**

Terminate conduit ..... No

The unit of measurement shall be the number of terminations made.

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.

Item ..... **Unit**

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.

Item ..... **Unit**

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.

Item ..... **Unit**

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.

Item ..... **Unit**

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.

Item ..... **Unit**

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.

Item ..... **Unit**

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.

Item ..... **Unit**

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.

Item ..... **Unit**

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.

PARTICULAR SPECIFICATION

E11: GENERAL ELECTRICAL EARTHING AND LIGHTNING PROTECTION

3	2012-05-30	Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance		
2	2010-05-03	Review Electrical Standards		
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**

City of Johannesburg
Johannesburg Water (SOC) Ltd

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 earthing and lightning protection to be installed under the contract. The purpose of an earthing and lightning protection system is to to protect personnel from harmful touch voltages, and personnel, electrical network, equipment and structures from destruction by direct lightning strikes. The designed and installed system should aim at eliminating or reducing the effects during a lightning strike.

E11.2 STATUATORY DOCUMENTS AND 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 shall be read in conjunction with this specification and shall be deemed to form part thereof:

E11.2.1 Standards

The earthing and lightning protection of all installations shall comply with the following standards and statutory requirements (as amended):

a) SANS 10198 The selection, handling and installation of electric power cables of rating not exceeding 33 kV

b) SANS 10313 The protection of structures against lightning

c) SANS 62305 Series

d) SANS 10142 Code of practice for the wiring of premises

e) SANS 10199 The design and installation of an earth electrode

f) Act 85/1993 Machinery and Occupational Safety Act

E11.2.2 Particular Specifications to be read in conjunction with this specifications

The following particular specifications shall be read in conjunction with the Project Specification:

- G01: PARTICULAR SPECIFICATION FOR COLOUR CODE
- G02: PARTICULAR SPECIFICATION FOR CORROSION PROTECTION
- E06: ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE INSTALLATION
- E05: LOW VOLTAGE POWER AND CONTROL CABLE
- E08: WIRING

E11.3 CERTIFICATE OF COMPLIANCE

The Contractor shall appoint an earthing and lightning protection specialist to perform resistance measurements. The obtained measurement/values shall form part of a certificate of compliance issued by the specialist, who shall be a professional Engineer, which shall contain:

- An evaluation of the obtained results;
- A statement that the earth network and earth electrode resistances are in accordance with the standards and requirements listed in Clause 11.2.1; and, if necessary;
- Details of areas of non-conformance in this regard.

Two copies of this certificate shall be submitted to the Engineer before handing over of any repair, modification or new installation involving earthing or lightning protection systems.

E11.4 GENERAL EARTHING

E11.4.1 Earthing Philosophy

The earthing philosophy is based on two broad principles:

- *Common Earth:* The installation shall make use of only one earth system. Every earth shall be bonded to the main plant earth.
- *Bonding:* All Equipment likely to be subjected to surge currents shall be securely bonded together and to the earth network.

E11.4.2 Common Earth

Unless otherwise specified herein, the installation shall make use of only one earth system. This implies the following:

- 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.
- All main distribution boards and sub distribution boards shall be connected to an earth bar that is connected to the main earth conductor.
- 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.
- Mains or “safety” earth networks and so called “clean” earth net-works shall be connected to each other, preferably somewhere outside the "clean" area.

E11.4.3 Bonding

E11.4.3.1 General

Bonding leads shall be short and shall run in straight or smoothly contoured routes. Items such as fences, pipes, cables and conduit shall be earthed at both ends. The following items shall all be securely bonded, in an electrically continuous manner, to the earth network:

E11.4.3.2 Earth busbars

All metal parts (e.g. enclosures, lighting masts, frames, steel columns, gates fencing, pipes, cable ladders and trays, roofs and steel reinforcing).

E11.4.3.3 Cable armouring and glands, cable screens and steel conduit shall all be bonded to the main system earth network.

E11.4.3.4 Earthing Electrodes

E11.4.3.5 Bonding Conductors

Unless otherwise specified herein, bonding shall be done by means of 16 mm², green PVC insulated, hard drawn, stranded copper conductor and terminated using crimping lugs or ferrules. As an antitheft measure, preference shall be given to alternative materials of equivalent effectiveness and approved by the Engineer.

E11.4.3.6 Lugs

Where the earth network is connected to the electrical system or bonded to structures, the earth or bonding conductor ends shall be fitted with lugs. The lugs shall be secured by means of a hydraulic compression crimping tool with hexagonal dies or by means of *brazing* or *silver*

soldering. **Dimple type indent crimping will not be acceptable.**

E11.4.3.7 Cable Armouring

At cable ends, the armouring shall be made off separately and be fitted with lugs. Armouring strands shall not be cut away to fit lugs. Cable armouring shall be bonded to the earth network at both ends of the cable.

E11.4.3.8 Cable Screens

Cable screens shall normally be bonded to the earth network at both ends of the cable. In cases where cable screens are used for signalling purposes (e.g. coaxial cables), the screens shall either not be earthed or earthed at one end only, depending on the application. If not specified, the screens shall be earthed at one end only. In addition, the cable shall either run inside earthed steel conduit or a separate earth conductor shall be installed alongside the cable.

Screens of 600/1000 V grade single core cables shall be earthed at one end only.

E11.4.3.9 Cable Ladders and Tray

Where there are breaks in the cable ladder or cable tray installation (e.g. at joints, bends or wall penetrations), the two sections shall be connected to each other. Both ends of cable ladder and cable tray runs shall be bonded to the earth network by means of 35 mm², stranded, bare copper conductor.

E11.4.3.10 Roofs

One 10 mm² bare copper conductor shall be installed over the full length of the ceiling void. This conductor shall be fixed to the top purlin and connected to the main earth conductor or earth bar of each distribution board. Conductive roof sections and gutters shall be connected to this conductor, at 15 m intervals, by means of 12 x 0, 8 mm copper strapping and galvanized bolts and nuts. Different roof levels and sections shall be bonded to each other.

E11.4.3.11 Non-conductive Wireways

Cables in PVC conduit or non-conductive sleeves shall be installed with stranded, bare copper earth conductors. These conductors shall be bonded to the earth network and other conductive items in the vicinity.

E11.4.4 Earthing of Substation Buildings

A substation copper earth bar, 50 mm x 6 mm x 600 mm, shall be fixed against the wall with cadmium bolts, in a suitably positioned cable duct, 200 mm above floor level. Ten holes of 10 mm diameter shall be provided in the earth bar.

All earth conductors shall be stranded copper conductors with crimped cable lugs. The following earth conductors shall be installed via the cable ducts:

- Two 70 mm^2 separate conductors, from the medium-voltage switchgear earth bar or earth bolt to the substation earth bar.
- One 70 mm conductor from every medium-voltage cable box and/or cable box stand.
- One 70 mm conductor from every low-voltage board/panel.

All double earth conductors shall be bound together neatly with plastic cable ties and be attached with the same bolt.

Only cadmium plated bolts and nuts shall be used for fixing earth conductors.

Final earthing shall be by means of three 70 mm^2 stranded copper conductors extending from the earth bar away from the substation, and installed in the ground in cable trenches, 900 mm deep and 50 m long and as close to 120° apart as possible. Furthermore, a 70 mm^2 bare copper earth conductor in a closed circuit around the substation building shall be installed at a depth of 900 mm and both ends shall be fixed together and to the earth bar.

After completion the subcontractor shall arrange for an earthing-resistance test to be carried out in the presence of the engineer. Any further earthing that may be required will be determined by the test results.

As an antitheft measure alternative materials to bare copper wire should be considered. Such alternatives must be proposed and approved by the engineer.

E11.4.5 Earthing of Miniature Substations and Transformers

The earth shall comprise of a 70 mm^2 bare copper earth conductor installed in a ring around the miniature substation base at a depth of 1 metre. 1,8 metre earth spikes shall be installed at each corner of the miniature substation and shall be connected to the earth installed around the miniature substation. Two further 70mm^2 bare copper earth conductors connected to the earth spike at each corner of the miniature substation shall be installed radially away from the miniature substation for a distance of six metres. A 1,8 metre earth spike shall be installed at the end of the radial earth conductors.

All earth conductors shall be terminated at the miniature substation, using crimped lugs securely bolted to the earth bar. The ends of the copper conductors shall be cleaned for a distance of 30 mm to obtain a good electrical contact with the lugs.

All earthing shall be done to the satisfaction of the engineer.

E11.4.6 Earth Continuity Conductors

Bare stranded copper earth continuity conductors shall be laid with all low-voltage cables from the miniature substations or main distribution board to the distribution kiosks and distribution boards. Crimped lugs shall be used for the termination of the earth conductors.

E11.4.7 Instrument Earth

In each motor control centre a separate instrument earth shall be provided. The instrument earth shall consist of a 50 mm x 6 mm x 600 mm solid copper earth bar which shall be fixed against the wall of the substation (above the cable trench) with cadmium bolts. Ten holes of 8 mm diameter shall be provided in the earth bar.

All earth conductors shall be green PVC insulated stranded copper conductors with crimped cable lugs. The following earth conductors shall be installed via the cable ducts:

- One 16 mm conductor from every instrument marshalling panel.
- One 16 mm conductor from every controller on PLC.
- One removable link (bolted) between the instrument earth bar and the substation earth bar.

Final earthing shall be as for substation earthing with the exception that the earth conductor shall be PVC covered up to the outside of the building and that the conductor size shall be 16 mm. The final earthing may share the same trench on condition that the two earths be separated by at least 400 mm.

After completion the contractor shall arrange for an earthing-resistance test to be carried out in the presence of the engineer.

E11.4.8 Earthing of Distribution Boards

The earth bar or earth terminal of distribution boards and Equipment shall be connected to the earth bar of the supplying distribution board in accordance with SANS 10142-1. These connections shall consist of bare, stranded copper conductors, installed along the same routes as the supply cables. If the supply connections consist of conductors in conduit, the earth conductors shall be installed in the same conduit.

Each earth bar shall be connected to the earth network by means of M8 lugs, brass bolts, nuts and locknuts. Unless otherwise specified herein, these connections shall be effected by means of 16 mm² copper earth conductor. Each earth conductor shall be connected to the busbar with its own bolt and nut.

E11.4.9 Earth Resistivity Test

Where specified in the Projection Specification, earth resistivity tests shall be carried out prior to the installation of the earthing installation by a Specialist Contractor and the results shall be submitted to the Engineer.

E11.4.10 Tests to be Carried Out

After completion the Contractor shall arrange for an earthing-resistance test to be carried out in the presence of the Engineer by a Specialist Contractor. Any further earthing that may be required will be determined by the test results.

The following are the maximum acceptable earth electrode resistances:

- Main substations - 1 ohm
- Miniature substations and kiosks - 2 ohms
- Highmasts - 5 ohms.

E11.5 GENERAL LIGHTNING PROTECTION

E11.5.1 Lightning Protection Philosophy

The lightning protection philosophy is based on sound earthing and the creation of relatively surge free areas. These areas will be referred to as protected areas.

E11.5.2 Earthing

The installation shall be earthed as specified above.

E11.5.3 Protected Areas

Main installations and subsystems shall be established as so-called protected areas. Protected areas shall be surrounded by a ring earth and all Equipment shall be bonded to the earth network as specified herein.

All cables crossing the barriers of the protected area into the unprotected environment shall be supplied with surge protection.

All conductive Equipment, such as pipes and fences, crossing the barriers of the protected area into the unprotected environment, shall be securely bonded to the earth network at the point of entry into the protected area.

E11.5.4 Surge Protection

Surge protection shall be provided to all power, data and communication cables entering or

leaving the protected area.

All types of surge protection utilized shall have a serviceability indication facility.

