



**THIKA WATER AND SEWERAGE COMPANY
LIMITED
(THIWASCO)**

TENDER NO: THIWASCO/049/2020-2022

**REPAIRS, SERVICING AND MAINTAINANCE OF
PUMPS, MOTORS AND GENERATORS**

**MANAGING DIRECTOR
THIKA WATER AND SEWERAGE COMPANY LTD,
P.O. BOX 6103 - 00100, THIKA – KENYA.**

(2020-2022)

CLOSING DATE: 10TH NOVEMBER 2020 AT 11.00AM

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Tender REF No. (THIWASCO/049/2020-2022

**Tender name: (REPAIRS SERVICING AND
MAINTAINANCE OF PUMPS, MOTORS AND GENERATORS**

- 1.1 The 1.1 Thika Water and Sewerage Company Ltd (THIWASCO) invites sealed tenders from eligible candidates for repairs, servicing and maintenance of pumps, motors and generators .
- 1.2 Interested eligible candidates may obtain further information from and inspect the tender documents at **(Thika Water and Sewerage Company located along Haile Selassie Road near Chania Falls)** during normal working hours during normal working hours.
- 1.3 A complete tender document may be obtained by interested candidates upon payment of a non- refundable fee of *kshs. 1,000.00* **(THIKA WATER AND SEWERAGE COMPANY LTD, EQUITY BANK ACCOUNT:0090294392028, EQUITY PLAZA, THIKA BRANCH). Tender documents code-027** or download the tender documents free of charge from the Thika Water and Sewerage Company Ltd Website www.thikawater.co.ke. Bidders who download the documents from the website MUST also forward their particulars immediately for records via email to procurement@thikawater.co.ke.
- 1.4 Prices quoted should be net inclusive of all taxes and delivery costs, must be expressed in Kenya shillings and shall remain valid for a period of (120) days from the closing date of the tender.
- 1.1 Completed tender documents are to be enclosed in plain sealed envelopes, marked with the tender number and be deposited in the tender box provided at **(our offices near the Procurement office or if by post to be addressed to:
Managing Director,
Thika Water and Sewerage Company,
P O Box 6103 - 01000,
Thika.
So as to be received on or before Tuesday, 29th November 2020 at 11.00am**
- 1.5 Tenders will be opened immediately thereafter in the presence of the tenderers representatives who choose to attend the opening at **Thika Water and Sewerage Company Ltd Main Offices near Blue Post Hotel.**

SECTION II – INSTRUCTIONS TO TENDERERS

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SECTION II INSTRUCTIONS TO TENDERERS

2.1 Eligible tenderers

- 2.1.1. This Invitation to tender is open to all tenderers eligible as described in the instructions to tenderers. Successful tenderers shall provide the services for the stipulated duration from the **date** of commencement (hereinafter referred to as the term) specified in the tender documents.
- 2.1.2. The procuring entity's employees, committee members, board members and their relative (spouse and children) are not eligible to participate in the tender unless where specially allowed under section 131 of the Act.
- 2.1.3. Tenderers shall provide the qualification information statement that the tenderer (including all members, of a joint venture and subcontractors) is not associated, or have been associated in the past, directly or indirectly, with a firm or any of its affiliates which have been engaged by the Procuring entity to provide consulting services for the preparation of the design, specifications, and other documents to be used for the procurement of the services under this Invitation for tenders.
- 2.1.4. Tenderers involved in corrupt or fraudulent practices or debarred from participating in public procurement shall not be eligible.

2.2 Cost of tendering

- 2.2.1 The Tenderer shall bear all costs associated with the preparation and submission of its tender, and the procuring entity, will in no case be responsible or liable for those costs, regardless of the conduct or outcome of the tendering process.
- 2.2.2 The price to be charged for the tender document shall not exceed Kshs. 5,000/=
- 2.2.3 The procuring entity shall allow the tenderer to review the tender document free of charge before purchase.

2.3 Contents of tender documents

- 2.3.1. The tender document comprises of the documents listed below and addenda issued in accordance with clause 6 of these instructions to tenders

- i) Instructions to tenderers
- ii) General Conditions of Contract
- iii) Special Conditions of Contract
- iv) Schedule of Requirements
- v) Details of service
- vi) Form of tender
- vii) Price schedules
- viii) Contract form
- ix) Confidential business questionnaire form
- x) Tender security form
- xi) Performance security form
- xii) Principal's or manufacturers authorization form
- xiii) Declaration form

2.3.2. The Tenderer is expected to examine all instructions, forms, terms, and specifications in the tender documents. Failure to furnish all information required by the tender documents or to submit a tender not substantially responsive to the tender documents in every respect will be at the tenderers risk and may result in the rejection of its tender.

2.4 Clarification of Documents

2.4.1. A prospective candidate making inquiries of the tender document may notify the Procuring entity in writing or by post, fax or email at the entity's address indicated in the Invitation for tenders. The Procuring entity will respond in writing to any request for clarification of the tender documents, which it receives no later than seven (7) days prior to the deadline for the submission of tenders, prescribed by the procuring entity. Written copies of the Procuring entities response (including an explanation of the query but without identifying the source of inquiry) will be sent to all prospective tenderers who have received the tender documents"

2.4.2. The procuring entity shall reply to any clarifications sought by the tenderer within 3 days of receiving the request to enable the tenderer to make timely submission of its tender

2.5 Amendment of documents

2.5.1. At any time prior to the deadline for submission of tenders, the Procuring entity, for any reason, whether at its own initiative or in response to a clarification requested by a prospective tenderer, may modify the tender documents by issuing an addendum.

2.5.2. All prospective tenderers who have obtained the tender documents will be notified of the amendment by post, fax or email and such amendment will be binding on them.

2.5.3. In order to allow prospective tenderers reasonable time in which to take the amendment into account in preparing their tenders, the Procuring entity, at its discretion, may extend the deadline for the submission of tenders.

2.6 Language of tender

2.6.1. The tender prepared by the tenderer, as well as all correspondence and documents relating to the tender exchanged by the tenderer and the Procuring entity, shall be written in English language. Any printed literature furnished by the tenderer may be written in another language provided they are accompanied by an accurate English translation of the relevant passages in which case, for purposes of interpretation of the tender, the English translation shall govern.

2.7 Documents Comprising the Tender

The tender prepared by the tenderer shall comprise the following components:

(a) A Tender Form and a Price Schedule completed in accordance with paragraph 9, 10 and 11 below.

(b) Documentary evidence established in accordance with Clause 2.11 that the tenderer is eligible to tender and is qualified to perform the contract if its tender is accepted;

(c) Tender security furnished is in accordance with Clause 2.12

(d) Confidential business questionnaire

2.8 Form of Tender

2.8.1 The tenderers shall complete the Form of Tender and the appropriate Price Schedule furnished in the tender documents, indicating the services to be performed.

2.9 Tender Prices

2.9.1 The tenderer shall indicate on the Price schedule the unit prices where applicable and total tender prices of the services it proposes to provide under the contract.

- 2.9.2 Prices indicated on the Price Schedule shall be the cost of the services quoted including all customs duties and VAT and other taxes payable:
- 2.9.3 Prices quoted **by** the tenderer shall remain fixed during the term of the contract unless otherwise agreed by the parties. A tender submitted with an adjustable price quotation will be treated as non-responsive and will be rejected, pursuant to paragraph 2.22.
- 2.9.4 Contract price variations shall not be allowed for contracts not exceeding one year (12 months)
- 2.9.5 Where contract price variation is allowed, the variation shall not exceed 10% of the original contract price.
- 2.9.6 Price variation requests shall be processed by the procuring entity within 30 days of receiving the request.

2.10 Tender Currencies

- 2.10.1 Prices shall be quoted in Kenya Shillings unless otherwise specified in the appendix to Instructions to Tenderers

2.11 Tenderers Eligibility and Qualifications.

- 2.11.1 Pursuant to Clause 2.1 the tenderer shall furnish, as part of its tender, documents establishing the tenderers eligibility to tender and its qualifications to perform the contract if its tender is accepted.
- 2.11.2 The documentary evidence of the tenderers qualifications to perform the contract if its tender is accepted shall establish to the Procuring entity's satisfaction that the tenderer has the financial and technical capability necessary to perform the contract.

2.12 Tender Security

- 2.12.1 The tenderer shall furnish, as part of its tender, a tender security for the amount and form specified in the Invitation to tender.
- 2.12.2 The tender security shall be in the amount not exceeding 2 per cent of the tender price.
- 2.12.2 The tender security is required to protect the Procuring entity against the risk of Tenderer's conduct which would warrant the security's forfeiture, pursuant to paragraph 2.12.7

2.12.3 The tender security shall be denominated in a Kenya Shillings or in another freely convertible currency and shall be in the form of:

- a) A bank guarantee.
- b) Cash.
- c) Such insurance guarantee approved by the Authority.
- d) Letter of credit

2.12.4 Any tender not secured in accordance with paragraph 2.12.1 and 2.12.3 will be rejected by the Procuring entity as non responsive, pursuant to paragraph 2.20

2.12.5 Unsuccessful tenderer's security will be discharged or returned as promptly as possible but not later than thirty (30) days after the expiration of the period of tender validity prescribed by the procuring entity.

2.12.6 The successful tenderer's tender security will be discharged upon the tenderer signing the contract, pursuant to paragraph 2.29, and furnishing the performance security, pursuant to paragraph 2.30.

2.12.7 The tender security may be forfeited:

(a) If a tenderer **withdraws** its tender **during** the period of tender validity specified by the procuring entity on the Tender Form; or

(b) In the case of a successful tenderer, *if* the tenderer fails:

(i) to sign the contract in accordance with paragraph 30

or

(ii) to furnish performance security in accordance with paragraph 31.

(c) If the tenderer rejects, correction of an error in the tender.

2.13 Validity of Tenders

2.13.1 Tenders shall remain valid for 60 days or as specified in the invitation to tender after date of tender opening prescribed by the Procuring entity, pursuant to paragraph 2.18. A tender valid for a shorter period shall be rejected by the Procuring entity as nonresponsive.

2.13.2 In exceptional circumstances, the Procuring entity may solicit the Tenderer's consent to an extension of the period of validity. The request and the responses thereto shall be made in writing. The tender security provided under paragraph 2.12 shall also be suitably extended. A tenderer may refuse the request without forfeiting its tender security. A tenderer granting the request will not be required nor permitted to modify its tender.

2.14 Format and Signing of Tender

2.14.1 The tenderer shall prepare two copies of the tender, clearly / marking each "ORIGINAL TENDER" and "COPY OF TENDER," as appropriate. In the event of any discrepancy between them, the original shall govern.

2.14.2 The original and all copies of the tender shall be typed or written in indelible ink and shall be signed by the tenderer or a person or persons duly authorized to bind the tenderer to the contract. All pages of the tender, except for unamended printed literature, shall be initialed by the person or persons signing the tender.

2.14.3 The tender shall have no interlineations, erasures , or overwriting except as necessary to correct errors made by the tenderer, in which case such corrections shall be initialed by the person or persons signing the tender.

2.15 Sealing and Marking of Tenders

2.15.1 The tenderer shall seal the original and each copy of the tender in separate envelopes, duly marking the envelopes as "ORIGINAL" and "COPY." The envelopes shall then be sealed in an outer envelope. The inner and outer envelopes shall:

(a) be addressed to the Procuring entity at the address given in the invitation to tender

(b) bear, tender number and name in the invitation to tender and the words: "DO NOT OPEN BEFORE(day, date and time of closing),"

- 2.15.3 The inner envelopes shall also indicate the name and address of the tenderer to enable the tender to be returned unopened in case it is declared “late”. —
- 2.15.4 If the outer envelope is not sealed and marked as required by paragraph 2.15.2, the Procuring entity will assume no responsibility for the tender’s misplacement or premature opening.
- 2.16 Deadline for Submission of Tenders**
- 2.16.1 Tenders must be received by the Procuring entity at the address specified under paragraph 2.15.2 no later than (*day, date and time of closing*)
- 2.16.2 The procuring entity may, at its discretion, extend this deadline for the submission of tenders by amending the tender documents in accordance with paragraph 6, in which case all rights and obligations of the procuring entity and candidates previously subject to the deadline will thereafter be subject to the deadline as extended.
- 2.16.3 Bulky tenders which will not fit in the tender box shall be received by the procuring entity as provided for in the appendix.
- 2.17 Modification and withdrawal of tenders**
- 2.17.1 The tenderer may modify or withdraw its tender after the tender’s submission, provided that written notice of the modification , including substitution or withdrawal of the tender’s is received by the procuring entity prior to the deadline prescribed for the submission of tenders.
- 2.17.2 The Tenderer’s modification or withdrawal notice shall be prepared, sealed, marked, and dispatched in accordance with the provisions of paragraph 2.15. A withdrawal notice may also be sent by cable, but followed by a signed confirmation copy, postmarked not later than the deadline for submission of tenders.
- 2.17.3 No tender may be modified after the deadline for submission of tenders.
- 2.17.4 No tender may be withdrawn in the interval between the deadline for submission of tenders and the expiration of the period of tender validity specified by the tenderer on the Tender Form. Withdrawal of a tender during this interval may result in the Tenderer’s forfeiture of its tender security, pursuant to paragraph 2.12.7.

2.17.5 The procuring entity may at any time terminate procurement proceedings before contract award and shall not be liable to any person for the termination.

2.17.6 The procuring entity shall give prompt notice of the termination to the tenderers and on request give its reasons for termination within 14 days of receiving the request from any tenderer.

2.18 Opening of Tenders

2.18.1 The Procuring entity will open all tenders in the presence of tenderers' representatives who choose to attend, at ...(*time, day, and date of closing*) and in the location specified in the invitation to tender. The tenderers' representatives who are present shall sign a register evidencing their attendance.

2.18.3 The tenderers' names, tender modifications or withdrawals, tender prices, discounts, and the presence or absence of requisite tender security and such other details as the Procuring Entity, at its discretion, may consider appropriate, will be announced at the opening.

2.18.4 The procuring entity will prepare minutes of the tender opening which will be submitted to the tenderers that signed the tender opening register and will have made the request.

2.19 Clarification of tenders

2.19.1 To assist in the examination, evaluation and comparison of tenders the procuring entity may at its discretion, ask the tenderer for a clarification of its tender. The request for clarification and the response shall be in writing, and no change in the prices or substance shall be sought, offered, or permitted.

2.19.2 Any effort by the tenderer to influence the procuring entity in the procuring entity's tender evaluation, tender comparison or contract award decisions may result in the rejection of the tenderers tender.

Comparison or contract award decisions may result in the rejection of the tenderers' tender.

2.20 Preliminary Examination and Responsiveness

2.20.1 The Procuring entity will examine the tenders to determine whether they are complete, whether any computational errors have been made, whether required securities have been furnished whether the documents have been properly signed, and whether the tenders are generally in order.

2.20.2 Arithmetical errors will be rectified on the following basis. If there is a discrepancy between the unit price and the total price that is obtained by multiplying the unit price and quantity, the unit price shall prevail, and the total price shall be corrected. If the candidate does not accept the correction of the errors, its tender will be rejected, and its tender security may be forfeited. If there is a discrepancy between words and figures, the amount in words will prevail.

2.20.3 The Procuring entity may waive any minor informality or nonconformity or irregularity in a tender which does not constitute a material deviation, provided such waiver does not prejudice or affect the relative ranking of any tenderer.

2.20.4 Prior to the detailed evaluation, pursuant to paragraph 23, the Procuring entity will determine the substantial responsiveness of each tender to the tender documents. For purposes of these paragraphs, a substantially responsive tender is one which conforms to all the terms and conditions of the tender documents without material deviations. The Procuring entity's determination of a tender's responsiveness is to be based on the contents of the tender itself without recourse to extrinsic evidence.

2.20.5 If a tender is not substantially responsive, it will be rejected by the Procuring entity and may not subsequently be made responsive by the tenderer by correction of the nonconformity.

2.21 Conversion to a single currency

2.21.1 Where other currencies are used, the procuring entity will convert those currencies to Kenya shillings using the selling exchange rate on the date of tender closing provided by the central bank of Kenya.

2.22 Evaluation and comparison of tenders.

2.22.1 The procuring entity will evaluate and compare the tenders which have been determined to be substantially responsive, pursuant to paragraph 2.20

2.22.2 The comparison shall be of the price including all costs as well as duties and taxes payable on all the materials to be used in the provision of the services.

2.22.3 The Procuring entity's evaluation of a tender will take into account, in addition to the tender price, the following factors, in the manner and to the extent indicated in paragraph 2.22.4 and in the technical specifications:

(a) operational plan proposed in the tender;

(b) deviations in payment schedule from that specified in the Special Conditions of Contract;

2.22.4 Pursuant to paragraph 22.3 the following evaluation methods will be applied:

(a) ***Operational Plan.***

The Procuring entity requires that the services under the Invitation for Tenders shall be performed at the time specified in the Schedule of Requirements. Tenders offering to perform longer than the procuring entity's required delivery time will be treated as non-responsive and rejected.

(b) ***Deviation in payment schedule.***

Tenderers shall state their tender price for the payment on a schedule outlined in the special conditions of contract. Tenders will be evaluated on the basis of this base price. Tenderers are, however, permitted to state an alternative payment schedule and indicate the reduction in tender price they wish to offer for such alternative payment schedule. The Procuring entity may consider the alternative payment schedule offered by the selected tenderer.

2.22.5 The tender evaluation committee shall evaluate the tender within 30 days from the date of opening the tender.

2.22.6 To qualify for contract awards, the tenderer shall have the following:-

(a) Necessary qualifications, capability experience, services, equipment and facilities to provide what is being procured.

(b) Legal capacity to enter into a contract for procurement

- (c) Shall not be insolvent, in receivership, bankrupt or in the process of being wound up and is not the subject of legal proceedings relating to the foregoing
- (d) Shall not be debarred from participating in public procurement.

2.23. Contacting the procuring entity

2.23.1 Subject to paragraph 2.19, no tenderer shall contact the procuring entity on any matter relating to its tender, from the time of the tender opening to the time the contract is awarded.

2.23.2 Any effort by a tenderer to influence the procuring entity in its decisions on tender evaluation tender comparison or contract award may result in the rejection of the tenderers tender.

2.24 Award of Contract

a) Post qualification

2.24.1 In the absence of pre-qualification, the Procuring entity will determine to its satisfaction whether the tenderer that is selected as having submitted the lowest evaluated responsive tender is qualified to perform the contract satisfactorily.

2.24.2 The determination will take into account the tenderer's financial and technical capabilities. It will be based upon an examination of the documentary evidence of the tenderers qualifications submitted by the tenderer, pursuant to paragraph 2.1.2, as well as such other information as the Procuring entity deems necessary and appropriate.

2.24.3 An affirmative determination will be a prerequisite for award of the contract to the tenderer. A negative determination will result in rejection of the Tenderer's tender, in which event the Procuring entity will proceed to the next lowest evaluated tender to make a similar determination of that Tenderer's capabilities to perform satisfactorily.

b) Award Criteria

2.24.3 Subject to paragraph 2.29 the Procuring entity will award the contract to the successful tenderer whose tender has been determined to be substantially responsive and has been determined to be the lowest evaluated tender,

provided further that the tenderer is determined to be qualified to perform the contract satisfactorily.

2.24.4 The procuring entity reserves the right to accept or reject any tender and to annul the tendering process and reject all tenders at any time prior to contract award, without thereby incurring any liability to the affected tenderer or tenderers or any obligation to inform the affected tenderer or tenderers of the grounds for the procuring entity's action. If the procuring entity determines that none of the tenderers is responsive; the procuring entity shall notify each tenderer who submitted a tender.

2.24.5 A tenderer who gives false information in the tender document about its qualification or who refuses to enter into a contract after notification of contract award shall be considered for debarment from participating in future public procurement.

2.25 Notification of award

2.25.1 Prior to the expiration of the period of tender validity, the Procuring entity will notify the successful tenderer in writing that its tender has been accepted.

2.25.2 The notification of award will signify the formation of the Contract subject to the signing of the contract between the tenderer and the procuring entity pursuant to clause 2.29. Simultaneously the other tenderers shall be notified that their tenders have not been successful.

2.25.3 Upon the successful Tenderer's furnishing of the performance security pursuant to paragraph 31, the Procuring entity will promptly notify each unsuccessful Tenderer and will discharge its tender security, pursuant to paragraph 2.12

2.26 Signing of Contract

2.26.1 At the same time as the Procuring entity notifies the successful tenderer that its tender has been accepted, the Procuring entity will simultaneously inform the other tenderers that their tenders have not been successful.

2.26.2 Within fourteen (14) days of receipt of the Contract Form, the successful tenderer shall sign and date the contract and return it to the Procuring entity.

2.26.3 The parties to the contract shall have it signed within 30 days from the date of notification of contract award unless there is an administrative review request.

2.27 Performance Security

2.27.1 Within thirty (30) days of the receipt of notification of award from the Procuring entity, the successful tenderer shall furnish the performance security in accordance with the Conditions of Contract, in the Performance Security Form provided in the tender documents, or in another form acceptable to the Procuring entity.

2.27.2 Failure of the successful tenderer to comply with the requirement of paragraph 2.29 or paragraph 2.30.1 shall constitute sufficient grounds for the annulment of the award and forfeiture of the tender security, in which event the Procuring entity may make the award to the next lowest evaluated or call for new tenders.

2.28 Corrupt or Fraudulent Practices

2.28.1 The Procuring entity requires that tenderers observe the highest standard of ethics during the procurement process and execution of contracts. A tenderer shall sign a declaration that he has not and will not be involved in corrupt or fraudulent practices.

2.28.2 The procuring entity will reject a proposal for award if it determines that the tenderer recommended for award has engaged in corrupt or fraudulent practices in competing for the contract in question;

2.28.3 Further, a tenderer who is found to have indulged in corrupt or fraudulent practices risks being debarred from participating in public procurement in Kenya.

ITT	Particulars of appendix to instructions to tenderers																										
2.1	Eligible Particulars of eligible tenderers: OPEN																										
2.3	Complete manual tender document may be obtained by interested candidates upon payment of a non-refundable fee of (Kshs.1,000.00) (THIKA WATER AND SEWERAGE COMPANY LTD,EQUITY BANK ACCOUNT:0090294392028,EQUITY PLAZA,THIKA BRANCH). <i>Tender documents code-027</i> or download the tender documents free of charge from the Thika Water and Sewerage Company Ltd Website www.thikawater.co.ke . Bidders who download the documents from the website MUST also forward their particulars immediately for records via email to procurement@thikawater.co.ke .																										
2.7	Language of tender: Documents prepared by the tenderer shall be written in English language																										
2.10.4	Validity of tender prices: Tender prices shall remain valid for 120 days up from date of opening																										
2.11	Prices shall be quoted in Kenya Shillings																										
2.12	Tender eligibility and qualifications: Refer to the Evaluation Criteria																										
2.14	Form of tender security: Tenderer shall furnish a tender security of Kshs.160,000.00 bid bond from tender security providers approved by PPRA																										
2.15.1	Validity of tenders: Tender prices shall remain valid for 120 days up from date of opening																										
2.17.2 b)	Day, Date and time of closing: Tuesday 10 th November 2020 at 11.00am																										
2.18	Deadline for submission of tenders: Tuesday 10 th November 2020 at 11.00am																										
2.20	Opening of tenders: Tuesday 10 th November 2020 at 11.00am																										
	EVALUATION CRITERIA-REPAIRS,SERVICING AND MAINTAINANCE OF PUMP, MOTORS AND GENERATORS The method of evaluation will be merit point system <table border="1"> <thead> <tr> <th>Item</th><th>Description</th><th>YES/NO</th><th>Reference-indicate serial no.of your tender where evidence is provided</th></tr> </thead> <tbody> <tr> <td>A</td><td>MANDATORY REQUIREMENTS</td><td></td><td></td></tr> <tr> <td>1.</td><td>Provide copy of Company incorporation / Registration Certificate.</td><td></td><td></td></tr> <tr> <td>2.</td><td>Provide valid copy of Registration certificate from National Construction Authority (NCA)</td><td></td><td></td></tr> <tr> <td>3.</td><td>Current valid Trade License/Local Authority Permit</td><td></td><td></td></tr> <tr> <td>4.</td><td>Provide a copy of Valid Company Tax</td><td></td><td></td></tr> </tbody> </table>			Item	Description	YES/NO	Reference-indicate serial no.of your tender where evidence is provided	A	MANDATORY REQUIREMENTS			1.	Provide copy of Company incorporation / Registration Certificate.			2.	Provide valid copy of Registration certificate from National Construction Authority (NCA)			3.	Current valid Trade License/Local Authority Permit			4.	Provide a copy of Valid Company Tax		
Item	Description	YES/NO	Reference-indicate serial no.of your tender where evidence is provided																								
A	MANDATORY REQUIREMENTS																										
1.	Provide copy of Company incorporation / Registration Certificate.																										
2.	Provide valid copy of Registration certificate from National Construction Authority (NCA)																										
3.	Current valid Trade License/Local Authority Permit																										
4.	Provide a copy of Valid Company Tax																										

		compliance certificate.		
	5	Valid ERC registration certificate		
	6.	Bidders shall prepare and submit two copies marked clearly “ORIGINAL BID” and “COPY BID”.		
	7.	Mandatory Site visit & Inspection		
	9.	Confidential business questionnaire duly completed detailing directors/partners/sole proprietorship		
	10.	Certificate of Confirmation of Directors and Shareholding (up to date CR12) for limited company or/ an ID Card for Sole Proprietorship/partnership		
		Note: Noncompliance with any MANDATORY requirement will automatically result in disqualification		
	B	Technical Evaluation stage – Evaluation Requirements	Score	Reference- indicate serial no.of your tender where evidence is provided
	1.	Financial Status of the Company		
	a)	Provide certified audited accounts for the last two (2) financial years 2017-2018, 2018-2019	5	
	b)	Provide letter of authority to seek references from tenderer’s bank (letters addressed to specific Banks giving authority to the Client to verify the bank statement).	5	
	2.	Experience of Work		
	a)	Proof of work of 4 similar magnitude undertaken in the last five years. Attach prove copies of completion certificate, letters of awards, LPOs/LSOs./contracts	20	
	b)	Attach Copy of Valid Certificate of N.S.S.F. and N.H.I.F.	5	
	3.	Manufacturers or Agency		