E11.5.5 Main Distribution Board

Course protection in the form of a high capacity 100KA surge arrester shall be installed at the main low voltage distribution board of the installation. All three phases, as well as neutral, shall be connected to earth via the arrester.

The surge arrester shall be solidly bonded to the distribution board earth bar by means of 16 mm² green insulated copper conductor and shall be as accessible as circuit breakers and other distribution Equipment fitted to the distribution board.

E11.5.6 Other Distribution Boards

Distribution boards, other than the main low voltage distribution board, feeding loads outside the protected area or being fed from outside sources, shall be supplied with 15kA overvoltage arresters. These arresters shall be installed between each phase and earth, as well as between neutral and earth.

Distribution boards, other than the main low voltage distribution board not feeding loads outside the protected area or being fed from outside sources, shall be supplied with 6.5kA overvoltage arresters. These arresters shall be installed between each phase and earth, as well as between neutral and earth.

The overvoltage arrester units shall be solidly bonded to the distribution board earth bar by means of 4 mm² green insulated copper conductor and shall be as accessible as circuit breakers and other distribution Equipment fitted to the distribution board.

Where use is made of more than one set of busbars in the same distribution board, all the busbar sets shall be provided with overvoltage arresters as specified herein.

E11.5.7 Data and Communication Cables

Data and communication cables entering or leaving the protected area shall be provided with suitable surge protection. The Contractor shall timeously submit detailed proposals of all surge and over-voltage protection Equipment to the Engineer for approval. The Contractor shall only utilise devices that are approved by TELKOM and which have levels of signal attenuation less than that specified as acceptable by the equipment manufacturer.

E11.5.8 Induced Surge

Cable sections between surge protection Equipment and the barrier of the protected area may induce surge currents in nearby cables and shall be regarded as being part of the unprotected environment. No other cables shall be installed in the same trench or wireways as these cables.

In addition, the following sets of cables, along parallel routes, shall not be installed closer than 500 mm from each other:

"Raw" power and UPS power cables.

Data/communication and mains power cables.

E11.5.9 Specific Surge Protection

The measures specified are aimed at generally limiting the impulse level to 1000 V. The Contractor shall ensure that all electrical and electronic Equipment will be suitable for continuous, reliable operation under these conditions and that all such Equipment is adequately

protected in accordance with their own withstand levels, whether such protection has been specified or not.

E11.6 MEASUREMENT AND PAYMENT

Item	Unit
Earthing of substation building	Sum

The tendered rate shall include full compensation for the supply of all material required and the installing of the earthing system and shall include for the testing of the earthing installation by a specialist contract.

Item	Unit
Earthing of miniature substations and transformers	Rate

The tendered rate shall include full compensation for the supply of the 70 mm□ bare copper conductor and lugs, the laying of the bare copper conductors, the termination of the conductors and the connection thereof to the earth bar.

Item	Unit
Supply and lay earth continuity conductors	m

The tendered rate shall include full compensation for the supply and laying of the specified earth continuity conductors.

Item	Unit
Terminating of earth continuity conductors	No

The tendered rate shall include full compensation for supplying all the material required to terminate and connect the earth continuity conductors and the connecting thereof to the earth bars in the miniature substations, main distribution boards, distribution kiosks and distribution boards.

Item	Unit
Extra over for the supply and installation of additional earth spikes of specified length including clamps for the connection of earth conductor	No

The tendered rate shall include full compensation for the supplying and installation of the earth spikes.

Item	Unit
Provision for additional earthing as required	Prov 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.

Item **Unit**

Provide an instrument earthing system ..... Sum

The tendered rate shall include full compensation for the supply of all material required and the installing of the instrument earthing system and shall include for the testing of the earthing by a specialist contractor.

Item **Unit**

Earth resistivity tests ..... No

The tendered rate shall include for the carrying out of the earth resistivity tests by a Specialist Contractor. The unit for measurement shall be per point where such tests have to be carried out.

Item **Unit**

Earth tests ..... No

The unit of measurement shall be the number of earth tests undertaken.

The tendered rate shall include full compensation for providing the equipment required to undertake the tests and the undertaking of the tests.

PARTICULAR SPECIFICATION

E12: ELECTRICAL MEDIUM VOLTAGE CABLES

2	2012-05-30	Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance		
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**

City of Johannesburg
Johannesburg Water (SOC) Ltd

PARTICULAR SPECIFICATION: VOLUME E12: ELECTRICAL MEDIUM VOLTAGE CABLES

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E12.1 INTRODUCTION

This specification covers the following:

- Medium Voltage (MV) cables for underground and surface installation.
- The type of MV cables that shall be used.
- The general requirements of the MV cables.
- The practice to be followed when storing, installing and testing the cables.

E12.2 SCOPE

E12.2.1 General

This specification details the requirements for single-core and three-core, MV cables. The preferred type of MV cable which is detailed in this specification is paper insulated lead covered steel wire armoured, electric cables with stranded annealed copper conductors, based on the requirements of SANS 97.

E12.2.2 Work to be included

The scope of work includes the supply, delivery, storage, laying and testing of MV cables prior to commissioning of plant and equipment.

The following is specifically included in the scope:

(a) Description of the MV cables required for the work.

(b) Marking and labelling of the cables and cable drums.

(c) Pre commissioning tests to be carried out on the cables.

E12.2.3 Work to be excluded

The following work and items are specifically excluded from the scope of work:

(a) All civil works

E12.3 STATUTORY DOCUMENTS AND STANDARDS

E12.3.1 Standards

The cables and their installation methods shall comply with the requirements of this specification including the relevant requirements of the following Acts, Codes of Practice and Standards:

a)	SANS 10142-1	Code of Practice for wiring of premises.
b)	BS 1433	Specification for copper for electrical purposes - Rod and bar
c)	SANS 97	Electric Cables – Impregnated paper-insulated metal-sheathed cables for rated voltages 3.3/3.3 kV to 19/33 kV.
d)	SANS 1507	Electrical cables with extruded solid dielectric insulation for fixed installations
e)	SANS 1411	Materials of insulated electric cables and flexible cords
f)	SANS 1520	Flexible electrical cables for use in mines
g)	IEC 173	Flexible cords

h) IEC 245 Rubber insulated cables

i) IEC 287 Current rating calculations

j) IEC 540 Insulation tests

k) VDE 0250 Standard for insulated wires and flexible cables

l) The Occupational Health and Safety Act (Act 85 of 1993)

m) The Mines Health and Safety Act (Act 78 of 1973)

n) The Minerals Act (Act 50 of 1991)

E12.3.2 Particular Specifications to be read in conjunction with this specifications

The following particular specifications shall be read in conjunction with the Project Specification:

- G01: PARTICULAR SPECIFICATION FOR COLOUR CODE
- G02: PARTICULAR SPECIFICATION FOR CORROSION PROTECTION
- E06: ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE INSTALLATION

E12.4 DEFINITIONS

PILC Cable	Single-core and three-core, paper insulated lead covered (PILC) – insulated, electric cables
Armour	A layer or layers of galvanized steel wires applied to the cable to provide mechanical protection or earth continuity, or both.
Sheath	A solid extruded protective covering applied as the exterior of a cable or a flexible cord.
Bedding	A layer of extruded compound applied to the cable beneath the armouring.
Core	A single insulated conductor without protective covering.

E12.5 CABLE REQUIREMENTS

E12.5.1 General

PILC cables shall comply with the requirements of SANS 97.

The following cable operating voltages (line voltage) shall apply:

- 11kV

The cores of three-core cables shall be identified by the colours Red, White and Blue (R, W, B).

E12.5.2 Specific Requirements of PILC Cables

E12.5.2.1 Voltage Frequency

The cable is needed for an underground, three phase, medium voltage, 50 hertz, alternating current distribution system.

E12.5.2.2 Core Screen

The core shall be individually screened. The core screen shall be strippable.

E12.5.2.3 Metal Sheath

The metal sheath shall comprise of pure lead.

E12.5.2.4 Bedding

A bitumass impregnated fibrous bedding complying with SANS 97 shall be provided.

E12.5.2.5 Armour

Double steel tape armouring in accordance with SANS 97.

E12.5.2.6 Outer Sheath (Serving)

An impermeable black PVC sheath in accordance with SANS 97 shall be provided.

E12.5.2.7 Conductors

The standard conductor shall be copper with cross-sectional areas as specified in Table 1:

1	2	3
Construction	**Rated voltage(kV)**	
	6.6	11
	Area (mm^2)	
3-core	25 35 50 70 95 120 150 185 240 300	25 35 50 70 95 120 150 185 240 300

E12.5.2.8 Cable Markings

Cables shall be legibly marked as specified in SANS 97, and shall also include the following:

(a) Conductor size in square millimetres

(b) Number of cores

(c) Conductor material (copper)

(d) The specification number (SANS 97) to which the cable has been manufactured.

(e) The year of manufacture

(f) A red stripe along the length of the outer sheath to indicate the relevant applications.

Typically marking – MAKE YEAR 6.6/11kV XXmm^2 x 3 Cu SANS 97

E12.6 MARKING, LABELLING AND PACKAGING

E12.6.1 Packaging

Cables shall be supplied on wooden drums.

Unless otherwise stated, standard drum lengths shall be 300m for all 3-core cables.

E12.6.2 Marking of drums

The marking of drums shall be in accordance with SANS 97.

The following information, in addition to that required in SANS 97, shall be provided:

(a) The specification number SANS 97;

(b) The type of armour;

(c) The order number or contract number;

(d) The outer sheath material.

E12.7 CABLE SIZING AND DE-RATING

For cable sizing and de-rating factors, refer to Annexure A, B and C.

E12.8 TESTING OF CABLES

The tests as specified in SANS 97, shall apply to all cables. Routine test certificates shall be supplied for each drum of cable supplied.

E12.9 QUALITY ASSURANCE

All cables supplied under the scope of works of this project shall be designed and manufactured under a quality control system, typically to SANS ISO 9000 series.

E12.10 MEASURE AND PAYMENT

All cables supplied under the scope of works of this project shall be designed and manufactured under a quality control system, typically to SANS ISO 9000 series.

Item	**Unit**
Supply and delivery of medium voltage paper insulated cable.....	m

The unit of measurement shall be the metre of cable supplied and installed.

The tendered rate shall include full compensation for the supply and delivery of the specified cable to the site.

City of Johannesburg
Johannesburg Water (SOC) Ltd

ANNEX A

GENERAL DATA FOR PILC SWA 11kV COPPER CABLES TO SANS 97

Conductor Area (mm^2)	Approx OD (mm)	Approx Weight (kg/km)	Impedance (Ω/km)	Ampere Rating		
				Ground	Duct	Air
25	31.38	4890	0.8779	105	90	105
35	33.64	5710	0.6371	130	110	125
50	33.49	6020	0.4751	160	135	165
70	36.50	7080	0.3365	195	165	200
95	39.33	8260	0.2499	235	200	245
120	41.73	9440	0.2053	265	225	280
150	44.36	10770	0.1739	295	250	315
185	47.42	12290	0.1481	335	280	360
240	52.14	14480	0.1245	380	325	415
300	56.15	16940	0.1106	425	365	470

ANNEX B

DERATING FACTORS FOR PILC SWA 11kV COPPER CABLES TO SANS 97

Table B1: Depth of laying – multicore PILC SWA cables

Depth of laying (mm)	Direct in ground		In single way ducts	
	Up to 300mm^2	Above 300mm^2	Single core	Multicore
500	1.15	1.15	1.15	1.15
600	1.10	1.10	1.10	1.10
800	1.00	1.00	1.00	1.00
1000	0.98	0.97	0.98	0.99
1250	0.96	0.95	0.95	0.97
1500	0.95	0.94	0.93	0.96
2000	0.92	0.90	0.90	0.94

Table B2: Variations of thermal resistivity of soil – single and multicore cables

Conductor size mm^2	Direct in ground				In single way ducts			
	Soil restivity, K.m/W				Soil restivity, K.m/W			
	1.0	1.5	2.0	2.5	1.0	1.5	2.0	2.5
25	1.06	0.93	0.85	0.78	1.03	0.96	0.91	0.86
35	1.06	0.93	0.85	0.78	1.03	0.96	0.90	0.85
50	1.07	0.93	0.84	0.77	1.03	0.96	0.90	0.85
70	1.07	0.93	0.84	0.77	1.03	0.96	0.90	0.85
95	1.07	0.93	0.84	0.77	1.03	0.95	0.89	0.84
120	1.07	0.92	0.83	0.76	1.03	0.95	0.89	0.83
150	1.07	0.92	0.83	0.76	1.04	0.95	0.89	0.83
185	1.07	0.92	0.82	0.75	1.04	0.95	0.88	0.82
240	1.07	0.92	0.82	0.75	1.04	0.95	0.88	0.82
300	1.07	0.92	0.82	0.74	1.04	0.95	0.87	0.82
400	1.07	0.91	0.81	0.74	1.04	0.94	0.86	0.81
500	1.08	0.91	0.80	0.72	1.05	0.94	0.84	0.78
630	1.08	0.91	0.79	0.72	1.05	0.94	0.84	0.78
800	1.08	0.90	0.79	0.71	1.05	0.93	0.83	0.77
1000	1.08	0.90	0.79	0.71	1.05	0.93	0.83	0.76

Table B3: Derating factors for grouping of multicore cables in horizontal formation in ground or ducts

No. of cables in group	In ground - Axial spacing (mm)					In ducts - Axial spacing (mm)			
	Touching	150	300	450	600	Touching	300	450	600
2	0.80	0.85	0.89	0.90	0.92	0.88	0.91	0.93	0.94
3	0.69	0.75	0.80	0.84	0.86	0.80	0.84	0.87	0.89
4	0.63	0.70	0.77	0.80	0.84	0.75	0.81	0.84	0.87
5	0.57	0.66	0.73	0.78	0.81	0.71	0.77	0.82	0.85
6	0.55	0.63	0.71	0.76	0.80	0.69	0.75	0.80	0.84

Table B4 Ground temperature derating factors

Maximum Conductor Temperature	Ground Temperatures (ºC)				
	25	30	35	40	45
70ºC	1.00	0.95	0.90	0.85	0.80
80ºC	1.00	0.96	0.92	0.88	0.83

Table B5 Air temperature derating factors

Maximum Conductor Temperature	Air Temperatures (ºC)			
	30	35	40	45
70ºC	1.00	0.94	0.87	0.79
80ºC	1.00	0.95	0.89	0.79

ANNEX C

SHORT CIRCUIT RATINGS FOR PILC SWA 11kV COPPER CABLES TO SANS 97

Table C1: Earth fault ratings

Conductor		Suspended conductor inception tempature	
		70ºC	80ºC
		Copper	Copper
Maximum Permissible Conductor Temperature	160ºC	0.115	0.107
	250ºC	0.154	0.148

Item No.	Cable Size	Fault Rating (1s) @ 160ºC	Fault Rating (1s) @ 160ºC
1	25	2.88	2.68
2	35	4.03	3.75
3	50	5.75	5.35
4	70	8.05	7.49
5	95	10.93	10.17
6	120	13.80	12.84
7	150	17.25	16.05
8	185	21.28	19.80
9	240	27.60	25.68
10	300	34.50	32.10

Item No.	Cable Size	Fault Rating (1s) @ 250ºC	Fault Rating (1s) @ 250ºC
1	25	3.85	3.70
2	35	5.39	5.18
3	50	7.70	7.40
4	70	10.78	10.36
5	95	14.63	14.06
6	120	18.48	17.76
7	150	23.10	22.20
8	185	28.49	27.38
9	240	36.96	35.52
10	300	46.20	44.40

PARTICULAR SPECIFICATION

E17: VARIABLE SPEED DRIVE (VSD) UNITS

3	2012-05-30	Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance		
2	2010-05-03	Review of Electrical Standards		
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**

City of Johannesburg
Johannesburg Water (SOC) Ltd

PARTICULAR SPECIFICATION : VOLUME E17 : VARIABLE SPEED DRIVES

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E17.1 SCOPE

This specification shall cover all variable speed drives to be designed, supplied installed and tested that shall drive any of the items of equipment to be supplied under the contract.

E17.2 INTERPRETATIONS

E17.2.1 Abbreviations

In this Specification the following abbreviations will apply:-

VSD : Variable Speed Drive
ANSI : American National Standards Institute
ASTM : American Society for Testing and Materials
BS : British Standards Institution
SANS : South African National Standards

E17.2.2 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 1222	Enclosures for electrical equipment (classified according to the degree of protection that the enclosure provides)
(b)	IEC 60 664 –1	Degree of Pollution – no condensation permitted during operation
(c)	EN 55011 (1991)	Electromagnetic Compatibility Emission - Class A
(d)	IEC 60 801-3 and EN61 000-4-3	Electromagnetic Compatibility Interference

E17.2.3 Particular Specifications to be read in conjunction with this specifications

The following particular specifications shall be read in conjunction with the Project Specification:

E04: PARTICULAR SPECIFICATION FOR MCC

E17.3 GENERAL REQUIREMENTS

(a) The VSD units shall be of a “vector control” type.

(b) The VSD units shall be specifically designed for those applications which require broader functionality and ability to ensure greater dynamic response than is normally available.

(c) The VSD units shall be provided with six programmable-isolated digital inputs. There shall be two scalable analog inputs (0V to 10 V, 0mA to 20 mA) which shall also be used as a $7^{th}/8^{th}$ digital input.

(d) The VSD units shall have two programmable analog outputs (0 mA to 20 mA).

(e) VSD units shall have three programmable relay outputs (30 V DC/5 A resistive load; 250V AC/2A inductive load)

(f) The VSD shall have low-noise motor operation due to high pulse frequencies.

(g) The VSD unit shall have complete protection for motor and inverter.

(h) The VSD units shall comply with the requirements of the EU low-voltage guideline.

(i) The VSD unit shall have the CE marking.

(j) All VSD units shall have the same interface, including a control panel, I/O connections and software, regardless of power rating, voltage or enclosure (IP rating).

(k) All VSD units shall be supplied with an internal Class A filter. The requirements are

fulfilled using shielded cables with maximum length of 25m.

(l) The VSD units shall be supplied with line commutating choke in line with EN61 000-3-2 regulations “Limits for harmonic currents with device input current < =16A per phase”.

(m) The maximum permissible motor cable lengths (shielded/unshielded) for a mains voltage of 380V to 400V are 150 m/ 225 m.

(n) The VSD units shall be supplied with output chokes.

(o) The VSD units shall be supplied with Basic Operator Panel (BOP) for parameterising the inverter.

(p) The unit shall have complete protection for motor and inverter.

(q) VSD units shall be supplied with mounting kits for installing the operator panels in the control cabinet doors

(r) The VSD units shall have the following communication modules PROFIBUS, DeviceNet, CANopen, MODBUS, MODBUSPLUS and ETHERNET.

E17.4 WORKING VOLTAGE AND SUPPLY SYSTEMS

(a) The following alternatives shall be available:

1 AC 200 V to 240 V +/- 10% constant torque 0.12kW to 3kW

3AC 200 V to 240 V +/- 10% constant torque 0.12 to 45kW variable torque 5.5 to 45kW

3AC 380 V to 480 V +/- 10% constant torque 0.37 to 200kW variable torque 75 to 250kW

3AC 500 V to 600 V +/- 10% constant torque 0.75 to 75kW variable torque 1.5 to 90kW

E17.5 ENVIRONMENTAL LIMITS

E17.5.1 Operating Temperature

	CT	VT
0.12kW to 75kW	-10°C to +122 °F (+14°F to 122 °F)	-10°C to +40 °F (+14°F to 104 °F)
90kW to 200kW (without derating)	0°C to +40 °C (+32°F to 104 °F)	

E17.5.2 Installation Altitude

0.12kW to 75kW	Up to 1000 m above sea level without derating
90kW to 200kW	Up to 2000 m above sea level without derating

E17.6 PROTECTION FUNCTIONS

The following protection functions shall be available:

Undervoltage
Overvoltage
Overload
Earth faults
Short-circuits
Stall prevention
Locked motor protection
Motor over temperature

Inverter over temperature parameter change protection.

E17.7 ASSEMBLY METHOD AND PROTECTION CLASS

VSD units in the power range from 0.75 to 110kW shall be wall mountable. Units with greater power may be available as freestanding units.
Wall mountable VSD units shall be available both IP54 and IP21 protection classes.
Wall mounted VSD units shall have IP21 protection class as a minimum in order to be installed against a wall or into a cabinet without any additional drip-water input terminal protection covers. IP20 is not acceptable.
Both IP21 and IP54 protection class VSDs shall have identical output current ratings.

E17.8 DOCUMENTATION

Technical details shall be delivered with the offered VSD unit:
User manual, describing step by step how to install, start up, trouble shoot and maintain the VSD
It shall be optionally possible to acquire multiple manuals together with a delivery unit.

Documents to be delivered per order:

a) Dimensional drawings (both AutoCAD and .pdf formats)
b) Customer connections and power wiring diagrams (both AutoCAD and .pdf formats).
c) Power losses and cooling air temperature (both in .xls and .pdf formats).
d) Manufactures statements on output currents available continuously in different ambient temperature up to 50°C. Type of product needed at 50°C continuous operations must be clearly listed.
e) Environmental product declaration according to life cycle assessment (LCA).

E17.9 MEASUREMENT AND PAYMENT

VSD units shall not be paid as a separate item in the Bill of Quantities. VSD unit form part of motor starter circuits and payment thereof shall be included in the price/s of motor control centres.

PARTICULAR SPECIFICATION

E18 : ELECTRICAL MINIATURE SUBSTATIONS

2	2012-05-30	Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance		
1	2009-05-12	Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance		
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City of Johannesburg
Johannesburg Water (SOC) Ltd

PARTICULAR SPECIFICATION : VOLUME E18 : ELECTRICAL MINIATURE SUBSTATIONS

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E18.1 SCOPE

This section covers the design, manufacture supply and delivery of distribution minisubstations.

E18.2 STATUATORY DOCUMENTS AND STANDARDS

E18.2.1 Standards

The minisubstations offered in terms of this specification shall comply with the requirements as set out in the detailed specification as well as the relevant sections of SANS 780:2004.

The units offered shall have the SANS mark of approval.

Any deviation from these conditions shall be clearly indicated, and any equipment so offered shall only be used with the express permission, in writing, of the engineer

The equipment offered and work performed, shall comply with the requirements of the governing occupational Health and Safety act, at time of tender.

The minisubstation shall be produced in a factory with ISO9000 rating and the applicable quality assurance standards.

a)	SANS 780	Distribution transformers
b)	SANS 1222	Enclosures for electrical equipment classified by IP code
c)	SANS 555	Unused and reclaimed mineral insulating oils for transformers and switchgear
d)	SANS 60529/IEC 529	Degrees of Protection Provided by Enclosures (IP Code)
e)	BSCP 1014	Protection of Electrical Power Equipment against Climatic Conditions
f)	SANS 61958	Indicating devices

E18.2.2 Particular Specifications to be read in conjunction with this specifications

The following particular specifications shall be read in conjunction with the Project Specification:

- G01: PARTICULAR SPECIFICATION FOR COLOUR CODE
- G02: PARTICULAR SPECIFICATION FOR CORROSION PROTECTION
- E06: ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE INSTALLATION
- E05: LOW VOLTAGE POWER AND CONTROL CABLES
- E08: WIRING

E18.3 ENVIRONMENTAL CONDITIONS

The minisubstations shall be suitable for use at full continuous rating, in terms of Paragraph 1.3 of the latest issue of SANS 780.