			Authorization letter		
	b)	Provide manufacturer's or agency authorization certificates or letters or any such written proof relevant to the supply, installation, testing, inspection, commissioning or otherwise of the scheduled equipment	5		
	4.	Qualification and Experience of Key Technical Personnel			
	a)	Provide detailed proposal of key technical members for the proposed project, copies and CV of the proposed team. <ul style="list-style-type: none"> • Project Manager (Minimum qualification is degree in related engineering field) – 5 points. • Site Agent (Minimum qualification is diploma in related engineering field) – 5 points. • Supervisors (Minimum qualification is diploma in related engineering field) – 5 points. • Foreman (Minimum qualification is diploma in related engineering field) – 5 points. 	20		
	5.	Attach products Catalogue of proposed parts and lubricants used.	10		
	6.	Supply and installation period- for motors,pumps parts and servicing -1-2 days-----10 -over 2days-----0	10		
	7.	Supply and installation period- for Genset -1-3 days-----10 -over 3days-----0	10		
	8.	Servicing period - Borehole -1-7 days-----10 -over 7 days-----0	10		
	7.	Indicate the credit line period you intend to give to the company 30days and above-----5 29 days and below-----3	10		

		Total	100	
		<p>(c) Financial Evaluation</p> <p>The firms that qualify at the technical evaluation stage shall have attained 70% and above.</p> <p>The evaluation committee shall determine whether the financial quote are complete, correct and without any computational errors.</p> <p>Note: Tenderers will be expected to quote in Kenya Shillings inclusive of all taxes.</p>		
	2.24	<p>Award Criteria;</p> <p>Award will be made to the lowest evaluated bidder who quoted for all the items</p> <p>In case of a tie competitive bidding shall be applied.</p>		
	2.27	<p>The amount of Performance Security</p> <p>shall be kshs.500,000.00</p>		

SECTION III GENERAL CONDITIONS OF CONTRACT

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SECTION III GENERAL CONDITIONS OF CONTRACT

3.1 Definitions

In this contract the following terms shall be interpreted as indicated:

- a) “The contract” means the agreement entered into between the Procuring entity and the tenderer as recorded in the Contract Form signed by the parties, including all attachments and appendices thereto and all documents incorporated by reference therein.
- b) “The Contract Price” means the price payable to the tenderer under the Contract for the full and proper performance of its contractual obligations.
- c) “The services” means services to be provided by the contractor including materials and incidentals which the tenderer is required to provide to the Procuring entity under the Contract.
- d) “The Procuring entity” means the organization sourcing for the services under this Contract.
- e) “The contractor means the individual or firm providing the services under this Contract.
- f) “GCC” means general conditions of contract contained in this section
- g) “SCC” means the special conditions of contract
- h) “Day” means calendar day

3.2 Application

These General Conditions shall apply to the extent that they are not superceded by provisions of other part of contract.

3.3 Standards

- 3.3.1 The services provided under this Contract shall conform to the 7 standards mentioned in the Schedule of requirements

3.5 Patent Right’s

The tenderer shall indemnify the Procuring entity against all third-party claims of infringement of patent, trademark, or industrial design rights arising from use of the services under the contract or any part thereof .

3.6 Performance Security

Within twenty eight (28) days of receipt of the notification of Contract award, the successful tenderer shall furnish to the Procuring entity the performance security where applicable in the amount specified in Special Conditions of Contract.

3.6.2 The proceeds of the performance security shall be payable to the Procuring entity as compensation for any loss resulting from the Tenderer's failure to complete its obligations under the Contract.

3.6.3 The performance security shall be denominated in the currency of the Contract, or in a freely convertible currency acceptable to the Procuring entity and shall be in the form of :

- a) Cash.
- b) A bank guarantee.
- c) Such insurance guarantee approved by the Authority.
- d) Letter of credit.

3.6.4 The performance security will be discharged by the procuring entity and returned to the candidate not later than thirty (30) days following the date of completion of the tenderer's performance of obligations under the contract, including any warranty obligations under the contract.

3.7 Inspections and Tests

3.7.1 The Procuring entity or its representative shall have the right to inspect and/or to test the services to confirm their conformity to the Contract specifications. The Procuring entity shall notify the tenderer in writing, in a timely manner, of the identity of any representatives retained for these purposes.

3.7.2 The inspections and tests may be conducted on the premises of the tenderer or its subcontractor(s). If conducted on the premises of the tenderer or its subcontractor(s), all reasonable facilities and assistance, including access to drawings and production data, shall be furnished to the inspectors at no charge to the Procuring entity.

3.7.3 Should any inspected or tested services fail to conform to the Specifications, the Procuring entity may reject the services, and the tenderer shall either

replace the rejected services or make alterations necessary to meet specification requirements free of cost to the Procuring entity.

3.7.4 Nothing in paragraph 3.7 shall in any way release the tenderer from any warranty or other obligations under this Contract.

3.8 Payment

3.8.1 The method and conditions of payment to be made to the tenderer under this Contract shall be specified in SCC

3.9 Prices

Prices charged by the contractor for services performed under the Contract shall not, with the exception of any Price adjustments authorized in SCC , vary from the prices by the tenderer in its tender or in the procuring entity's request for tender validity extension as the case may be. No variation in or modification to the terms of the contract shall be made except by written amendment signed by the parties.

3.10 Assignment

The tenderer shall not assign, in whole or in part, its obligations to perform under this contract, except with the procuring entity's prior written consent.

3.10 Termination for Default

The Procuring entity may, without prejudice to any other remedy for breach of Contract, by written notice of default sent to the tenderer, terminate this Contract in whole or in part:

- a) if the tenderer fails to provide any or all of the services within the period(s) specified in the Contract, or within any extension thereof granted by the Procuring entity.
- b) if the tenderer fails to perform any other obligation(s) under the Contract.
- c) if the tenderer, in the judgment of the Procuring entity has engaged in corrupt or fraudulent practices in competing for or in executing the Contract.

In the event the Procuring entity terminates the Contract in whole or in part, it may procure, upon such terms and in such manner as it deems appropriate, services similar to those undelivered, and the tenderer shall be liable to the Procuring entity for any excess costs for such similar services.

3.12 Termination of insolvency

The procuring entity may at the any time terminate the contract by giving written notice to the contractor if the contractor becomes bankrupt or otherwise insolvent. In this event, termination will be without compensation to the contractor, provided that such termination will not produce or affect any right of action or remedy, which has accrued or will accrue thereafter to the procuring entity.

3.13 Termination for convenience

3.13.1 The procuring entity by written notice sent to the contractor may terminate the contract in whole or in part, at any time for its convenience. The notice of termination shall specify that the termination is for the procuring entity convenience, the extent to which performance of the contractor of the contract is terminated and the date on which such termination becomes effective.

3.13.2 For the remaining part of the contract after termination the procuring entity may elect to cancel the services and pay to the contractor on agreed amount for partially completed services.

3.14 Resolution of disputes

The procuring entity's and the contractor shall make every effort to resolve amicably by direct informal negotiations any disagreement or dispute arising between them under or in connection with the contract.

If after thirty (30) days from the commencement of such informal negotiations both parties have been unable to resolve amicably a contract dispute either party may require that the dispute be referred for resolution to the formal mechanisms specified in the SCC.

3.15 Governing Language

The contract shall be written in the English language. All correspondence and other documents pertaining to the contract, which are exchanged by the parties, shall be written in the same language.

3.16 Force Majeure

The contractor shall not be liable *for* forfeiture of its performance security, or termination for default if and to the extent that its delay in performance or other failure to perform its obligations under the Contract is the result of an event of Force Majeure.

3.17 Applicable Law.

The contract shall be interpreted in accordance with the laws of Kenya unless otherwise specified in the SCC

3.18 Notices

Any notices given by one party to the other pursuant to this contract shall be sent to the other party by post or by fax or E-mail and confirmed in writing to the other party's address specified in the SCC

A notice shall be effective when delivered or on the notices effective date, whichever is later.

SECTION IV SPECIAL CONDITIONS OF CONTRACT

- 4.1 Special conditions of contract shall supplement the general conditions of contract, wherever there is a conflict between the GCC and the SCC, the provisions of the SCC herein shall prevail over those in the GCC.
- 4.2 Special conditions of contract with reference to the general conditions of contract.

General conditions of contract reference	Special conditions of contract
3.7	Specify performance security: kshs.500,000.00
3.12	Specify method payments: payments shall be made upon receipt of the services or the invoice
3.9	Specify price variation allowed: None
3.18	Specify resolution of disputes: Disputes to be settled as per the arbitration laws of Kenya
3.19	Specify applicable law: laws of Kenya

SECTION V – SCHEDULE OF REQUIREMENTS/PRICE SCHEDULE

This part will include any deliverables under the service contract

Supply & Installation of Items Listed below as per Required Schedule						Unit cot
NO.	EQUIPMENT	ITEMS (Supply, Install & Servicing)	REQUIRED SCHEDULE	UNITS	Delivery Time Start _____ End _____	
1	Raw water pump NO. 7,6,8 Chania river(550 m3/hr @10m, 1460rpm),Model: KSB Pumps LTD,ETAR-200- 250 NO-081.9.1013 Year 1989	bearings	Quartely	nr		
		Sleeves	Semi annual	nr		
		Shaft	Annual	nr		
		Coupling rubbers	Semi annual	nr		
		Coupling	2 years	nr		
		Laser alignment	Quartely	Sum (Per each Alignment)		
		General inspection	annual	Sum (per inspection)		
		Painting protection	2 year	m ²		
2	Raw water pumps No. 1,2,3 TRI (model 215 m3/hr @10m-1&3),(model ksb 200m 3/hr@20MH	bearings	Quartely	nr		
		Sleeves	Semi annual	nr		
		Shaft	Annual	nr		
		Coupling rubbers	Semi annual	nr		
		Coupling	2 years	nr		
		Laser alignment	Quartely	Sum (Per each Alignment)		
		General inspection	annual	Sum (per inspection)		
		Painting protection	2 year	m ²		
3	Old Pump House Pump No. 3 (312.5m3/hr @57m, 1460 Rpm Model Worthington Simpson Ltd Newark on Trent England	bearings	Quartely	nr		
		Sleeves	Semi annual	nr		
		Shaft	Annual	nr		
		Coupling rubbers	Semi annual	nr		
		Coupling	2 years	nr		
		Laser alignment	Quartely	Sum (Per each Alignment)		
		General inspection	annual	Sum (per inspection)		
		Painting protection	2 year	m ²		