E18.4 CONSTRUCTION REQUIREMENTS

In addition to the requirements of SANS 780, the following shall also be considered:

E18.4.1 The miniature substations are intended for as self-contained distribution centres in wastewater treatment works and are to be mounted on side of road where possible. Therefore the compactness in design and a pleasing appearance is important

E18.4.2 The miniature substation roof (roof, walls and doors) shall be manufactured from metal and not from glass reinforced resin or other non-metallic substance.

E18.4.3 The colour of the miniature substation shall be an acceptable match to colour no. C12: Avocado Green to SANS 1091.

E18.5 MANUFACTURING

E18.5.1 Detailed drawings indicating the dimensions of miniature substation must be submitted.

E18.5.2 The factory inspection of the miniature substation shall be possible.

E18.6 MV COMPARTMENT

E18.6.1 MV Compartment for Type B Miniature Substation

In the MV compartment, an approved 11kV Ring Main Unit or equivalent ring main Tee-off fuse or circuit breaker switch unit shall be mounted, having the following characteristics:

The ring main unit shall comprise of an automatic fuse switch or air switch or circuit breaker switch controlling the transformer and, two non-automatic oil switches, controlling the ring main circuit, combined into one compact unit, with a common oil tank, suitable for indoor and outdoor use.

a) It must be possible to operate all the mechanisms from the front.

b) The operating handle shall have four positions, viz., ON - OFF and OFF – EARTH.

c) The operating handle is to be such that it must be relocated from the ON – OFF position to the OFF – EARTH position before the earthing switch can be closed

d) Clearly visible ON – OFF and OFF – EARTH indicators shall be provided and provision shall be made for locking the mechanisms by means of selector levers, preventing the insertion of the operating handle in any position.

e) All busbars and connections shall be immersed in oil.

f) All bushings shall be of the epoxy monobloc type.

g) An adjustable transformer thermal overload tripping scheme shall be provided whereby the ring main unit tee-off fuse switch shall trip. The scheme shall also include an emergency trip facility by means of a pushbutton located in the LV compartment.

E18.6.2 MV Compartment for Type A Miniature Substation

The MV compartment for the Type A mini-substation shall contain the following:

a) Four (4) mounting studs for fitting of a three-way or alternatively a four way “interswitch” on-load isolator. The high voltage cables connecting the above switchgear to the high voltage bushings shall also be supplied.

b) The minimum internal dimensions of the high voltage compartment to house a three-way or alternatively four-way on-load isolator shall be as indicated below:

Dimensions	Three-Way or Four-Way
Depth	560mm
Width	770mm
Height	1350mm

E18.6.3 Ratings

The continuous current rating of the Ring Main Unit shall not be less than 630A. The continuous

current rating of the Tee-Off fuse switch shall not be less than 90A with overload making capacity minimum 32.5kA. The short circuit rating shall be at least 350MVA at 11kV and:

a) The fuse switch shall be in accordance with BSS 2692.

b) The oil switch shall be in accordance wikth BSS 2631.

E18.6.4 Tee-off fuse switch

The operating mechanism of the Tee-Off fuse switch shall be of the fixed trip type, which ensures the full closure of the switch and full clearance of fault by the fuses before tripping the switch.

a) The fuse carriage must be so arranged that when the striker pin fuses are fitted, the operation of a fuse in any phase trips all the phases simultaneously. Conversely, if any one fuse is blown, then it shall not be possible to close the switch.

b) Manual tripping is to be provided by means of a pushbutton and not by using the operating handle.

c) Automatic shutters shall be provided, to safe-guard against inadvertent contact with “live”parts when the fuse carriage is removed.

d) The operating mechanism must me interlocked with the fuse carriage cover, to allow access to the fuse carriage only when the operating mechanism is in the OFF position.

e) The fuses and carriage shall be housed vertically in a separate compartment on the front of the unit. The fuse carriage design is preferred which would accept both 336mm and 254mm long by 64mm diameter HRC fuses.

f) One designation blank label shall be provided.

g) Fuses shall be fitted before delivery.

E18.6.5 Circuit breaker with overcurrent and earth fault relay

a) With reference to items 1 to 14, it is required that these miniature substations be supplied with at least 200A 11kV circuit breaker ring main units with overcurrent and earth fault protection relay switches or protection relay that has the same tripping curves as normal HRC MV fuses.

b) Manually operated mechanisms for cable and transformer switches are to be supplied as standard with an option that they can also be fitted with motor operation.

c) The circuit breaker system of protection shall not require an external power supply.

d) SF6 or vacuum circuit breakers shall be acceptable for this purpose although a virtually maintenance-free system with a high level of reliability is preferred.

e) This R.M.U. is required to be supplied with the following standard equipment:

- Earthing switches
- Operating mechanisms with integral mechanical interlocking
- Operating handle
- Facilities for padlocks on all switches functions
- Bushings for cable connection in front with cable cobvers.
- Manometer for SF6 pressure/density monitoring (where applicable).
- Lifting lug for easy handling.
- All units are designed for the subsequent fitting of an integral remote control and monitoring unit.
- Three way configuration.

f) All R.M.U. shall comply with NRS 006 and SANS 1874.

g) All R.M.U. operating, cable testing facilities cable terminating and indication devices must be fully accessible only from the front of the MV compartment.

h) The R.M.U. configuration shall be Switch Disconnector, Circuit Breaker and Switch Disconnector.

i) The cable boxes shall comply with NRS012 and shall require type 2 terminating clearances.

E18.6.6 Ring Main Isolators

The triple pole oil immersed contacts of the isolators shall be gang-operated by a spring assisted manual mechanism.

a) Integral cable test terminals shall be provided and shall only be accessible from the front of the unit when the switch is in the EARTH – TEST position. Interlocks shall be provided to ensure that the switch cannot be moved from the EARTH – TEST position when the test terminal cover is open. If alternative ring main units are offered, then one set of test prongs shall be supplied for each unit.

b) No cable end boxes are required. However, provision shall be made for the clamping of cross-linked polyethylene and PILC type cables by means of a split wooden block.

c) The size of cables used shall be 70mm^2, 3 core and 185mm^2 PILC. The clamps which must accept different sizes of cable shall be mounted approximately 600mm below the terminals.

d) Each isolator shall be provided with a designation white sandwich board label which shall be left blank.

E18.6.7 Oil

Oil shall be provided for all mini-substations. The grade of oil to be provided shall be as required per the SANS standards.

E18.6.8 Drawings

One set of drawings shall be supplied detailing:

a) Front, side and a plan elevation, the position of the cable entry in relation to the switchgear and the details for the supporting of the cross-linked polyethylene type or PILC.

b) All schematic drawings.

c) Concrete plinth with minimum required specifications.

E18.6.9 Finish

The ring main unit shall be painted as specified in E15.4.3.

E18.6.10 Fuses

The ring main unit shall be shall be supplied with suitably rated HRC striker pin fuses to suit the transformer rating size and voltage with dimensions of 254mm long by 63.5mm diameter. Fuses shall be fitted to the unit and not be supplied loose.

E18.6.11 Loose items

All maintenance tools and operating handles shall preferably be housed inside the front MV compartment cover of each ring main unit. An operating and maintenance manual with instructions shall be supplied.

The ring main unit shall be bolted to the steel base to form a integral unit with the miniature substation.

E18.7 LOW VOLTAGE SECTION

The low voltage section of the miniature substation shall be divided into two compartments. One compartment is to house LV circuit breakers or fuses and other compartment is to house

meters, miniature circuit breakers and street lighting control. Each compartment shall have a separate door with separate locking facilities. In the case of the Type A miniature substation, the fuses and street lighting control shall be in one compartment.

The following are the requirements:

E18.7.1 Low voltage circuit breaker compartment

a) The LV compartment of a Type B miniature substation shall consist of a mounting panel with a suitable unistrut utilising K-clamps for the cable from each outgoing circuit breaker at the bottom and a single earth/neutral bar above the unistrut. The unistrut shall be suitable to accept copper cables from 70mm^2 to 240mm^2.

b) Provision shall be made for outgoing circuits with triple pole moulded case circuit breakers or fuses with stub busbar connectors as shown in the schedule below. The space between the unitstrut and the bottom terminals of the circuit breakers shall be at least 550mm.

c) Class 3, 10VA current transformers to measure the transformer load.

d) Suitable rated Re, Yellow, Blue phase and Earth/;Neutral busbars to carry the full load of the transformer.

e) Three (3) x instantaneous and maximum demand indicating ammeters for total transformer load with a fifteen minute response time scaled for the CT ratio as shown in the schedule below. A 20% overscale shall be provided. The indicating needles of the ammeter shall have a common pivot.

f) A clear space of 70mm shall be allowed above the MCB for circuit labels.

g) The low voltage compartment for the Type A shall contain the following:

- Two support brackets with a fibre panel attached to it on the one side, including the mounting of the following equipment:
  - A minimum of 4 to 400A three-phase Henly or equivalent fuse units directly on the support brackets (including the neutral link).
  - Three maximum demand indicating ammeters on the fibre panel with current transformers, busbars and tails from the low tension bushing to the busbars.
- The fibre panel shall have sufficient open space to allow for mounting of street light control equipment if required.

h) 1 x 0 – 250V Voltmeter (industrial type) together with a selector switch shall be fitted. The selector switch must switch the voltmeter so that the various phase voltage can be measured. The panel layout shall be submitted when tendering.

i) No gland plate or unistrut is required for the Type A miniature substation.

Transformer Rating kVA	**Number and Size of circuit Breakers**	**Number of circuit for fuses**	**CT Ratio**
1000kVA	6 x 300A	6	1500/5
800kVA	5 x 300A	6	1200/5
630kVA	4 x 300A	6	1000/5
500kVA	5 x 250A	6	800/5
400kVA	4 x 300A	6	600/5
315kVA	4 x 250A	4	500/5
200kVA	3 x 175A	4	300/5

E18.7.2 Meter Compartment (if required when ordered)

a) The meter compartment shall have a separate set of busbars to carry a load of at least 400A. The busbars must be protected by means of a separate three phase circuit breaker within the low voltage compartment with the following kA ratings:

Transformer Rating kVA	**Fault Current**	**Circuit Breaker Size Size**
1000kVA	32.5kA	250A
800kVA	26.3kA	250A
630kVA	17.3kA	250A
500kVA	13.9kA	250A
400kVA	12.4kA	200A
315kVA	9.8kA	200A
200kVA	6.3kA	150A

b) Provision shall be made for mounting 24 single phase kWh meters and 24 miniature (curve 1) circuit breakers. The miniature circuit breakers shall be held in position by clip-trays. Provision shall be made to replace 12 single phase meters with 9 three phase kWh meters.

c) The kWh meters shall be supplied and installed after the delivery of the miniature substations.

d) The metal or masonite mounting plate shall be drilled and tapped and provided with 20mm long 3mm diameter screws for securing the meters to the mounting plate, or alternatively, screws with nuts in suitable clearance holes could be supplied.

e) The tenderer is to provide the wiring for the meter compartment. The wiring required shall consist of 24 x 16mm^2 copper conductors, coloured black, crimped into suitable lugs and bolted to the neutral busbar and 8 red, 8 yellow and 8 blue, 16mm^2 copper conductors shall be supplied from the 24 miniature circuit breakers to the meter positions.

f) The neutral wires shall be wired to each meter position. The coloured wires shall be wired to the 24 MCB's. Suitable labels marked 1 to 24 shall be fixed to the MCB and meter positions so that each MCB can indicate which meter is controlled. The ends of all wiring shall be taped up.

g) No wiring shall be provided from the load side of the ammeters. Wiring from the earth/neutral busbar shall be taken to the neutral terminal of each meter. All meter wiring shall be made with 16mm^2 PVC insulated copper conductor, bearing the SANS mark.

h) One combined neutral and earthing bar with mounting holes to accommodate 9 x 16mm^2 copper conductor and 1 x 35mm^2 minimum copper conductor each, shall be bolted to the mounting plate.

E18.7.3 Streetlighting Section (if required when ordered)

Provision for the following shall be made:

a) 3 x 30A MCB's

b) 60A Streetlighting contactor (AC 3)

c) 1 x 5A contactor coil MCB

d) Suitable two-way switch for manual/automatic streetlight control.

e) Terminals for streetlight control and power cable to take 16mm^2 copper conductors.

f) Complete set of wiring to CB's, streetlight control and terminals.

g) Mounting of a receiver.

E18.8 DOORS

All the doors shall be mounted on a suitable number of non-removable or hidden hinges.

All doors shall be fitted with locking mechanisms with provision for pad-locking. A suitable cover shall be fitted over the handles to prevent vandalism. The top of the cover shall be cut open and covered with expanded metal. Provision must be made for a night latch to be installed.

E18.9 COMPOSITION OF ENCLOSURE

The enclosure of the miniature substation shall be fabricated of mild steel and of suitable thickness for an application of this nature. Suitable reinforcing ribs shall be incorporated.

After manufacturing, the steel and welding shall be cleaned and passivated in accordance with the Code of Practice issued by the suppliers of the steel. Full details of proposals shall accompany the tender.

E18.10 DANGER NOTICES

The standard 100 x 150 mm embossed danger (WW7) and MV, LV notice shall be attached to each door. Cast aluminium notices are also acceptable. Painted labels shall not be acceptable.

Notices shall be fixed to the doors by means of brass rivets or other approved means.

E18.11 TESTS

Routine tests in accordance with SANS 780:2004 shall be performed.

The engineer reserves the right to witness such tests.

The results of these tests shall be made available to the engineer for his evaluation prior to acceptance and delivery of the minisubstations.

Type tests and special tests to SANS 780:2004 shall be performed on one minisubstation of the size to be delivered in terms of this contract unless the manufacturer can provide certificates of previous tests done on identical minisubstations.

Two copies of test results shall be provided to the engineer.

E18.12 TECHNICAL DATA AND DRAWINGS

Tenderers shall furnish the following drawings together with their tenders:

(a) Outline drawings of the minisubstations, with all fittings, showing the most important external dimensions.

(b) Details of MV and LV bushings

The successful tenderer shall provide three copies of each of the following drawings, to the engineer, before manufacturing may commence:

(a) GA drawings indicating the headroom necessary to remove the cores *in situ*

(b) Show the mass of the various components on the GA drawings

(c) The internal construction of the minisubstation and the arrangement of the windings, giving full particulars of insulation, as well as the bracing of the cores and windings.

(d) A diagram of the connections showing the exact manner in which the leads are taken from the tank, as well as the number of windings.

(e) Full technical details of all components.

E18.13 SOUND LEVEL

During design and manufacture of minisubstations, care should be exercised to limit minisubstation noise and vibration to within the parameters as recommended in SANS 780:2004.

E18.14 IDENTIFICATION TAGS

All data on the identification tags shall be in SI units.

E18.15 MEASUREMENT AND PAYMENT

Item	**Unit**
Supply, delivery and off-loading of minisubstations	No

The tendered rate shall include full compensation for the supply, delivery and off-loading of the minisubstations together with all other materials and ancillary equipment required to effect a complete installation.

Item	**Unit**
Installation, testing and commissioning of minisubstations	No

The tendered rate shall include full compensation for installing the minisubstations in the designed positions and for the testing and commissioning of the minisubstations.

The rate shall include for the installation of the control cables between the minisubstation and the switchgear and all auxiliaries and the connection thereof.

The rate shall include for the filling of the minisubstation with oil to the specified level, as well as the undertaking of any drying out process which may be required to ensure the minisubstations are ready for operation.

Item	**Unit**
Type tests and special tests of minisubstations	Sum

The tendered sum shall include full compensation to undertake special and type tests as required in the detailed specification. Each test shall be separately priced.

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

E21 : ELECTRICAL LIGHTING AND ILLUMINATION

Johannesburg Water (SOC) Ltd.
PO Box 61542
Marshalltown
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Revision 1

August 2019

City of Johannesburg
Johannesburg Water (Pty) Ltd

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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 luminaries).

(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 cabtyre 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 luminaries 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 ≥45°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

(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

(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 ≥ 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 ½ 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.

Item **Unit**

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.

Item **Unit**

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.

Item **Unit**

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.

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PARTICULAR SPECIFICATION

G01 : COLOUR CODING OF EQUIPMENT

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**

City of Johannesburg
Johannesburg Water (Pty) Ltd

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
Water, non-drinkable			
Cooling water	Brilliant Green		
Final treated effluent		White	
Recycled effluent		Black	Dark Violet
Air saturated effluent		Black	Dar Violet
Filtrate		Black	Aquamarine
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	-
Thickener overflow from:			
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

Contents of Pipeline	Basic Colour	Colour Coding Indicator	
		Single Band	Second Band
Treated effluent		Dark Violet	-
Dewatering liquors		Black	Ultramarine
Acids	Jacaranda		
Ferric chloride		Crimson	
Ferric sulphuric		Artic Blue	
Alkalis			
Lime Slurry	Dove Grey		
Gases			
Sludge gas	Light Stone	Jacaranda	
Steam	Pastel grey	Aluminium	Clad/lagging
Nitrogen	Light Stone	Black	Light Grey
Hydrogen	Light Stone	Black	Signal Red
Methane (digested)	Light Stone	Turquoise Blue	
Carbon dioxide	Light Stone	Light Grey	
Chlorine/Hypochloride	Canary Yellow		
Oxygen	White		
Compressed Air	Artic Blue		
Ventilated Air	Artic Blue		
Vacuum Air	Artic Blue		
Instrument Air	Artic Blue		
Sludges			
Anaerobically digested	Middle Brown	Maroon	
Anaerobically digested: thickened		Maroon	Light Grey
Raw Sludge	Dark Violet		
Lime treated	Dark Brown	Dove grey	
Primary	Dark Brown	Crimson	
Primary thickened	Dark Brown	Crimson	
Digester supernatant liquor	Middle Brown	Salmon Pink	
Activated : mixed liquor	Royal Blue	Canary Yellow	
Activated : gravity thickened	Royal Blue	Canary Yellow	Dark Violet
Activated : return sludge	Royal Blue	Canary Yellow	Middle Brown
Activated : DAF overflow/float	Royal Blue	Canary Yellow	Turquoise Blue
Activated : primary	Royal Blue	Canary Yellow	Crimson
Activated : digested	Royal Blue	Canary Yellow	Maroon
Activated : waste	Royal Blue	Canary yellow	
Pasteurised	Light Brown		
Oil			
Diesel oil	Black	White	
Hydraulic oil	Golden brown	Salmon Pink	
Lubricating	Golden brown	Brilliant Green	
Transformer	Golden brown	Crimson	
Other Liquids			
Polyelectrolyte	Golden Yellow	Jacaranda	
Cooling liquid	White		

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 paining 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 panting application shall be included for and the surface preparation, transporting of equipment to and fore from the applicator shall be included for. No separate measurement item shall be included for the application of these coatings.

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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

M17: MECHANICAL ACTUATOR EQUIPMENT

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 local control station with a selector switch for local/off/remote pad-lockable in any of the positions shall be part of each control if a remotely mounted valve control station is not available.

In remote control the actuator shall be controlled by externally open/close/stop contacts.

The contacts for this control are voltage-free. The inputs of these signals must be separated from the control by opto-cupplers in the actuator.

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:
        - Open
        - Closed
        - Remote selection
    - Inputs from an external source for:
        - Open
        - Closed

b) For all modulating valves, the following interfacing must be provided:
    - Potential free N/O contacts for:
        - Open
        - Closed
        - Remote selection
    - An active 4 – 20 mA output from the valve, to be supplied to an external load of max 500Ω.
    - 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 devise 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 ±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, ad 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 relief 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 until 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 intension 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 guarantee 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 call 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

Rev	Date	Description	Signature: JW Wastewater Partnership	Signature: Approval from Johannesburg Water
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3	2012-07-30	General review	T Wellard	
2	2010-02-16	General review	J Ritchie	
1	2009-05-12	Review of Mechanical / Electrical and Control / Instrumentation Standards, plus New Design Guidance		

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 Jointing Material

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 Contact between Dissimilar Metals

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 General

(a) Marking of Valves

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) By-passes

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) Hand wheels and Direction of Closure

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. Vales 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 ASTMA 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 ± 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 nitrite 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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Volume	1	2	3	4	Part	T1	T2	C1	C2	C3	C4

Johannesburg Water SOC Ltd

Johannesburg Water

CONTRACT NO. JW13504

BUSHKOPPIE WASTEWATER TREATMENT WORKS

RECTIFICATION OF CONTRACT JW13504 – CONSTRUCTION OF A BALANCING TANK THROUGH MIXERS (15 MIXERS) REDESIGN AND REINSTALLATION, AND REINSTATEMENT OF ASSOCIATED ANCILLARIES

VOLUME 1

PART 2: PRICING DATA

Volume	1	2	3	4	Part	T1	T2	C1	C2	C3	C4

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Employer:		Contractor:	
Witness:		Witness:	

Volume	1	2	3	4	Part	T1	T2	C1	C2	C3	C4

C2 PRICING DATA

C2.1 PRICING INSTRUCTIONS

C2.1.1 GENERAL PREAMBLE TO THE BILL OF QUANTITIES (CIVIL ENGINEERING WORKS)

a) 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.

b) 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 Specifications. Variations and amendments to the Project Standard Specifications are contained in the Scope of Work, Portion 2: Variations and/or Additions to the Project Standard Specifications.

c) 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.

d) 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.

e) Unless otherwise stated, items are measured net in accordance with the drawings, and no allowance is made for waste.

f) 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 Employer’s Agent 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. The Contractor must not order the quantities of materials stated in the Bill of Quantities until he has confirmed from the Construction Drawings or measurement on Site that such quantities are in fact the correct quantities.

g) 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.

h) 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 or rates in the Schedule.

Employer:		Contractor:	
Witness:		Witness:	

Volume	1	2	3	4	Part	T1	T2	C1	C2	C3	C4

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)
m^2	=	square metre	No.	=	number
m^2 pass	=	square metre pass	sum	=	lump sum
ha	=	hectare	MN	=	mega-newton
m^3	=	cubic metre	MN.m	=	mega-newton-metre
m^3km	=	cubic metre-kilometre	PC sum	=	Prime Cost sum
l	=	litre	Prov sum	=	Provisional sum
kl	=	kilolitre	%	=	percent
MPa	=	megapascal	kW	=	kilowatt
W/day	=	Workday	R/only	=	Rate only

i) 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 1200.

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.

j) 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.

k) While the Employer has every intent to complete the full scope of works, the Employer reserves the right to reduce of increase the scope of works according to the dictates of the budget, or to terminate this contract, with adjustment to the agreed rates, sums or fees and without payment of any penalty in this regard. The Service Provider shall however be entitled to pro-rata payment for all services carried out in terms of any adjustment to the Scope of Work or, in the case of termination, remuneration and/or reimbursement.

l) The Bill of Quantities shall be completed by hand in INK or TYPED. The Bill of Quantities in the tender document may be replaced with the typed electronic Bill of Quantities, without changing the quantities, items and description.

Employer:		Contractor:	
Witness:		Witness:	

C2.1.2 Sufficiency of tender

The Contractor shall be deemed to have satisfied himself before tendering as to the correctness and sufficiency of his Tender for the construction of the Works and of the rates and prices, which rates and prices shall, except in so far as it is otherwise provided in the Contract, cover all his obligations under the Contract and all matters and things necessary for the proper execution and completion of the Works.