4	Old Pump House Pump No. 1 & 2 (312.5m³/hr @57m, 1470 Rpm Model Worthington Simpson Ltd Newark on Trent England, G.P.M 695/1460, 200/140 feet TDH,	bearings	Quartely	nr		
		Sleeves	Semi annual	nr		
		Shaft	Annual	nr		
		Coupling rubbers	Semi annual	nr		
		Coupling	2 years	nr		
		Laser alignment	Quartely	Sum (Per each Alignment)		
		General inspection	Annual	Sum (per inspection)		
		Painting protection	2 year	m ²		
5	Bendor Treated Water pumps TRI (80 m³/hr @70m), Italy CAPRARI Model: 481001/2 6/17 Type MEC-hrs 80-3/2A	bearings	Quartely	nr		
		Sleeves	Semi annual	nr		
		Shaft	Annual	nr		
		Coupling rubbers	Semi annual	nr		
		Coupling	2 years	nr		
		Laser alignment	Quartely	nr		
		General inspection	Annual	Sum (per inspection)		
		Painting protection	2 year	m ²		
6	High lift pumps NO 1,2,3,4 & 5 (Main Pump house) Weir Pumps LTD Scotland, Unit No: 65804/003, Unit Code: 3DC160/200	bearings	Annual	nr		
		Sleeves (shaft)	2 years	nr		
		Shaft	3 years	nr		
		Coupling rubber	1 year	nr		
		Laser alignment	3 months	Sum (Per each Alignment)		
		Painting protection	2 year	m ²		
		General inspection	Annual	Sum (per inspection)		
7	Ngoingwa Booster Pumps No. 1, 2 (Head of 110m),model KSB pump wkl 100/5	bearings	Annual	nr		
		Sleeves (shaft)	2 years	nr		
		Shaft	3 years	nr		
		Coupling rubber	1 year	nr		
		Laser alignment	3 months	Sum (Per each Alignment)		
		Painting protection	2 years	m ²		

		General inspection	Annual	Sum (per inspection)		
8	630 KVA GENSANG GENSET	General service, including but not limited to replacement of;				
		(i) Oil and lubricants	Annual	sum		
		(ii) oil filter	Annual	nr		
		(iii) Fuel filter	Annual	nr		
		(iv) Fuel system	Annual	nr		
		(v) Air cleaner	Annual	nr		
		(Vi) Fuel water separation	Annual	nr		
		(Vii) Starter batteries (12 Volts *200 AH)	Annual	nr		
9	100 KVA Generator	(i) Oil and lubricants	Annual	sum		
		(ii) oil filter	Annual	nr		
		(iii) Fuel filter	Annual	nr		
		(iv) Fuel system	Annual	nr		
		(v) Air cleaner	Annual	nr		
		(vi) Fuel water separation	Annual	nr		
		(vii) Starter batteries (12 Volts N70X2)	Annual	nr		
10	Electric Motors	1. 15 kwt Electric Induction Motor				
		(i) Replacement of bearing	Annual	nr		
		(ii) Replacement of terminal blocks	Annual	nr		
		(iii) Painting	5 years	m ²		
		2. 22 kwt Electric Induction Motor				
		(i) Replacement	Annual	nr		

of bearing				
(ii) Replacement of terminal blocks	Annual	nr		
(iii) Painting	5 years	m ²		
3. 55 kwt Electric Motor				
(i) Replacement of bearing	2 years	nr		
(ii) Replacement of terminal blocks	Annual	nr		
(iii) Painting	5 years	m ²		
4. 65kwt Electric Motor				
(i) Replacement of bearing	2 years	nr		
(ii) Replacement of terminal blocks	Annual	nr		
(iii) Painting	5 years	m ²		
5. 110kwt Electric Motor				
(i) Replacement of bearing	2 years	nr		
(ii) Replacement of terminal blocks	Annual	nr		
(iii) Painting	5 years	m ²		
6. 125kwt Electric Motor				
(i) Replacement of bearing	2 years	nr		
(ii) Painting	5 years	m ²		
7. 150 kwt Electric Motor				
(i) Replacement of bearing	2 years	nr		
(ii) Painting	5 years	m ²		

11	Boreholes	Borehole Test Pumping	Annual	Sum (per Service)		
		Borehole Development	Annual	Sum (per Service)		
		Borehole Flushing	2 years	Sum (per Service)		
		Replacement of Motor/Pump set (range 5.5kWt to 11KWt)	2 years	nr		
		Replacement of Motor/Pump set (range 11kWt to 18KWt)	2 years	nr		
12	Portable generator (petrol)	Servicing of 6.5 kwt Genset	Annual	Sum (per Service)		
13	Dewatering pumps petrol engine driver	Servicing	Annual	Sum (per Service)		
Total price vat inclusive						

NOTE:

Failure to quote any of the items shown above, will lead to disqualification for financial evaluation.

SECTION VI DESCRIPTION OF SERVICES

1 GENERAL MECHANICAL AND ELECTRICAL WORKS SPECIFICATIONS

1.1 General Requirements

1.1.1 Related Work

The Contractor shall, under this section, co-ordinate with the Electrical Section of these Specifications to ensure compatibility with electrical and control components and completeness of supply without extra cost to the Employer.

1.1.2 Shop Drawings and Operating Manuals

Shop drawings for all units to be furnished under this section shall be provided in accordance with the General Clauses.

1.1.3 Appurtenances, Fittings, Connecting Piping and Accessories

All appurtenances, fittings, connecting piping and accessories necessary for the proper functioning of the equipment or reasonably inferable from the Drawings shall be supplied and installed with the equipment, whether or not indicated on the Drawings or specified herein.

1.1.4 Materials Handling and Storage

The Contractor shall ensure safe delivery of all materials to the site. Materials are to be handled at all times with care to avoid damage. Loading, unloading and movement of materials into place by means of hoists, ropes or skid ways shall be carried out in such a manner as to avoid shock of any kind resulting from having been dropped or rolled against one another.

The Contractor is to ensure that materials and equipment are properly stored and protected onsite against weather, damage and theft to the satisfaction of the Engineer.

1.1.5 Materials and Workmanship

Furnish under this contract only materials and equipment which are first-class in every respect and can be constructed and finished in a workmanlike manner. Use materials suitable for the service intended and selected and fabricated in accordance with the best engineering practice. Equipment shall be modern in design and shall not have been used at any time previous to delivery except as required by tests.

1.1.6 Concrete Equipment Bases

Unless otherwise recommended by the equipment manufacturer, equipment shall be finally set on 25 mm of cement grout, on a 150 mm high 'housekeeping' concrete base, chamfered at the edges.

Where equipment is to be set on a concrete base, the concrete base itself shall be anchored to the floor slab with cast in-place reinforced steel. If bases are to be cast onto an existing floor, the steel shall be epoxy grouted a minimum of 150mm deep into the existing concrete. The existing concrete shall also be roughened and coated with a suitable epoxy immediately prior to plating of the plinth or housekeeping base so as to ensure a good bond between the existing and new concrete. Concrete used in paths and housekeeping bases shall be 30 MPA concrete (Class C25).

1.1.7 Anchors Bolts

Unless otherwise specified, anchor bolts for equipment shall be of stainless steel type 304 or cadmium plated steel having ample size for the purpose intended. They shall be set by the Contractor in accordance with the manufacturer's reviewed shop drawings.

1.1.8 Electric Motors

Unless otherwise specified electric motors shall be of high efficiency, totally enclosed, fan-cooled, tropicalised class F. insulation, Class B temperature rise with anti-condensation heaters, 1.15 service factors; all copper windings (rewindable).

1.1.9 Direct Connected Motors

Provide flexible shaft couplings to motors directly connected to pumps or equipment.

1.1.10 Guards

Cover all belt drives and motor shaft couplings with a suitable guard.

1.1.11 Motors

Unless otherwise specified, electric motors supplied for equipment under this Section shall be of the high efficiency totally enclosed fan-cooled, tropicalised class F. insulation, Class B temperature rise with anti-condensation heaters, 1.15 service factors; all copper windings.

- Less than 0.375 kW: 240V/1 p/50Hz power supply;
- 0.375kW and larger: 415V/3 p/50Hz power supply;
- Enclosure: TEFC, Corrosive Chlorine Atmosphere;

- Service Factor: 1.15

1.1.12 Standards

The design and construction of systems and equipment shall comply with the requirements of these Specifications and:

- ASME Codes or equivalent BS standards;
- Chlorine Institute Standards or equivalent BS standards.

In case of conflict among the requirements those with the higher standards shall apply.

1.2 Dosing Pump Units

1.2.1 Design Workmanship and Construction

The Pump shall be designed and built for continuous operation and suitable for starting against an open valve. Similar pumping units shall be of identical design and manufacture with corresponding parts interchangeable

Castings shall be free from flaws and imperfections and machined surfaces shall be finished true. All joints shall be machined and all castings shall be shop faced for nuts. All similar parts shall be made to similar gauge wherever possible.

The inside and outside corners and edges of all castings shall be rounded off, wherever possible, with fillet and chamfers. All screws, bolts and nuts shall be US Standard or metric standard, as specified under CLASS 1.8. large nuts 30 mm and larger shall have bronze cotter pins. No patching, plugging, shimming or other such means of overcoming defects, discrepancies or errors shall be resorted to without the written permission of the Engineer.

The drives shall have adequate capacities to run the pumps at all conditions of operation. All pumps shall be statically and dynamically balanced.

1.2.2 Duty Pump Design

The contractor shall supply standard pumps and motors (commonly available).

1.2.3 Pump Type and Configuration

The required pump type is a horizontal, end suction and radial/side discharge, multi stage, mixed flow type, electric motor driven surface centrifugal pump. The centrifugal pumps shall comply with the relevant clause of the general specification.

All pumps and associated equipment are to be derated for an ambient temperature of 35 degree Celsius and an altitude of 1355 masl.

Pumps are to be selected to transfer water from any water level in the suction well to the receiving Reservoir, having due regard to the range of water levels and possible friction losses. In particular;

- When pumping against the maximum head with all pumps in operation, each pump must have an adequate throughput for cooling
- With one pump running alone, the selected pump must not overload its motor when pumping against the minimum possible head
- The pump curves must be sufficiently steep to avoid excessive draw downs when pipe friction losses are low
- The selected pumps shall be free from cavitation at all times

The pumps shall be protected against low water level in the wet well/reservoir using an electrode probe and a protection relay (installed in the starter box of the centrifugal pump compartments).

The metering instruments shall be calibrated in metric units, namely cubic metre for water meter and metre or bar for pressure gauge. The pressure gauge shall be connected by a three-way cock.

Surge vessels sized for the pipeline system will be installed on the common discharge pipe on the sites shown in the drawings.

For the pump station at the treatment plant, the existing common suction and common discharge pipelines will be utilized, making modifications only to the tees and bends on the common suction and discharge pipelines which connect to the independent suction and discharge pipelines of each pump.

1.2.4 Scope of Work

The contractor's duties shall include but not limited to;

- supply & delivery of the equipment to site
- Install pump with power & level control cables, control panels, headwork's piping, pressure gauge, water meter, non-return valve, gate valve, air release valve etc, lifting equipment at each pump station
- Connect station piping to the suction wet well & to the discharge collector pipe

- Connect collector piping to the suction wet well & to transmission pipe at the discharge valve chamber
- install trash rack, gate & sundry metal works
- install control cables from each pump station to delivery reservoir or as required
- Connect the pump power & control cables to the panel board in the pump room at the pump site and conduct pump test
- Commissioning of equipment & training of the staff.

1.2.5 Scope of Supply

The supply shall include the following items among others as indicated in the corresponding drawings;

- pumps with power & control cables, pump control panel
- suction & delivery piping
- Non-return valves
- Gate valves
- Butterfly valves
- Air release valves
- Pressure gauges
- Pressure switches
- Piping to connect pump to the suction wet well outlet pipe
- Piping to connect pump to the discharge (collector) pipe.

1.2.6 Pump Construction

(a) Casing:

- close grained high tensile cast iron to ASTM A-278 class 25 or equivalent; or ductile from ASTM A-395;
- back pall out design with flanged suction and discharge nozzles cast integrally with the main pump casing;
- suction and discharge flanges to ANSI clam 125, faced, drilled and spot faced;
- provide tapped openings for drain and gauge connections;
- hydrostatic to 1.5 times the sum of maximum suction pressure and shut off head;
- Provide lifting lugs or eye bolts.

(b) Impellers:

- bronze, cast in one piece;
- enclosed, non-overloading type, secured to the shaft by a key and locked in place;
- Statically and dynamically balanced.

(c) Wearing Rings:

- Provide wearing rings for casing and impeller;
- renewable bronze or a combination of bronze and stainless steel;
- Where suitable, double labyrinth type design is preferred.

(d) Shaft:

- high grade carbon steel, heat treated, annealed, machined and polished; adequately sized to take all kinds of loading without vibration and fatigue failure;
- fitted with sleeves of corrosion-resistant iron- chromium alloy (11 to 14% Cr.) or equivalent, easily replaceable design. Provide O-ring type seals to prevent leakage.