C2.1.3 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.

C2.1.3.1 Applicability of payment items

All payment items forming part of this Contract shall not apply to ordered Works completed by the Contractor under this Contract, where completed Works:

- are not completed to acceptable quality;
- are not issued by the Employer's Agent;
- are still within the defects and liability period; or
- are not accepted by the Employer's Agent or his duly authorised representative.

C2.1.3.2 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:

1. clearly state this in his qualifications; and

2. 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.

C2.1.3.3 Working outside normal hours

The additional costs, if any, to perform works outside normal working hours shall be deemed to have been allowed for in the provided activity pricing rates and/or prices.

C2.1.3.4 Materials and equipment

C2.1.3.4.1 Materials

The Employer shall not provide any materials, as this shall be provided by the Contractor and deemed to have been included in the various provided rates and prices.

C2.1.3.4.2 Equipment

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

C2.1.3.4.3 Damage to materials provided by the Employer

Where the Contractor or public damage any materials, provided by the Employer, whilst in the care of the Contractor, he shall immediately report such damage, arrange for the replacement and all replacement costs shall be at his expense.

C2.1.3.5 Permits and way-leaves

All associated costs to obtain permits and way-leaves 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.

C2.1.3.6 Locating existing services

The cost to locate existing services shall be included in the various works activity pricing rates and/or prices, including any excavations required and the provision and use of service detection personnel and equipment. Identified existing services shall be suitably marked at regular intervals for reference purposes.

C2.1.3.7 Confined space

The Contractor shall note that a portion of the work will be executed within confined spaces and it shall be deemed that allowance has been made in all provided activity pricing rates and/or prices.

C2.1.3.8 Concrete

Descriptions (prices) of concrete work shall be deemed to include the design of concrete mixes and all testing of concrete and materials other than compressive strength testing of concrete samples from concrete being placed in the works (the Contractor shall only be entitled to payment for those samples and compressive strength tests called for by the Employer's Agent or his duly authorized representative and which pass the test requirements), handling and depositing (by hoisting or lowering) concrete in the forms, working and packing concrete around reinforcement, all "construction joints" other than "designated joints" as defined in SANS 1200G which are given separately, shaping tops of components as required and striking off and curing.

Descriptions (prices) of concrete in surface beds cast in panels shall be deemed to include formwork, fillets and the like in forming the panels.

C2.1.3.9 Formwork

Formwork is measured to the net surfaces of concrete to be supported, except at intersections of beams with beams, columns, walls, etc. and tops of columns with slabs, beams, etc. where no deductions have been made and descriptions (prices) shall be deemed to include use and waste, except where the formwork is of a

permanent nature or is to be left in, fitting together to all required shapes, all cutting, intersections, cambering where required, holes for rods, bolts, pipes and the like, propping, maintaining, keeping damp whilst the concrete is being deposited and removing of formwork.
Formwork "left in" and permanent formwork shall be deemed to include leaving in formwork, props, etc.

Descriptions (prices) of formwork to soffits shall be deemed to include propping not exceeding 3.5m high unless otherwise described. Descriptions (prices) of formwork to walls and columns shall be deemed to be not exceeding 3.5m high above bearing level unless otherwise described.

Descriptions (prices) of formwork to soffits of solid slabs shall be deemed to be to slabs not exceeding 300mm thick unless otherwise described.

C2.1.3.10 Smooth formwork

Descriptions (prices) shall be deemed to include for rubbing off all projections at seams etc. after removal of the formwork, making good any defects with 2:1 cement mortar and leaving a smooth surface with all arises slightly rounded, all to the satisfaction of the Employer's Agent or his duly authorized representative.

C2.1.3.11 Reinforcement

Descriptions (prices) for all steel reinforcement to concrete shall be deemed to include cutting and waste, bending, hooked ends, binding at lappings and intersections with annealed wire, all as above described, hoisting or lowering and maintaining in position whilst the concrete is being deposited and cover blocks and spacers in accordance with the relevant SANS Codes of Practice.

C2.1.3.12 Precast concrete

Descriptions (prices) of precast concrete shall be deemed to include reinforcement required for manufacturing, handling and erection purposes, steel rod or wire loop hooks and/or mortices for Lewis bolts required for handling and transporting, any necessary temporary propping and strutting, bedding, jointing and pointing.

C2.1.3.13 Testing

The cost of testing of the ordered Works shall be included in the various applicable Works items. In particular those:

- clearly intended by or provided for in the specifications.
- involving testing or tests to ensure that the design of the whole of the Works or any part of the Works is appropriate for the purpose which it was intended to fulfil.

No additional or separate payment for testing shall be entertained by the Employer.

C2.1.3.14 Cost of samples

All samples shall be supplied by the Contractor at his own cost unless the supply thereof is clearly intended in the specifications or Bill of Quantities to be at the cost of the Employer. Payment shall not be made for samples which do not comply with the specifications.

C2.1.3.15 Failure to submit reports and associated visual media

The Contractor's payment certificate shall be accompanied by confirmation from the Employer's Agent or his duly authorised representative then at items listed for payment have been successfully executed and/or delivered as required. Failure to obtain such confirmation from the Employer's Agent or his duly authorised representative shall result in non-payment of the Contractor's payment certificate until the default has been corrected or the deemed incomplete items are excluded from the payment certificate.

C2.1.3.16 Payment ONLY for works completed

The Contractor shall note that payment shall only be made for Work activities successfully (delivering the end result) executed, complying with the quality requirements and provided to the Employer's Agent or his duly authorized representative.

C2.1.3.17 Training

The Contractor is required to provide training on all equipment installed during the installation and commissioning periods of the contract. Pricing shall make adequate provision for the training of the Employer's delegated staff members.

C2.1.3.18 Maintenance

Pricing shall include for attendance to maintenance items in accordance with the requirements of the contract conditions and specifications.

C2.1.3.19 Disposal of existing equipment

Pricing shall provide allowance for the successful disposal of all redundant and obsolete equipment indicated for removal from the facility.

C2.1.3.20 Certificate of Compliance

Pricing shall provide allowance for the issuing of the relevant Certificates of Compliance for the installation(s) at the facility. One certificate of compliance is required per electrical distribution board completed, and the certificate shall cover all downstream works.

C2.1.4 SMME Portion of the Works

A particular portion of the works has been allocated for completion by an appointed SMME, as per the Scope of Works. These items are marked with "SC" and the "Amount" Column has been crossed out. These items must not be priced by the Contractor. An indicative provisional sum for all the SC-marked items has been allowed for in the Preliminary and General items.

The Main Contractor shall retain liability and responsibility for the management, scheduling, and quality control of all works performed by the sub-contractors. After appointment of the Main Contractor, Johannesburg Water will supply the Main Contractor with a list of SMMEs which the Main Contractor can approach to provide rates for the items marked with SC in the Bill of Quantities. The Main Contractor will be expected to conduct a competitive process to recommend a Sub-Contractor or Sub-Contractors to Johannesburg Water. Johannesburg Water will then evaluate all rates provided by the Sub-Contractor for fairness. Johannesburg Water will then either a) approve the appointment of the Sub-Contractor or Sub-Contractors or b) enter into negotiations with the Main Contractor and sub-contractor / s or c) request that the Contractor recommend a different sub-contractor.

Further an allowance has been made for the contractor to complete the following tasks:

Employer:		Contractor:	
Witness:		Witness:	

Volume	*1*	2	3	4	Part	*T1*	T2	C1	**C2**	C3	C4

- The Contractor shall ensure that the Subcontractor(s) complies with the paying all amounts due in respect of his employees and himself in terms of all relevant legislation and regulations including, but not confined to, the
    - Income Tax Act, the
    - Compensation for Occupational Injuries and Diseases Act,
    - Unemployment Insurance Act,
    - Basic Conditions of Employment Act
- Monitoring of the Quality of Work completed by the Sub-contractor/SMME
- Skills transfer during the execution of the project
- Compliance with all aspects of the Scope of Work
- Assistance with sourcing of applicable material in line with the technical data sheets

Further an allowance has been made for “Training” – this is related to CETA accredited training which is to be agreed with the Employer during project execution. No amount can be claimed under this item for on-site or on-the-job training, only for accredited training which the SMME receives.

Employer:		Contractor:	
Witness:		Witness:	

Volume	***1***	2	3	4	**Part**	*T1*	T2	C1	**C2**	C3	C4

BILL OF QUANTITIES

Contract JW13504

Bushkoppies Wastewater Treatment Works

BALANCING TANK REINSTATEMENT

Contents **Page No.**

SUMMARY OF BILL OF QUANTITIES PD.4
SCHEDULE 1 : PRELIMINARY & GENERAL PD.5- PD.7
SCHEDULE 2 : MECHANICAL PD.8 - PD.9
SCHEDULE 3 : ELECTRICAL PD.10

SUMMARY OF SCHEDULE OF QUANTITIES	
DESCRIPTION	**AMOUNT**
SCHEDULE 1: PRELIMINARY & GENERAL **SCHEDULE 2: MECHANICAL ENGINEERING WORKS** **SCHEDULE 3: ELECTRICAL ENGINEERING WORKS**	
SUB TOTAL 1	
ADD: 15% of above sub-total (2) for **VALUE ADDED TAX (VAT)**	
TOTAL CARRIED TO FORM OF OFFER	

SCHEDULE 2 : PRELIMINARY & GENERAL						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
1	**SANS 1200A**	**SCHEDULE 1 : PRELIMINARY & GENERAL**				
1.1	**8.3**	**SCHEDULED FIXED-CHARGE AND VALUE RELATED ITEMS**				
1.1.1	8.3.1	Contractual Requirements	Sum	1.00	R -	R -
1.1.2	8.3.2	Establishment of Facilities on Site				
1.1.3	8.3.2.1	Facilities of the Engineer				
1.1.5		c) Nameboard (1 No.)	Sum	1.00	R -	R -
1.1.6		d) Survey Assistant, Equipment and Materials	Sum	0.00	R -	R -
1.1.7	8.3.2.2	Facilities for Contractor:				
1.1.8		a) Offices and storage sheds(Incl. Fencing)	Sum	1.00	R -	R -
1.1.9		b) Workshops	Sum	1.00	R -	R -
1.1.12		e) Ablution and latrine facilities	Sum	1.00	R -	R -
1.1.13		f) Tools and equipment	Sum	1.00	R -	R -
1.1.14		g) Water supplies, electric power and communications	Sum	1.00	R -	R -
1.1.15		h) Dealing with water (see clause 5.5 of SANS1200A)	Sum	1.00	R -	R -
1.1.16		i) Access (see clause 5.5 of SANS1200A)	Sum	1.00	R -	R -
1.1.17		j) Plant (Construction Equipment)	Sum	1.00	R -	R -
1.1.18	8.3	Other Fixed-charge Obligations				
1.1.19		a) Compliance with the Health & Safety Specification and Plan	Sum	1.00	R -	R -
1.1.20		b) Compliance with the Environmental Management Plan	Sum	1.00	R -	R -
1.1.21		c) Quality Control plan and compliance	Sum	1.00	R -	R -
1.1.22		d).....				
1.1.25	8.3.4	Removal of Site Establishment (Facilities of the Engineer and Contractor)	Sum	1.00	R -	R -
1.2	**8.4**	**SCHEDULED TIME-RELATED ITEMS**				
1.2.1	8.4.1	Contractual Requirements	Sum	1.00	R -	R -
1.2.2	8.4.2	Operation and Maintenance of Facilities on Site for the Duration of Construction, except where otherwise stated				
1.2.3	8.4.2.1	Facilities for Engineer				
1.2.4		c) Nameboard (1 No.)	Sum	0.00		R -
1.2.5		d) Survey Assistant, Equipment and Materials	Sum	0.00	R -	R -
1.2.6	8.4.2.2	Facilities for Contractor:				
1.2.7		a) Offices and storage sheds	Sum	1.00	R -	R -
1.2.8		b) Workshops	Sum	1.00	R -	R -
1.2.9		e) Ablution and latrine facilities	Sum	1.00	R -	R -
1.2.10		f) Tools and equipment	Sum	1.00	R -	R -
1.2.11		g) Water supplies, electric power and communications	Sum	1.00	R -	R -
1.2.12		h) Dealing with water (see clause 5.5 of SANS1200A)	Sum	1.00	R -	R -
1.2.13		i) Access & Security control (see clause 5.5 of SANS1200A)	Sum	1.00	R -	R -
1.2.14		j) Plant (Construction Equipment INCLUDING CRANAGE)	Sum	1.00	R -	R -
1.2.15	8.4.3	Supervision for Duration of Construction	Sum	1.00	R -	R -
		TOTAL CARRIED FORWARD				

SCHEDULE 2 : PRELIMINARY & GENERAL						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
		TOTAL BROUGHT FORWARD				
1.2.16	8.4.4	Company and Head Office Overhead Costs for the Duration of the Contract	Sum	1.00		
1.2.17	8.4.5	Other Time-related Obligations				
1.2.18		a) Compliance with the Health & Safety Specification and Plan	Sum	1.00		
1.2.19		b) Compliance with the Environmental Management Plan	Sum	1.00		
1.2.20		c) Quality Control plan and compliance	Sum	1.00		
1.2.21		d)……..				
1.2.22		e)……..				
1.3	**8.5**	**SUMS STATED PROVISIONALLY BY EMPLOYER'S AGENT**				
1.3.1		Allow a provisional sum for materials control testing and Factory Acceptance Tests of Equipment ordered by the Engineer	P.Sum	1.00	R 80,000.00	R 80,000.00
1.3.2		Appointment of Project CLO for duration of Contract Period	P.Sum	1.00	R 174,825.00	R 174,825.00
1.3.3		Provision of Maintenance Spares	P.Sum	1.00	R 100,000.00	R 100,000.00
1.3.4		SCADA Integration programming / troubleshooting	P.Sum	1.00	R 50,000.00	R 50,000.00
1.3.5		Contractor's stated commission on the 1.3.1 to 1.3.4 provisional sum a	%		R 404,825.00	
1.4	**8.7**	**DAYWORKS (Provisional)**				
1.4.1		Labour:				
1.4.2		a) Foreman	hour	40.00		
1.4.3		b) Skilled	hour	40.00		
1.4.4		c) Semi-skilled	hour	40.00		
1.4.5		d) Unskilled	hour	40.00		
1.4.6		e) Surveyor with transport, instruments and labour	hour	16.00		
1.4.7		Plant:				
1.4.8		a) Front loader (CAT 930 [75 kW] or similar)	hour	40.00		
1.4.9		b) Tip truck:				
1.4.10		2) 6m³	hour	16.00		
1.4.11		c) TLB	hour	16.00		
1.4.12		d) Plate compactor	hour	16.00		
1.4.13		e) Generator and Breaker	hour	40.00		
1.4.14		f) Min of 25 Ton crane inclusive of a rigging study for double handling of equipment	hour	40.00		
1.4.15		Materials:				
1.4.16		a) Supplied by the Contractor under Dayworks	P.Sum	1.00	R 50,000.00	R 50,000.00
1.4.17		b) Contractor's stated commission on the 1.4.16 provisional sum ab	%		R 50,000.00	
1.5	**8.6**	**CONTRACTORS DOCUMENTATION FOR ALL EQUIPMENT UNDER THIS SCOPE OF WORKS** *The cost shall include for the preparation, submission and acceptance by the Engineer and shall be broken down as follows:* *• 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*				
		TOTAL CARRIED FORWARD				

SCHEDULE 2 : PRELIMINARY & GENERAL						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
		TOTAL BROUGHT FORWARD				
1.5.1		**Mechanical Equipment**				
1.5.1.1		Operations and Maintenance Manuals	Sum	1.00		
1.5.1.2		As-Built or Record Drawings	sum	1.00		
1.5.2		**Electrical Equipment**				
1.5.2.1		Operations and Maintenance Manuals	Sum	1.00		
1.5.2.2		As-Built or Record Drawings	sum	1.00		
1.5.3		**Control, Instrumentation, Security and Fire Protection**				
1.5.3.1		Operations and Maintenance Manuals	Sum	1.00		
1.5.3.2		As-Built or Record Drawings	sum	1.00		
1.6	**8.4.5**	**DEFECTS LIABILITY PERIOD**				
1.6.1		Serving and/or Maintenance Call-out / Visit of equipment during the Defects Liability Period	Trips	4.00		
		TOTAL OF SCHEDULE 1 CARRIED FORWARD TO SUMMARY				

SCHEDULE 2: MECHANICAL						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
2		**SCHEDULE 2: MECHANICAL**				
		SURFACE MOUNTED MIXERS FOR BALANCING TANK				
2.1		**Decommission, dismantle, removal and Storage on site the Existing Equipment, Associated steelwork or ancillaries**				
2.1.1		15 kW Mixer Assembly (including gearbox, motor, shaft, impellers, baseplates and ancillaries). **Total dry weight is 969kg per unit**	No.	15.00		
2.2		**Mixer Rectification - Engineering Design**				
2.2.1	PSY6.16.2	Detailed Design Professional Services fees	sum	1.00		
2.2.2		Computational Fluid Dynamic (CFD) modelling and simulation to confirm mixer design as per specification requirements.	sum	1.00		
2.2.3		Report compilation (incl. mixer drawings) and submission to JW for approval	sum	1.00		
	M05	**New Mixer Assembly**				
2.2		**Fabricate, Corrosion Protection, Colour Code, Supply, Deliver and Store (if required) with QA and/or O&M Documentation**				
2.2.1	E01.27	15kW 3-ph,4P,50HZ 400V IE3, Flange mounted, Cast Iron Motor	No.	0.00		RATE ONLY
2.2.2	M08.18.2	**15kW Gearbox (SF>2.25), from Cast Iron and output speed of 37RPM complete with:** *1) Input/output shaft* *2) Oil drain pipe, valve and plug in 316S/S* *3) Oil-level sight glass tube / gauge* *4) Mounting fasteners to both baseplate and motor*	No.	0.00		RATE ONLY
2.2.3		**SAF2205 Supper Duplex S/S** Mixer Shaft with end flanges and axial impeller mounting with MAX **length=4800mm AND 200mmDia. Shaft**	No.	0.00		RATE ONLY
2.2.4		**316L S/S** Mixer Impellers **Radial=4-5W/m3** with flange mounting AND with tip speed of **less than 2.5m/s (dia. Less than**	No.	0.00		RATE ONLY
2.2.5		**Cast iron / MS epoxy** coated Mixer Shaft and gearbox coupling	No.	0.00		RATE ONLY
2.2.6		MS Painted Mixer Raised/Elevated Base Plate (must allow gearbox oil draining)	No.	0.00		RATE ONLY
2.2.7		316 S/S Mixer Base Plate Holding Down Studs, washers and Bolts (Anchor) **M20X300** to Concrete platform Jacking bolts **(x4 set per Base Plate Mixer)**	No.	0.00		RATE ONLY
2.2.8		Mixer flange shaft fastener set in **316S/S studs, washers, nuts (x8 set per flange)**	No.	0.00		RATE ONLY
2.3		**SURFACE MOUNTED MIXERS FOR BALANCING TANK** **Strip and Quote for Rectification of Mixers (Drive Unit and Impeller)**				
2.3.4		**Service Overhaul for 11kW SEW Eurodrive Electric Motor - Major servicing labour (adjustments/setting of components, cleaning of motor internals, filters, condensation drain etc.) for motor (at over 10,000 operating hrs). Scope shall include but not limited:** **1) Relining of brake linings per motor** **2) Replacement of switch contacts per motor** **3) Replace rolling bearing(s) per motor** **4) Replace seals per motor** **5) Replace grease lubrication (70g per motor)**				
2.3.4,1		Strip and Quote	No.	15.00		
2.3.4,2		Clean	No.	15.00		
2.3.4,3		Bake	No.	15.00		
		TOTAL CARRIED FORWARD				

SCHEDULE 2: MECHANICAL						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
		TOTAL BROUGHT FORWARD				
2.3.4,4		Rewind	No.	15.00		
2.3.4,5		Replace rolling bearing(s) per motor	No.	15.00		
2.3.4,6		Replace Fan	No.	15.00		
2.3.4,7		Replace Fan Cover	No.	15.00		
2.3.4,8		Balance rotor	No.	15.00		
2.3.4,9		Balance fan	No.	15.00		
2.3.4,10		Replace Fasteners	No.	15.00		
2.3.4,11		Replacement of switch contacts per motor	No.	15.00		
2.3.4,12		Replace Shaft	No.	15.00		
2.3.4,13		Replace Terminal Boxes	No.	15.00		
2.3.4,14		Replace Terminal Blocks	No.	15.00		
2.3.4,15		Replace seals per motor	No.	15.00		
2.3.4,16		Shot-blast and re-coat motor housing including reinstatement of weather-hood, fasteners replacement (if required)	No.	15.00		
2.3.4,17		Replace Couplings	No.	15.00		
2.3.4,18		Reassembly and Transportation to Site	No.	15.00		
2.3.5		**Major Service Overhaul for 11kW SEW Eurodrive RF137 Speed Reducer (Gearbox)**				
2.3.5,1		Strip and Re-assemble for refurbishment : **Gearbox**	No.	15.00		
2.3.5,2		Major servicing labour (adjustments/setting of components, cleaning internals, etc.) for motor (**at over 10,000 operating hrs**). The scope shall include: 1) External fasteners replacement 2) Machining of gears and reloading the sealed for-life grease 3) All perishable seals, rubber buffer, and gaskets to be a replacement 4) Oil level gauge replacement 5) Drain plug, breather valve, valve and pipe replacement 6) Replacement of bearings incl. flexible bushing.	No.	15.00		
2.3.5,3		Replacement of Cam ring / Coupling ring	No.	15.00		
2.3.5,4		Shot-blast and re-coat motor housing including reinstatement of weather-hood, fasteners replacement	No.	15.00		
2.3.5,5		Gearbox lubrication Oil 100% fill-up compliant with gearbox OEM specification including labour and handling and testing	Litres	300.00		
2.3.6		**Modification and/or Replacement of Mixer Impeller**				
2.3.6.1		Strip and Re-assemble for refurbishment : **Shaft and Impeller**	No.	15.00		
2.3.6.2		Procure material (304L Stainless Steel) and Manufacture of Mixer Impeller as per new design per impeller (including fasteners)	No.	15.00		
2.3.7		**Major Service Overhaul for Cornell 12NHTM-F18DB- Pump**				
2.3.7,1		Strip and Re-assemble for refurbishment : **Pumps**	No.	4.00		
2.3.7,2		Major servicing labour (adjustments/setting of components, cleaning of motor internals, filters, condensation drain etc.) for motor (**at over 10,000 operating hrs**). Scope shall include: 1) Replacement of tyre coupling between motor and pump shaft 2) Repaired of mechanical seal 3) Lubrication of drive shaft 4) Inspect ball bearing and lubricate 5) Replacement bearing sets	No.	4.00		
		TOTAL CARRIED FORWARD				