(e) Stuffing Boxes:

- designed for integral water scaling;
- bronze lantern gland packed with PTFE or Nitril Synthetic Fibre or equivalent, no asbestos, and non-toxic packing material;
- provide drip boxes and tapped drainage opening allow collection of waste SCW water to drain;
- provide deflector or slinger rings to prevent entry of water into the bearings.

(f) Bearings:

- designed to take line and thrust loads under all operating conditions;
- anti-friction type, sized and rated for at least 100,000 hours B-10 Bearing Rating Life;
- Oil or grease lubricated.

1.2.7 Pump Accessories

(a) Couplings:

- forged steel, gear type flexible shaft coupling or Fenner “tyre type” with spacer to connect pump and motor;
- designed to transmit full power limit end play of motor; absorb angular and parallel misalignment as well as axial movement due to vibration or thermal expansion and contraction of pump and motor;
- provide coupling guard of expanded metal construction, properly anchored to the base plate.

(b) Base plates:

- heavy cast or welded steel common base plate with machined hub for mounting both pump and motor;

- provide: grouting holes; drilled lugs for anchor bolts; drain gutter around pump area, fitted with 25 mm dia. drain connection;
- both pump and motor shall be assembled in the shop for initial alignment and doweling.

1.2.8 Pressure Gauges

- provide suction and discharge pressure gauges for each pump;
- 100 % accuracy over 90 % of range;
- 150 mm dia. Bourdon tube;
- black phenol case;
- supply snubbers and isolating cocks;
- range (dual graduation): suction -10 m to + 10 m (water bend); discharge 0 to + /- (Closed Valve Pressure + 20 m).

1.2.9 Motors

Motors to meet Electrical specifications.

1.2.10 Shop Painting

All non-machined surfaces of the pumping units shall be thoroughly cleaned and smoothed before painting. Surface preparation shall conform to Specification SSPC-SP-6 'Commercial Blast Cleaning'.

The interior of the horizontal pump casting shall be given three coats of an approved taste and odour free paint before shipment. Exterior surfaces of the pumps shall be primed with two coats of Epoxy Ester Phenolic primer, dry film thickness of 38 to 50 mil. Electric motors may be supplied with the manufacturer's standard finish, colour as directed by the Engineer. Other machined surfaces such as shafting shall be well coated with grease or anti-rust compound before shipment.

1.2.11 Anchor Bolts

The Contractor shall furnish anchor bolts of type 304 stainless steel having ample size for the purpose intended.

They shall be set by the Contractor in accordance with the Manufacturer's approved working drawings.

1.2.12 Shop Tests

All pumps shall be tested in accordance with the 'Hydraulic Institute Standards' Test Code for centrifugal pumps.

Each pump shall be guaranteed for the rating capacity and efficiency when operating at the specified conditions of head and load.

The pumps shall be shop tested by the manufacturer over their range of operation from shutoff pressure to a point at least 20% beyond the point of rated capacity. A certified test curve in duplicate showing head, capacity, efficiency and power shall be furnished to the Engineer for review.

Standard commercial shop tests shall be carried out on motors and certified data submitted to the Engineer for review.

The Engineer reserves the right to witness any of the pump and motor test without extra cost to the Employer.

1.2.13 Installation of Pump Units

All pumping units shall be installed by the Contractor in accordance with the manufacturer's instructions reviewed by the Engineer. Only mechanics with at least 3 years experience in the installation of rotating machinery shall be employed.

1.2.14 Supervision

A Supervision period of two days shall be allowed for manufacturer's representatives to inspect the installation of the equipment, to start up the equipment and to instruct operating personnel in its operation and maintenance. This period may be divided into two or more separate periods as required by the Engineer.

1.2.15 Field Tests

The pumping units supplied shall be tested by the Contractor and manufacturer's representative and witnessed by the Engineer after installation to ensure that the specified requirements are met, and that the operation of the unit is satisfactory in all respects. In the event of any unit failing to meet the requirements of these specifications, the Engineer reserves the right to reject it. Subsequently, the equipment shall be repaired or made good to the satisfaction of the Engineer.

1.2.16 Spare Parts

Two years supply of spare parts essential for regular servicing of equipment as recommended by the manufacturer or indicated in the service manuals is required. The spare parts for each pump shall at least include the following items;

- Shaft sleeves;
- wearing rings;
- bearings (line & thrust);
- packing gland complete with cages;
- gasket material (no. of changes);
- packing material (no. of changes);
- Complete set of spare fuses or MCB's as required
- Spare coils and contactors for starters
- Spare overload relays and contacts for starters
- Recommended spares for control systems
- Service kit, Bearing, Mechanical seal, Packing gland etc. for surface pumps & motors
- Recommended service parts and spares for generator sets and control panels
- Any other spares recommended by the manufacturer

All spare parts shall be new, unused and strictly interchangeable with the parts for which they are intended to be replacements. The parts shall be treated and packed for long storage under the climatic conditions prevailing at the site. Each spare part shall be clearly marked or labelled on the outside of its packing with its description and purpose.

When more than one spare is packed in a single case or other container, general description of its containers and other packages shall be marked and numbered in an approved manner for purposes of identification.

1.2.17Certificates of Installation

On completion of installation and testing, the manufacturer's certification of the correctness of the installation shall be submitted to the Engineer.

1.2.18Painting

All piping supports, valves, and equipment shall be cleaned and all rust, dirt, grease and oil be removed, whether such items are to be painted or not.

All items of equipment supplied under this Section shall receive shop painting consisting of one primer coat and two finish coats. All steel work, other than galvanised, plated or stainless steel, shall receive at least one coat of zinc chromate-alkyd primer. Finish painting, where required, to the colours to be selected by the Engineer.

All scratched and marred finish and primer coats shall be retouched to the satisfaction of the Engineer.

1.2.19 Specific Specifications of the pumps

Pump Component Material Specifications

Item	Component	Material
1	Basket strainer	Stainless steel to ASTM grade 316
2	Suction cover	Cast iron, alternatively phosphor bronze CT1 to BS 1400
3	Shaft sleeves	Stainless steel to ASTM grade 316
4	Bearing bushes	Leaded bronze LB2 to BS 1400
5	Pump diffuser	Cast iron, alternatively phosphor bronze CT1 to BS 1400
6	Impeller	Stainless steel to ASTM Grade 316
7	Wearing rings, impeller and casing	Gunmetal LG2 and leaded bronze LB2 to BS 1400
8	Shaft nut	Phosphor bronze CT1 to BS 1400
9	Pump shaft	Stainless steel, chromium, nickel, copper, molybdenum.25/5/3/2 to BS 2789
10	Studs, nuts and washers	Stainless steel 30% or aluminium bronze AB2 to BS 1400
11	Tube adaptor	Leaded bronze LB2 or gunmetal LG2 to BS1400
Relevant British and American Standards		
Cast Iron	BS 1452	Grade 220
Phosphor bronze	BS1400	Grade PB1 or CT1
Leaded Bronze	BS1400	Grade LB2
Gunmetal	BS 1400	Grade LG2
Aluminium bronze	BS 1400	Grade AB2
Stainless steel	BS 970 or ASTM	Grade 316

Line Shafts and Column Pipes

The line shaft shall be of machine ground stainless steel running within an

Line shaft and Column Material Specifications

Item	Component	Material
1	Shaft, keys and couplings	Stainless steel, chromium, nickel, copper, molybdenum. 25/5/3/2 to BS 2789
2	Enclosing tube	HFS carbon steel. BS 3601 Grade HFS 360 or equivalent
3	Column pipe	HFS carbon steel. BS 3601 Grade HFS 360 or equivalent
4	Bolts, nuts, and washers	Stainless steel. BS 970 pt 4

enclosing tube carrying clean lubricating water. Intermediate couplings shall be positioned above each bearing and they shall be of a self-aligning type, adequately keyed and threaded to carry torque and axial load. Renewable sleeves shall be provided where the shaft passes through the bearing bushes. The bottom bearing and all intermediate bearings shall be of the cutlass rubber type and shall be spaced to ensure steady running of the shaft at not more than 75% of its first critical speed. The column pipe shall be flanged and spigotted into the sandwich bearing body and sealed by means of “O” rings. The enclosing tube shall be “O” ring sealed above and below the bearing body.

The enclosing tube shall be “O” ring sealed above and below the bearing body. The headgear stool is to be provided with a water lubricated, packed stuffing box and gland where the shaft emerges from the column pipe. The shaft shall have a renewable sleeve where it passes through the stuffing box and the gland shall be split and held by swing bolts. The column pipe shall be designed and fabricated with proper regard to the head room available for removal, hydraulic and mechanical efficiency, static and dynamic stresses and such other properties as will ensure rigid, vertical suspension and vibration-free running and operation.

The material specifications for line shafts and columns are shown in the table below.

Line Shaft Lubrication

The line shafts shall be lubricated via the existing 50mm clean water supply pipe from the high lift pump station. The existing pumps are supplied from a common manifold running adjacent to the main discharge manifold. The contractor shall ensure that the line sizes and pressures are suitable to provide reliable and adequate lubrication of the line shaft bearings. The

supply is provided at a pressure of approximately 42 m water head. Control provisions shall be arranged to ensure that bearing water lubrication is occurring before a pump starts.

Head Gear

The upper end of the column pipe shall be bolted to the underside of the head gear stool base plate in such a way as to permit easy assembly and disassembly. The head gear stool shall be of heavy fabricated steel construction of such weight and rigidity as to ensure that the pump runs without undue vibration. In the case of dispute regarding undue vibration, the amplitude of the vibration shall be measured at the upper end of the line shaft, and if the amplitude is found to be in excess of 50% of the acceptable field limit of the ISO 7919-2:2009, then the cause of the vibration shall be fully investigated by the Contractor and shall be made good at the Contractor's expense.

The head gear stool shall provide easy access for inspection and removal of the shaft gland, thrust bearing and the coupling which connects pump and motor shafts. The mating faces of all components located concentrically about the vertical axis of the shaft shall be spigotted to ensure correct alignment, except for the motor which is to be dowelled in position after final alignment of the coupling. The stool shall also permit easy access for vertical adjustment of impeller clearances and enclosing tube as necessary.

The main thrust and journal bearing shall be of taper roller, grease lubricated type and must be capable of withstanding reverse rotation for 15 minutes in the event of backflow. The pump shaft /motor shaft coupling shall be of an appropriate type and adjustable to permit impeller positioning, splined or keyed to the shafts.

400 V Motors

The motors shall be suitable for indoor operation at an elevation between approximately EL 1 050 m with an ambient temperature of 40°C and a relative humidity of 80%. The motors shall be designed in accordance with the latest IEC, BSI or NEMA standards and shall, in particular, suit the torques and speed characteristics of the pumps.

Ratings

The motors shall be rated for 400 V, 3 phase, 50 Hz service. They shall be 1 500 rpm synchronous speed, continuous duty with a duty type S1. The motors shall be of high efficiency type and shall be equipped with power

factor correction capacitors to maintain a power factor of at least 95% at the design point.

Construction

The motors shall be vertical, squirrel cage induction type, constant speed motors. They shall be high thrust, open drip proof and suitable for full voltage starting and shall have Class F modified insulation to IEC 85 or equal standard. The full load temperature rise shall not exceed Class B by resistance method above 40°C ambient.

Each motor shall be designed and certified for 85 dBA maximum sound pressure level measured 1.5 m distant from the pump in any direction. Each motor shall be equipped with a minimum of three positive temperature coefficient thermistors connected in series, with leads brought out to a suitable terminal box. The motor frame and end shields shall be made of cast iron and all exterior and interior surfaces shall be primed and finished in accordance with manufacturer's standards. Threaded drain holes with plugs shall be provided in the lowest points of the motor enclosures to permit drainage of condensate. All openings in the motor enclosures shall be vermin proof. All machined fits shall be coated with corrosion resistant material. All hardware such as bolts and nuts shall be made of corrosion resistant material. Terminal boxes shall be of cast iron or heavy gauge cold rolled steel construction, diagonally split and suitable for 4 (four) 90-degree positions. Gaskets shall be furnished at the boxes to seal out liquids. Motor leads shall pass through a watertight grommet or gasket seal where they enter the boxes from the stator frames. Boxes shall be tapped for standard conduit or cable connector openings. Terminal boxes shall be properly sized for cable terminations.

All motors shall be equipped with 230V AC space heaters to prevent condensation when the motor is de-energised. Heaters shall have a sheath of chrome steel or other corrosion resistant alloy. The surface temperature of each space heater shall not exceed 60°C. Space heater leads shall be brought out to a space heater terminal box, adjacent to the motor terminal box. All leads shall be properly identified.

Motors shall be equipped with properly sized grounding lugs in the terminal boxes. The motor frames shall have provision for grounding. All motors shall be equipped with grease lubricated rolling element bearings and fittings.

The motors shall be suitable for at least 4 starts per hour.

1.3 Penstocks Specifications

1.3.1 General

Sluice gates shall be furnished with a handwheel crank-operated floor stand having not less than a 2:1 gear ratios or electric motors, as shown, and shall conform to AWWA Standard C501, except as otherwise specified herein. The Contractor shall furnish all material, labor, equipment and incidentals required to produce a complete installation ready for operation. All equipment shall be manufactured by reputable firms having at least 15 years experience in the design and fabrication of such equipment. All gates and appurtenances shall be furnished by one manufacturer. Gate assemblies shall be shop tested and manufacturer certified to meet the maximum heads shown on the Drawings.

1.3.2 Coatings

Each gate together with wall thimble and all accessories shall be epoxy-coated as specified in Subsection 6.2.4. Care shall be exercised to protect all machined surfaces during sandblasting and coating. All damage to surface coatings incurred during shipment and/or installation shall be repaired to the satisfaction of the Engineer prior to installation.

1.3.3 Frames and Guides

- a) All sluice gate frames and guides shall be of one-piece cast iron construction, designed to withstand the total thrust due to the seating and unseating water pressure and the wedging action, and shall be of the flange back type with rectangular or circular opening as shown. All contact surfaces shall be machined, and grooves machined the entire length of the guide to allow 1.6 mm clearance between the disc tongue and the guide groove. The guides shall be of such length as to support at least $\frac{1}{2}$ the slide in the fully open position. The guides shall be attached to the frame with studs and nuts of Type 316 stainless steel.
- b) Bronze wedge seats shall be securely attached to machine pads on the guides. Each frame shall have machined dovetail grooves on the front face into which bronze shall be driven and machined to a 0.1 mm finish. The back flange of the frame shall be machined to bolt directly to the machined face of a wall thimble. Frames for sluice gates subject to unseating pressure shall have integrally cast pads machined with key ways to receive top and bottom wedge seats.

1.3.4 Discs

- a) The disc shall be of cast iron, one-piece, rectangular construction with integrally cast vertical and horizontal ribs. A reinforcing rib along each side

shall be provided to ensure rigidity between the side wedges. The disc shall have machined dovetail grooves on the seating face into which bronze seating facings shall be driven and machined to a 0.1mm finish. A tongue on each side extending the full length of the disc shall be machined on all sides with a 1.6mm clearance between the disc tongue and the gate guide groove. A heavily reinforced nut pocket shall be cast integrally on the vertical centerline above the horizontal centre and shall be of a shape designed to receive the square backed bronze thrust nut. The pocket shall drain freely. The maximum clearance between seating surfaces, with the gate in the closed position shall be 0.1 mm.

- b) Unless otherwise shown, the sluice gate shall be of flush-bottom closure where indicated with a compressible resilient seal attached to the bottom of the disc with Type 316 stainless steel bar and fasteners. The seal shall produce a wide sealing are on a machined cast iron stop bar bolted and keyed to the gate frame and forming a flush bottom. The differential sealing pressure of the resilient seal on the stop bar shall be adjustable using the side wedges of the gate.

1.3.5 Wedging

Wedges shall be provided to ensure practical water tightness. At a minimum, gates subject to seating pressure shall have side wedges, and gates subject to unseating pressure shall have top, side and bottom wedges. Wedges shall be solid, of cast bronze and machined on all contact surfaces. They shall be attached to the disc with Type 316 stainless steel studs, nuts and adjusting screws with locknuts.

1.3.6 Seat Facings

Seat Facings shall be extruded bronze of a composition resistant to dezincification, and shall be shaped to permanently lock in the dovetail grooves when pneumatically impacted into place. Attaching pins or screws will not be allowed.

1.3.7 Wall Thimbles

All sluice gates shall be furnished and installed with cast iron, E or F-pattern wall thimbles to match the thickness of the walls in which they are installed. The thimbles are to be supplied by the gate manufacturer, and shall be machined and tapped to match the gate frame. The alignment shall be clearly marked, and the thimble sized to withstand all reasonable construction and operational stresses. The thimbles shall be of one-piece cast iron construction, and have a centred stop ring. A permanent gasket of uniform thickness shall be provided between the sluice gate and the thimble.

1.3.8 Stems

Operating stems to Type 316 stainless steel shall be provided and shall be of sufficient size to withstand the stresses induced by normal operation without buckling or permanent distortion. Stem guides shall be provided to ensure that the L/R ratio does not exceed 200. The stem shall be designed to transmit in compression at least twice the rated output of the floor-stand without distortion. Multi-section stems shall be connected with interchangeable bronze couplings threaded and keyed to the stems. Threading shall be subject to the Engineer's approval.

1.3.9 Stem Guides

Stem guides shall be bronze bushed cast iron, and mounted on cast iron brackets. They shall be adjustable in two directions and spaced not further apart than 3.0m and not to exceed an L/R ratio of 200.

1.3.10 Stem Covers

Clear, plastic stem covers shall be provided for all sluice gates. The stem covers shall be strong, tough butyrate plastic which resists breakage and remains clear during outside service. The stem covers shall be mounted on the floor-stands by cast aluminium adaptors.

1.3.11 Anchor Bolts

Anchor bolts shall be furnished and installed where shown on the Drawings or directed, and shall be of Type 316 stainless steel.

1.3.12 Manual Operating Mechanisms

Operators shall be equipped with stem covers and shall be mounted on weather proof cast iron or fabricated steel pedestals. The pedestal shall have an ample base area to evenly distribute the load to the supporting concrete structure. The centerline of the manual operator shall be approximately 1.0 m above the base of the pedestal. Sluice gate hoist heads shall be cast iron. The operating nut shall be of solid 85-5-5-5 bronze. Operating thrust shall be taken on roller or ball bearings. All parts shall be provided with an alternative lubrication system. The unit shall be designed so that a maximum of 18kgf effort on the crank will operate the gate. Clockwise movement of the crank shall close the gate. The operating crank shall be easily removable to facilitate the use of a portable power operator.

1.3.13 Electric Motor Operated Sluice Gate Assembly

Each electric motor-operated sluice gate control assembly shall include the motor operator, reduction gearing, limit switch gearing, limit switches, torque switches, reversing starters, fully machined drive sleeve, declutch

lever, clear plastic stem cover, auxiliary handwheel and a cast iron floor-stand as a self contained operator. The electric motor operator shall conform to Clause 9.3 except as required elsewhere or as directed by the Engineer.

The penstocks shall be electrically driven, water-lubricated, enclosed vertical spindle type with below floor discharge branches. They shall be designed specifically to give trouble free operation without the need for frequent withdrawal for inspection, overhaul or repair. Consequently the gate thicknesses, sliding seals spindle diameter and thicknesses, etc shall be generously designed so as to provide a high degree of reliability. The penstock materials shall be at least of the quality specified below and Bidders who wish to recommend different materials of higher quality in order to enhance the reliability of the penstocks and minimise component corrosion or wear shall be free to do so. Such recommendations shall be shown in the Technical Data Sheet in Section IV – Bidding Forms. Where components of dissimilar material are used for adjacent components and these would be prone to corrosion if they come into contact, they shall be separated by suitable protective material. Routine maintenance shall, as far as possible, be such that it will not require the attention of highly skilled personnel.

Bidders shall provide substantiated evidence of reliability and corrosion/wear resistance for equipment similar to those offered that have been installed elsewhere and have been operating under similar conditions.

The penstocks shall comply with the appropriate BSI or AWWA or ISO Standards and this information shall be submitted as part of the supplementary technical information that accompanies the Bid. All penstocks shall be Works and Site tested in accordance with the specifications below.

1.3.14 Additional features

The penstocks shall be provided with corrosion resistant material. All casings shall be corrosion free/ stainless steel.

Headstocks shall have cast iron pillars and hand wheel and incorporate ball bearings. Hand wheel shall be adequate diameter so as to follow one-man operation without excessive effort, and if necessary shall be geared. Extension spindles shall be made of stainless steel, with sufficient number of cast iron guide brackets provide to prevent distorting of the spindle. Guide

brackets shall be “bolt on” pattern complete with fixing bolts. Penstocks with a width exceeding 1.2 m shall be equipped with two spindles.

Generally: The control valve actuator shall be suitable for remote control, local control, and manual control. The unit shall be equipped with limit switches for end positions, position feedback potentiometer for regulation, and position indication as well as all necessary control and monitoring devices. The control and monitoring panel shall be part of the common control board/cabinet.

The actuators shall be designed in such a way that following the failure of the actuator, the shut-off element may still be actuated manually (handwheel or similar device). The actuators shall be perfectly suitable for the duty intended (opening and/or closing and regulating the control valve) under the specified differential pressures and ambient conditions. The actuators shall be equipped with limit switches for both end positions, and if the corresponding valve has a control function, a position feedback potentiometer for regulation and position indication as well as all necessary control and monitoring devices will have to be provided. The minimum protective system for the electric actuator unit shall be IP 55. All actuators are to be equipped with limit switches as well as with torque limit switches. If the standard equipment comprises a thermal protection, this thermal protection is to be integrated in the control system. The actuator units are to be delivered for a voltage of 220 – 230 / 380 – 400V. The limit switch and safety limit switch messages are to be issued as potential-free contacts. An anti-condensation heater is to be envisaged. With valves which are exclusively operated by hand, the corresponding values according to DIN 3230 are to be met. The closing times of the electrically operated valves will have to be in accordance with the hydraulic calculation.

The motors shall be horizontal, squirrel cage induction type, constant speed motors. They shall be high thrust, open drip proof and suitable for full voltage starting and shall have Class F modified insulation to IEC 85 or equal standard. The full load temperature rise shall not exceed Class B by resistance method above 40°C ambient.

Motors shall be equipped with a minimum of three positive temperature coefficient thermistors connected in series, with leads brought out to a suitable terminal box. The motor frame and end shields shall be made of cast iron and all exterior and interior surfaces shall be primed and finished in accordance with manufacturer's standards. Threaded drain holes with plugs shall be provided in the lowest points of the motor enclosure to permit drainage of condensate. All openings in the motor enclosures shall be

vermin proof. All machined fits shall be coated with corrosion resistant material. All hardware such as bolts and nuts shall be made of corrosion resistant material. Terminal boxes shall be of cast iron or heavy gauge cold rolled steel construction, diagonally split and suitable for 4 (four) 90-degree positions. Gaskets shall be furnished at the boxes to seal out liquids. Motor leads shall pass through a watertight grommet or gasket seal where they enter the boxes from the stator frames. Boxes shall be tapped for standard conduit or cable connector openings. Terminal boxes shall be properly sized for cable terminations.

All motors shall be equipped with 230V AC space heaters to prevent condensation when the motor is de-energised. Heaters shall have a sheath of chrome steel or other corrosion resistant alloy. The surface temperature of each space heater shall not exceed 60°C. Space heater leads shall be brought out to a space heater terminal box, adjacent to the motor terminal box. All leads shall be properly identified.

Motors shall be equipped with properly sized grounding lugs in the terminal boxes. The motor frames shall have provision for grounding. All motors shall be equipped with grease lubricated rolling element bearings and fittings.

The motors shall be suitable for at least 4 starts per hour.

1.4 Surge Vessel And Air Compressor

1.4.1 General

The Surge Vessels shall be installed at the Raw Water Pump station to protect the pumping main from the adverse affects of the water hammer when the pumps trip off due to power failures or sudden stoppage of the pump. The Surge Vessels shall consist of a vertical steel tank, enclosed bladder, compressor, connection valve, pipes and all necessary appurtenances to arrest surges in water pumping main. The surge vessels and accessories should be supplied by a single manufacturer who will also provide analysis on the selected size. The supply and services include:

- Design of the surge vessels
- Supply of surge vessels as described below
- Installation of the surge vessel
- Construction of suitable concrete base for the surge vessel
- Supply and installation of necessary pipes and fittings, valves etc., necessary for smooth function of the surge vessel.

1.4.1.1 Type

Surge vessel shall be of air pressured vertical, bladder type suitable for open-air installation, subject to the condition that vessel capacity shall not be less than 1 m³. If there is any deviation in vessel capacity, details of the surge analysis calculations shall be submitted. For this calculation the Contractor can obtain the basic data from the given pump specifications and detail drawings. Detailed drawings showing materials of construction shall be submitted to the Engineer before fabrication of the vessel.