SCHEDULE 2: MECHANICAL						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
		TOTAL BROUGHT FORWARD				R -
2.3.8	PSY6.16	**Major Service Overhaul for WEG 280SM-55kW-6P-380V Motor** Major servicing labour (adjustments/setting of components, cleaning of motor internals, filters, condensation drain etc.) for motor (**at over 10,000 operating hrs**). Scope shall include: 1) Relining of brake linings per motor 2) Replacement of switch contacts per motor 3) Replace rolling bearing(s) per motor 4) Replace seals per motor 5) Replace grease lubrication (70g per motor)				
2.3.6,1		Strip and Quote	No.	4.00		
2.3.6,2		Clean	No.	4.00		
2.3.6,3		Bake	No.	4.00		
2.3.6,4		Rewind	No.	4.00		
2.3.6,5		Replace rolling bearing(s) per motor	No.	4.00		
2.3.6,6		Replace Fan	No.	4.00		
2.3.6,7		Replace Fan Cover	No.	4.00		
2.3.6,8		Balance rotor	No.	4.00		
2.3.6,9		Balance fan	No.	4.00		
2.3.6,10		Replace Fasteners	No.	4.00		
2.3.6,11		Replacement of switch contacts per motor	No.	4.00		
2.3.6,12		Replace Shaft	No.	4.00		
2.3.6,13		Replace Terminal Boxes	No.	4.00		
2.3.6,14		Replace Terminal Blocks	No.	4.00		
2.3.6,15		Replace seals per motor	No.	4.00		
2.3.6,16		Shot-blast and re-coat motor housing including reinstatement of weather-hood. fasteners replacement (if required)	No.	4.00		
2.3.6,17		Replace Couplings	No.	4.00		
2.3.6,18		Reassembly and Transportation to Site	No.	4.00		
2.4	**M05.19.3**	**Handle and Install** *NB. Contractor shall make allowance for Rigging/lifting, positioning, hold down bolts preparation, grouting, drilling and breaking to mount the equipment assembly to the concrete floor where required including all tools & equipment required*				
2.4.1		Complete New 15kW Mixer Assembly Installation	No.	0.00		RATE ONLY
2.4.2		Complete Assembly and Installation of 11kW refurbished Mixer assembly	No.	15.00		
2.4.3		Complete Sewer Pumps Re-assembly and Installation	No.	4.00		
2.5	**M05.19.3**	**Testing, Commission and Handing over to End-user**				
2.5.1		Complete New 15kW Mixer Assembly Installation	No.	0.00		RATE ONLY
2.5.2		Complete Assembly and Installation of 11kW refurbished Mixer assembly	No.	15.00		
2.5.3		Complete Sewer Pumps	No.	4.00		
2.6		**Provisional Sums as stated by the Employer's Agent**				
2.6.1		Supply, and installation of **15kW Mixer Assembly**	P.sum	1.00	R 3,600,000.00	R 3,600,000.00
2.6.2		Contractor's stated commission on the 2.6.1 provisional sum above	%		R 3,600,000.00	
2.7	PSY6.16.7	**Mechanical Commissioning Spares**				
2.7.1		Cornell 12NHTM-F18DB- Pump - Impeller	No.	1.00		
2.7.2		Cornell 12NHTM-F18DB- Pump - Impeller Lock Screw and Setscre	No.	1.00		
2.7.3		Cornell 12NHTM-F18DB- Pump - Wearing Rings	No.	2.00		
2.7.4		Mixer Drive Coupling Set	No.	4.00		
		TOTAL OF SCHEDULE 2 CARRIED FORWARD TO SUMMARY				

SCHEDULE 3: ELECTRICAL - MIXER AMD PUMPSTATION POWER SUPPLY & CONTROL CABLES						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
3		**SCHEDULE 3: ELECTRICAL - MIXER AMD PUMPSTATION POWER SUPPLY & CONTROL CABLES**				
3.1		**Design Selection, Procure, Fabricate/Manufacture, Corrosion Protection, Colour Code, Supply, Deliver and Store (if required) with QA and/or O&M Documentation**				
3.1.1	**E05.9**	**LV Power Cable - 600/1000V Cu/PVC/PVC/SWA/PVC**				
3.1.1.1		4 Core , 185mm²	m	0.00		RATE ONLY
3.1.1.2		4 Core , 16mm²	m	0.00		RATE ONLY
3.1.1.3		4 Core , 10mm²	m	0.00		RATE ONLY
3.1.1.4		4 Core , 4mm²	m	0.00		RATE ONLY
3.1.2	**E06.7**	**LV Power Cable-600/1000V Cu/PVC/PVC/SWA/PVC-Terminations**				
3.1.2.1		4 Core , 185mm²	No.	0.00		RATE ONLY
3.1.2.2		4 Core , 16mm²	No.	0.00		RATE ONLY
3.1.2.3		4 Core , 10mm²	No.	0.00		RATE ONLY
3.1.2.4		4 Core , 4mm²	No.	0.00		RATE ONLY
3.1.3	**VOL 6**	**Control Cables - CU/XLPE/IND+OVERALL SCR/SWA/PVC**				
3.1.3.1		7 core, 2.5 mm²	m	0.00		RATE ONLY
3.1.3.2		Fibre optionc cabling	m	0.00		RATE ONLY
3.1.4	**VOL 6.6**	**Control Cables - CU/XLPE/IND+OVERALL SCR/SWA/PVC-Terminations**				
3.1.4.1		7 core, 2.5 mm²	No.	0.00		RATE ONLY
3.1.4.2		Fibre optionc cabling	No.	0.00		RATE ONLY
3.2	PSY6.16	**Replacement of PLC equipment (including programming intergration of unit)**				
3.2.1		PLC I/O modules - Digital Input 16 Channel	No.	2.00		
3.2.2		Ethernet Switch replacement	No.	2.00		
		Scheider M580 PLC unit	No.	1.00		
3.3	PSY6.16	**Instrumentation Recalibration and Repair**				
3.3.1		Ultrasonic level meter	No.	3.00		
3.3.2		Gearbox Oil flow switch **(procure new)**	No.	15.00		
3.3.3		Proximity switches (valve limit switches)	No.	4.00		
3.3.4		No-flow switch	No.	4.00		
3.3.5		Electrical Actuated Valve ("AUMA")	No.	2.00		
3.3.6		Local Control stations	No.	15.00		
3.3.7		55kW VSD drive unit	No.	4.00		
3.4	PSY6.16	**General Equipment Repair / Servicing**				
3.4.1		500kVA Minisub	sum	1.00		
3.4.2		MCC and Pump station ventilation (1kw fan size)	No.	1.00		
3.4.3		Pump Station submersible pump	No.	1.00		
3.4.4		MCC Servicing panel (cleaning) (Refer Single line diagram)	sum	1.00		
		Testing and repair of fibre optic hardware	sum	1.00		
3.5		**Provisional Sums as stated by the Employer's Agent**				
3.5.1		Supply, and installation of **LV power cables**	P.sum	1.00	R 274,000.00	R 274,000.00
3.5.2		Supply, and installation of **Control cables**	P.sum	1.00	R 64,000.00	R 64,000.00
3.5.3		Supply, and installation of **Upgrade of MCC Motor starters**	P.sum	1.00	R 70,474.50	R 70,474.50
3.5.4		Contractor's stated commission on the 3.5.1 to 3.5.3 provisional sum ab	%		R 408,474.50	
3.5		**Overall Handling, Installation, Testing and Commissioning (as noted above)**	sum	1.00		
		TOTAL CARRIED FORWARD				

SCHEDULE 3: ELECTRICAL - MIXER AMD PUMPSTATION POWER SUPPLY & CONTROL CABLES						
ITEM No.	PAYM. REFERS	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
		TOTAL CARRIED FORWARD				
		Electrical and Control & Instrumentation Commissioning Spares				
3.6	PSY6.16.7	**11kW SEW Eurodrive Electric Motor - Mixer Bucket Spares**				
3,6,1		F1 - Elsec X	No.	3.00		
3,6,2		F2 - Overload Relay	No.	3.00		
3,6,3		H1 - Indication Lamp (Green)	No.	3.00		
3,6,4		H3 - Indication Lamp (Red)	No.	3.00		
3,6,5		H2 + H4 - Indication Lamp (Yellow)	No.	3.00		
3,6,6		H5 - Indication Lamp (White)	No.	3.00		
3,6,7		K1 - Contactor	No.	3.00		
3,6,8		K12- K16 - Relay	No.	3.00		
3,6,9		K18T - Timer	No.	3.00		
3,6,10		P1 - Ammeter	No.	3.00		
3,6,11		Q1 - Circuit Breaker	No.	3.00		
3,6,12		Q1 - Circuit Breaker Varidepth Operating Handle Complete	No.	3.00		
3,6,13		Q2 + Q3 - Circuit Breaker	No.	3.00		
3,6,14		S1 - Stop Pushbutton	No.	3.00		
3,6,15		S2 - Start Pushbutton	No.	3.00		
3,6,16		S3 - 3 Pos Selector Switch	No.	3.00		
3,6,17		S4 - 2 Pos Selector Switch	No.	3.00		
3,6,18		S5 - Reset Pushbutton	No.	3.00		
3,6,19		T1 - Current Transformer	No.	3.00		
3,6,20		T2 - Transcore	No.	3.00		
3.6	PSY6.16.7	**WEG 280SM-55kW-6P-380V Motor - Pump Bucket Spares**				
3,6,1		F1 - Elsec X	No.	1.00		
3,6,2		F2 - Overload Relay	No.	1.00		
3,6,3		H1 - Indication Lamp (Green)	No.	1.00		
3,6,4		H3 - Indication Lamp (Red)	No.	1.00		
3,6,5		H2 + H4 - Indication Lamp (Yellow)	No.	1.00		
3,6,6		H5 - Indication Lamp (White)	No.	1.00		
3,6,7		K1 - Contactor	No.	1.00		
3,6,8		K12- K16 - Relay	No.	1.00		
3,6,9		K18T - Timer	No.	1.00		
3,6,10		P1 - Ammeter	No.	1.00		
3,6,11		Q1 - Circuit Breaker	No.	1.00		
3,6,12		Q1 - Circuit Breaker Varidepth Operating Handle Complete	No.	1.00		
3,6,13		Q2 + Q3 - Circuit Breaker	No.	1.00		
3,6,14		S1 - Stop Pushbutton	No.	1.00		
3,6,15		S2 - Start Pushbutton	No.	1.00		
3,6,16		S3 - 3 Pos Selector Switch	No.	1.00		
3,6,17		S4 - 2 Pos Selector Switch	No.	1.00		
3,6,18		S5 - Reset Pushbutton	No.	1.00		
3,6,19		T1 - Current Transformer	No.	1.00		
3,6,20		T2 - Transcore	No.	1.00		
3.7	E021	**Balancing Tank MCC and Pump Station Lighting Replacement**				
3.7.1		58W FLUORESCENT LUMINAIRE - Replacement with LED	No.	2.00		
3.7.2		58W WATER PROOF FLUORESCENT LUMINAIRE - Replacement with LED	No.	2.00		
3.7.3		58W WATER PROOF FLUORESCENT LUMINAIRE WITH 1 HOUR BATTERY BACKUP - Replacement with LED	No.	2.00		
		TOTAL OF SCHEDULE 3 CARRIED FORWARD TO SUMMARY				

Volume	*1*	2	3	4	Part	*T1*	T2	C1	**C2**	C3	C4

SUMMARY OF BILL OF QUANTITIES

SUMMARY OF BILL OF QUANTITIES

DESCRIPTION	AMOUNT
SCHEDULE 1: PRELIMINARY & GENERAL	**R**
SCHEDULE 2: MECHANICAL ENGINEERING	**R**
SCHEDULE 3: ELECTRICAL - MIXER AMD PUMPSTATION POWER SUPPLY & CONTROL CABLES	**R**
Sub Total 1	**R**
THE ABOVE PRICES ARE FIRM	
ADD: 15% of above sub-total (1) for **VALUE ADDED TAX (VAT)**	**R**
TOTAL CARRIED TO FORM OF OFFER	**R**

DATE **SIGNATURE OF TENDERER**

Employer:		Contractor:	
Witness:		Witness:	