1.4.1.2 Quality Assurance

The surge vessel manufacturer shall be certified according to the relevant authority (BSI, ISO etc.) for the manufacturing facility of the surge vessel. The Contractor is responsible for obtaining the necessary approvals from the relevant authorities for legal operation on the Site under the ruling conditions of operation. Total Quality Assurance system shall comply with ISO BS 5750, ISO 9001 or 9002 series/BS EN ISO 9001 or 9002 series or an equivalent acceptable to the Engineer. The certificates valid for current production (years 2012/13) shall be submitted together with detailed drawings.

1.4.2 Vessels

1.4.2.1 Vessel Design

The surge vessel shall be made of welded steel shells and dome ends according to BS 1501 Part 1 or equivalent. The volume of the tank and operating pressure shall be in accordance to the calculation given by the manufacturer subject to a minimum of 1 m³. The vessels shall each be provided with a manhole access and a drainage system. The vessels shall be of vertical type and mounted on legs. The vessel shall be provided with all necessary pipe works, valves etc., and connections, tapping points for instrumentation, vents and drains and a pressure gauge. The vessel shall be protected with a safety valve and volume of vessel shall not be less than 1 m³. The Surge vessel shall be designed for anchor bolting to a concrete foundation. The supports shall be designed to withstand all natural loadings, any hydraulic and pneumatic thrusts resulting from surges.

1.4.2.2 Painting

The surge vessel shall be painted as indicated below:

- Internal coating – Food quality epoxy paint approved by paint manufacture with a 10 year warranty.
- External coating – 3 coats of epoxy, approved by a paint manufacturer with a 10 year warranty.

- External coating colour-Shall be Sky Blue .

1.4.2.3 Bladder

The bladder shall be made out of butyl and shall be easily replaceable. It shall be suitable and approved for use in drinking water systems. The bladder shall be perfectly watertight and airtight after the installation inside the vessel.

1.4.2.4 Fittings and Instruments

Each surge vessels shall be equipped with the following:

- Flanged outlets
- Inspection hole
- Drainage plug
- Glass tube levels indicator with an isolating valve
- Pressure gauge with isolating valve
- Safety valve
- Air inflation plug

Supporting legs

- Lifting lugs
- Air Compressor
- Sluice valves with necessary bypass arrangement with orifice plate to cater return wave if necessary.

1.4.3 Factory Testing

1.4.3.1 Materials

Strength tests of the steel, Butyl and welded joints of the surge vessel shall be performed in accordance with the applicable standards. The Contractor shall furnish the Engineer with certified copies of the results of all tests along with the standards.

1.4.3.2 Hydraulic Test

The surge vessel shall be hydrostatically tested at 1.5 times the maximum working pressure for not less than 60 minutes. During the test, the vessel should not show any undue deflection, signs of weakness at any point or leaks through welded joints/ gaskets or other defects. The Contractor shall furnish the certified copy of test results to the Engineer.

1.4.3.3 Performance Test

The surge vessel shall be factory tested for its performance. The Contractor shall submit the test results before shipment of the vessel.

1.4.3.4 Surge Vessel

The supplier shall submit all the calculations if necessary and details related to the above surge vessel as per the specifications. The surge vessels are to be installed at locations shown on the drawings.

Raw Water Pump station

Description		Surge vessel at Intake Pump station
Maximum vessel capacity	 (indicate)
Base plate coefficient	 (indicate)
The allowable pressure range in the pipe line	Minimu m	-0.6
	Ma xim um	25 bars
Expected particle size	

The vessels shall be designed to maintain the pipeline pressure within the range mentioned above. For basic data required for surge analysis, please refer data given under pump specification and the Drawing.

1.4.4 Specifications for Air Compressor

1.4.4.1 Scope

The compressor shall be integrated units with vertical or horizontal tank and piston compressor aggregate mounted on the top and total product should be confirmed to ISO/BS standards. The compressor shall be compatible with the surge vessel specification, to create necessary pressure requirement of the above surge vessel.

1.4.4.2 Design

The compressor unit shall be protected against corrosion.

The unit shall be equipped with: oil separator for oil free outlet of compressed air, pressure regulator, and suction filter, automatic pressure control of start and stop of the compressor aggregate, line circuit breaker and water trap. Mains supply: 400 VAC, 3 Ph, 50 Hz Starting method : DOL

(Direct On-Line) Maximum allowed noise pressure : 85 dB @ 1m. The compressor with tank may be regarded as pressure vessel and thus they shall be supplied with approval for operation in Kenya from the relevant authorities.

Type	Capacity (lit)	Maximum pressure/ (bar)	Type of connection
Reciprocating type, with squirrel cage, three phase induction motor	50 -100	10	Flexible Hose up to connection

DETAILS TO BE PROVIDED FOR APPROVAL

Surge Vessel

	Make & Country of Manufacture
	Name and address of Manufacturer's factory E-mail Address Fax/Tel
	Type
	Model
	Volume of the cylinder (m3)
	Standard to which the Surge Vessel is Manufactured
	Maximum Working Pressure
	Maximum and minimum surge pressure of the pumping main without the surge vessel

	Maximum and minimum surge pressure of the pumping system with the surge vessel operation
	Material of construction a. Vessel b. Bladder
	Are all fittings and instruments specified available
	Indicate quality of painting a Internal b External
	Operating principle
	Adjustable Range

Air Compressor

	Make & Country of Manufacture
	Name and address of Manufacturer's factory E-mail Address Fax/Tel
	Type
	Model
	Capacity (m ³ /hr)
	Delivery pressure m / bar
	Casing Material
	Speed RPM
	Noise Level dB

1.5 OSEC Plant

1.5.1 Scope

The main scope of this activity is supply, install and commissioning of **An On Site Electrolytic Chlorination (Osec) Plant and its associated equipment** at Thika Water & Sewerage Company Ltd's Water Treatment No. 2. The assignment is divided into 2 parts as follows:

- Supply, install and commission an OSEC Plant complete (including mechanical and electrical works) with all accessories; as proposed by the bidder
- Civil works (piping to the existing salt saturator 50m from the OSEC building) and ancillary items.

The components of the assignment are implementation of necessary investigations (options to connecting to existing plant), detailed design and installation of one unit of OSEC Plant. This will require detailed descriptions and 'As Built' drawings and all other necessary documents upon commissioning.

1.5.2 Specifications

The On Site Electrolytic Chlorination (OSEC) plant is a system used to provide viable, efficient and safe chlorine for potable water disinfection.

An OSEC plant uses softened water and salt (Sodium Chloride) to produce Sodium Hypochlorite on site and on demand through the electrolysis of a brine solution. This is a convenient system because the sodium hypochlorite can be produced on site as and when it is needed. The hypochlorite is generated electrolytically from solution of brine and softened water by OSEC electro-chlorinator.

A typical OSEC plant generally has the following components:

- a) **WATER SOFTENER:** to provide softened water to the brine equipment and electro chlorinator
- b) **SALT SATURATOR:** to produce the concentrated brine solution used by the electro chlorinator
- c) **THE BRINE PUMP:** for metering and pumping the brine from the saturator to the electro chlorinator
- d) **ELECTRO CHLORINATOR:** which generates the Sodium hypochlorite solution
- e) **TRANSFORMER/RECTIFIER UNIT:** which provides the low voltage/high current DC supply to the electro chlorinator to effect electrolysis
- f) **CONTROL UNIT:** This controls the level of operation of the plant automatically depending on different operating parameters e.g. temperature

- g) **STORAGE TANKS:** for storage of the sodium hypochlorite and allowing release of the hydrogen gas to the atmosphere

The OSEC system to be supplied shall be complete with all the components including installation and commission.

There is already an old system running. Inclusion of parts of the existing system shall be at the discretion of the Client during the award of the Contract.

The system to be supplied should have been on the market for a minimum period of two (2) years.

1.5.3 Water Softener

In an OSEC plant, the saturated brine and the dilution water which is used by the electrolyzers to produce NaOCl solution must be as soft as possible (Maximum 25mg/liter of CaCO_3) to eliminate the buildup of deposits on the electrolyser electrodes during electrolysis, as these deposits would seriously impair the efficiency of the OSEC unit. As such, the plant should include a water softener capable of producing water not exceeding 25mg/liter of CaCO_3 .

1.5.4 Size of Plant

- a) The OSEC plant should be able to produce Sodium Hypochlorite adequate to meet the full capacity of the Client's Water Treatment Plant of 30 Mega liters a day.
- b) The minimum demand of Sodium Hypochlorite per day is 285 kg/day.
- c) This means that components like the brine pump should have adequate capacity to pump enough brine solution from the saturator to meet this chlorine demand. This also means the OSEC electrolyzers should be capable of generating a minimum of 285 kg/day of Sodium Hypochlorite.

1.5.5 Transformer/Rectifier Unit and Control Panel

The supplier shall describe and specify the kind of transformer and rectifier that shall be used for powering the OSEC electrolyzers to the satisfaction of the client. Further to this, details should be given for the device that shall be used for the automatic control of the operation of OSEC plant.

1.5.6 Salt Specifications

The OSEC plant should be able to conform to the salt that is currently used by Thika Water & Sewerage Company Ltd. The salt has the following specifications:

- Maximum level of Water Insolubles of 0.1%
- Maximum level of Calcium Sulphate 0.14%
- Maximum level of Magnesium Sulphate 0.02%
- Maximum level of Magnesium Chloride 0.1%
- Minimum level of Sodium Chloride 99.82%

These specifications are for **Pure Vacuum Dried Salt**.

Alternatively the supplier should specify the kind of salt that shall be used for the OSEC plant that they are proposing to install. In case of the supplier proposing an OSEC plant that uses salt outside the specifications given above, the supplier should give an indication of the current cost of the salt per kilogram and where it can be sourced bearing in mind the geographical location of Kenya.

The equipment also has to be capable of handling any of salt outside these specifications but capable of producing the same quality of Sodium Hypochlorite.

1.5.7 Specification of Quality of Sodium Hypochlorite produced

The plant should be capable of producing a Sodium Hypochlorite solution concentration of between 0.8 to 1% concentrations.

1.6 Construction Elements

1.6.1 General

A clearance of at least 2 meters shall be given to overhead structures to provide for unobstructed passage.

All equipment which is not embedded shall have lifting lugs, holes for eye bolts or have instructions for fixing of lifting belts for easy handling. Rotating machine parts shall be provided with solid covers. The covers shall be easy to remove for inspection.

1.6.2 Bolts, Studs, Nuts, Screws, Washers

All bolts, studs, nuts etc. shall have a standard metric threading and conform to the relevant standards as regards shape and tolerance, and they shall be marked by manufacturer's symbol and class of strength.

Nuts and bolt-heads shall be hexagonal in shape and truly faced. Bolts and screws with sunk heads such as Hexagon Socket Head Cap Screws or Hexagon Socket Countersunk Head Cap

Screws shall be hot dip galvanised only.

All bolts, studs, nuts, washers screws etc., above size M 16, shall be hot dip galvanised, except for bolts above Strength Class 8.8., for which corrosion resistant materials or electrolytic zinc-coating will be preferred.

Bolts, etc., smaller than size M 16 shall be hot dip galvanised steel.

All bolts and nuts used in bolted and screwed joints in hydraulic steel structures shall have a minimum dimension of M 16.

Expansion bolts shall have a minimum dimension of M 16 and be in hot dip galvanised steel.

Bolts, nuts, studs and screws, which require frequent tightening and unbolting during inspection or maintenance procedures, shall be in hot dip galvanised steel.

1.6.3 Stairs, Ladders and Platforms

Generally all equipment shall conform to international accepted standards.

Platforms and stairs shall be provided with slip resistant gratings or checker plates.

All ladders and platforms in waterway (gate shaft etc.) shall be made from GRP.

Stairs, ladders and platforms etc. may be manufactured in Aluminium, if the rigidity of the structures is duly considered.

1.7 Instrumentation

1.7.1 Field Instrumentation

For design, construction and testing the applicable codes and standards as listed in this document shall be followed.

The instrumentation equipment must be suitable for continuous full load operation under the given environmental conditions.

1.7.1.1 General Design and construction criteria

General

In general, all field instruments must be suitable for open air operation, independent of the actual installation condition and location.

All instruments in a drinking water process must be suitable for drinking water application in compliance with the WHO Regulations.

In order to obtain a high reliability, long term and undistributed operation of the instrumentation, the following basic requirements must be observed:

- All instruments shall be of high quality industrial standard type.
- All instruments shall be solidly built using high quality components of the latest up-to-date technology.
- Measuring errors and response time shall be as low as possible.

- All materials shall be selected to withstand for their life time the media and the environmental conditions that they will be exposed to.
All equipment and materials must be designed and selected accordingly, considering also the possible changes in the water analysis due to changed receiving conditions.

Instrument Measuring Units

In general, the metric system (SI-system) shall be used for all purposes.

The following measuring units shall be used for calculations as well as for indication of instrument scales, controllers and read out units:

Temperature	oC (degrees centigrade)
Static pressure bar	
Absolute pressure	bar (a)
Differential pressure	bar, mbar
Level	m, mm
Flow	m ³ /hr, l/sec
Velocity	m/s
Vibration	mm/s
Hydrogen	ionactivity pH
Conductivity	μS/cm
Chloride	mg/l (ppm)
Turbidity	NTU

Accuracy Requirements

The instruments shall guarantee the accuracy features being specified in this section.

Accuracy will be expressed in percent of adjusted span as far as not specified in percent of the measured value.

The given %-values contain the whole instrument loop including power supply units up to the output signal to the control system.

1.8 Plant and Equipment Identification

The Contractor shall prepare comprehensive plant identification schedules showing the name and number of each item of plant and its respective arrangement drawing number and add any additional items necessary to

fully identify the plant which are subject to works under this contract. The identification and numbering of equipment, systems, items etc. provided, as well as all documents and drawings, shall be in accordance with existing numbering and the Engineer's instructions. In other words, all important parts of plant and equipment must be described to such an extent, that an identification by the operating staff (not only specialists) would be easy possible. The Contractor shall supply all labels, nameplates, instruction and warning plates necessary for the identification and safe operation of the plant and all inscriptions shall be in English. All labels, nameplates, instruction and warning plates shall be securely fixed, all appropriate items of plant and equipment with stainless steel or aluminium rivets, plated self-tapping screws or other approved means. The use of adhesives will not be permitted as well as the use of paper labels.

Outdoor nameplates, labels and instruction plates for plant and equipment identification and record purposes shall be manufactured from stainless steel or aluminium with a matt or satin finish and engraved with black capital lettering of a size which is legible from the working level.

Outdoor warning plates shall be manufactured from stainless steel with a matt or satin finish, engraved with red lettering and sited in a position which affords maximum personnel safety. Indoor labels, nameplates and instruction plate shall be manufactured from synthetic material (e.g. laminated rigid plastic labels) with the same substantial requirements as above mentioned. All equipment within panels and desks shall be individually identified by proper labels.

Each valve shall be fitted with a stainless steel nameplate with the number according to "Classification System for Plant and Equipment" indicating the valve schedules as approved by the Engineer. Where possible valve nameplates shall be circular and fitted under the handwheel captive nut. On check valves and small valves the Contractor may provide rectangular nameplates fitted to brackets on the valve or attached to a wall or steelwork in a convenient position adjacent to the valve.

1.9 Pre-Service Cleaning and Protection of Plant And Equipment

1.9.1 General

This clause covers mechanical and chemical pre-service cleaning and protection of the plant items and equipment that are not subsequently to be painted. Cleaning of fabricated component items shall be carried out after fabrication and final heat treatment or welding at manufacturer's works or at site, as appropriate. Mechanical cleaning as opposed to alternative chemical cleaning is the preferred method for works cleaning except where this is precluded by design or access considerations.

Machined surfaces shall be protected during the cleaning operations. In the event of the surfaces not being cleaned to the Employer's satisfaction, such parts of the cleaning procedures or agreed alternatives as are deemed necessary to overcome the deficiencies shall be carried out at the Contractor's sole expense. For reclining small areas, hand cleaning by wire brushing may be permitted. Wire brushes used on austenitic materials shall have austenitic steel bristles. Austenitic stainless steels, copper and aluminium alloys, cast iron, bimetallic/plastic items and components fabricated by spot welding or riveting shall not be chemically cleaned. All weld areas shall be suitably stress relieved before chemical cleaning.

The date and place at which works cleaning will be carried out shall be notified to the Employer or its Consultant at least six weeks in advance for witnessing and inspection. The Contractor shall take all responsibility for the treatment and disposal of waste according to the local law, in agreement and to the satisfaction of the Employer.

1.9.2 Mechanical Cleaning at Manufacturer's Works

Mechanical cleaning shall preferably be carried out by abrasive blasting. The Employer is prepared to consider alternative methods provided they achieve the necessary surface condition.

Surface condition:

The metal surfaces shall be clean and free of mill scale, rust dirt, grease and any other deleterious matter. Where metal surfaces are to be painted, the surface profiles shall conform with the painting specification requirements. Where this does not apply surfaces shall have a surface texture not coarser than Grade 80 abrasive paper.

Abrasives:

Abrasives containing silica, silicates or slag residues shall not be used for water/steam side surfaces of plant except for cleaning sand castings, where hydro blasting with sand may be used.

1.9.3 Protection at Manufacturer's Works

As soon as all items have been cleaned and within four hours of the subsequent drying, they shall be given suitable anti-corrosion protection, of sufficient quality to protect the materials and equipment for an extended period of time, in case of delayed dispatch or commissioning.

All water, air and oil side surfaces shall be protected by the application of approved watersoluble corrosion inhibitors, or at site the plant shall be made available for inspection. In the event that the surfaces are not cleaned to the

Engineer's satisfaction such parts of the cleaning procedure or agreed alternatives as are deemed necessary to overcome the deficiencies shall be carried out at the Contractor's sole expense.

1.10 Ancillary Mechanical Equipment

1.10.1 Gear Reduction Units

Units shall utilize bevel and helical gears and be designed to DIN standards, or other approved standard. Each reduction unit shall be designed to withstand all internal loading developed at the full load power of the motor (including motor starting torque up to 250% motor running torque), and the reverse torque produced upon stopping the prime mover together with any external loading produced by thrust, unbalance and vibration resulting from operating conditions.

Gears, pinions and shafting shall be made out of wrought and alloy steels. The gear teeth shall be hardened by a suitable method. All gears shall be manufactured to DIN or equivalent standards.

Housing shall be constructed of high-test grey cast iron to GG25 or fabricated mild steel and shall have adequate strength and rigidity to withstand all loads imposed by the operation of the equipment. Lifting lugs shall be provided.

All bearings incorporated in the gear reduction units shall be of the anti friction type having a life expectancy of 100,000 hours based on the relevant ASTM standard.

1.10.2 Lifting Gear

1.10.2.1 General

Lifting gear and associated equipment shall comply in general with relevant DIN standards.

The assembly shall be suitable for lifting the heaviest single item of equipment within the working area. The load hook, incorporating ball swivel joint, shall extend to within 1.0m of the lowest working level, whilst sufficient headroom shall be allowed below the crane hook to enable the tallest item of machinery to clear the motor floor level by 1.5m.

1.10.2.2 Runway beam hoist

Runway beams shall be supplied complete with all fixings, fish-plates, bolts and end stops.

1.10.2.3 Travelling Bridge Crane (general)

Flat bottomed crane rails to DIN standard shall be complete with all fixing bolts holding down bolts, fish-plates, end stops etc. The crane rails shall be supported on concrete or steel corbels. Allowance shall be made for expansion.

1.10.2.4 Travelling crane (hand operated)

Travelling cranes and trolleys in general shall be of the single girder hand operated type. The crane shall have a geared cross travel, together with a suitable geared hoist, be fitted with an automatic braking arrangement and shall be capable of lifting the heaviest single item of the machinery within the working area.

1.10.2.5 Travelling crane (electrically operated)

The long travel drive motors shall be totally enclosed type with extended shafts and adjustable torque type disc brakes. The drive motors shall be fed from adjustable characteristics solid state soft controllers designed for the required high start-frequency including inching.

The crane motions shall be controlled by a low voltage pendant push-button station suspended from a track section, utilizing a festooned flexible PVC insulated platform cable and allowing control from any point across the span independent of the hoist position. A strain wire shall be provided. Both the push-button and the crane structure shall be clearly marked to indicate the directions of travel.

1.10.2.6 Davits

Davits shall be of the removable type complete with fixing socket and designed in general to DIN standards.

1.10.3 Chemical Storage Tanks

Prefabricated tanks for chemical storage shall be GRP, polypropylene as appropriate to the duty. GRP tanks shall comply to DIN standards. Hand lay-up chopped fibre construction will not normally be permitted. All necessary accessories such as ladders, rails, manholes, instrument connections de-aeration and filling pipe shall be included in the delivery. Emergency basin volume 1.0 x tank volume.

1.10.4 Foundations

Surface pump units, blowers, aerators, etc. shall be placed on the floor, but should always have a raised footing (support) which will distribute the weight more evenly and avoid damage. Height min 100mm. The footing should be made of reinforced concrete and should form one part with the floor. After installing, the steel foundation/baseplate of the units have to be grouted, thickness 15-30mm.

- The design of the base-plate shall be such that:
 - The stability of the equipment is guaranteed
 - Vibrations do not occur
 - The units easily can be dismantled without removing the base-plates

- Thread fasteners:
 - Material: hot dip galvanized steel or stainless steel (in aggressive ambient)
 - Anchor-bolts shall be placed in the concrete structure
 - For the purpose of leveling the machine no use shall be made of the anchor bolts; only set bolts shall be used
 - For grouting only a resin based mortar shall be used; use of cement mortar is not allowable. The grouting of the base-plates are included in this contract.
 - After the grout has cured the set-bolts shall be removed and the anchor-bolt shall be tightened

1.10.5 Pressured Air Vessel

Pressurized air vessel shall be designed, fabricated and tested in accordance with BS5500 and BS5169. It shall also comply with the Regulations in Kenya and shall be registered, as required by the Regulations.

The contractor shall submit the Test Certificate for the vessel to the Engineer.

The working pressure of the vessel shall be not less than 1700kPa.

1.11 Construction Elements

1.12 General

A clearance of at least 2 meters shall be given to overhead structures to provide for unobstructed passage.

All equipment which is not embedded shall have lifting lugs, holes for eye bolts or have instructions for fixing of lifting belts for easy handling.

Rotating machine parts shall be provided with solid covers. The covers shall be easy to remove for inspection.

1.12.1 Bolts, Studs, Nuts, Screws, Washers

All bolts, studs, nuts etc. shall have a standard metric threading and conform to the relevant standards as regards shape and tolerance, and they shall be marked by manufacturer's symbol and class of strength.

Nuts and bolt-heads shall be hexagonal in shape and truly faced. Bolts and screws with sunk heads such as Hexagon Socket Head Cap Screws or Hexagon Socket Countersunk Head Cap Screws shall be hot dip galvanized only.

All bolts, stud, nuts washers screws etc., above size M 16, shall be hot dip galvanized, except for bolts above Strength Class 8.8., for which corrosion resistant materials or electrolytic zinc-coating will be preferred.

Bolts, etc. smaller than size M16 shall be hot dip galvanized steel.

All bolts and nuts used in bolted and screwed joints in hydraulic steel structures shall have a minimum dimension of M16.

Expansion bolts shall have a minimum dimension of M16 and be in hot dip galvanized steel.

Bolts, nuts, stud, and screws, which require frequent tightening and unbolting during inspection or maintenance procedures, shall be in hot dip galvanized steel.

1.12.2 Stairs, Ladders and Platforms

Generally all equipment shall conform to international accepted standards.

Platforms and stairs shall be provided with slip resistant gratings or checker plates.

All ladders and platforms in waterway (gate shaft etc.) shall be made from GRP.

Stairs, ladders and platforms etc. may be manufactured in Aluminium, if the rigidity of the structures is duly considered.

1.13 Instrumentation

1.13.1 Field Instrumentation

For design, construction and testing the applicable codes and standards as listed in chapter 19.1.2 shall be followed.

The instrumentation equipment must be suitable for continuous full load operation under the given environmental conditions.

1.13.1.1 General Design and construction Criteria

General

In general, all field instruments must be suitable for open air operation, independent of the actual installation condition and location.

All instruments in a drinking water process must be suitable for drinking water application in compliance with the WHO Regulations.

In order to obtain a high reliability, long term and undistributed operation of the instrumentation, the following basic requirements must be observed:

- All instruments shall be of high quality industrial standard type.
- All instruments shall be solidly built using high quality components of the latest up to date technology.
- Measuring errors and response time shall be as low as possible.
- All materials shall be selected to withstand for their life time the media and the environmental conditions that they will be exposed to.

All equipment and materials must be designed and selected accordingly, considering also the possible changes in the water analysis due to changed **receiving conditions**.

Instrument measuring Units

In general, the metric system (SI-system) shall be used for all purposes.

The following measuring units shall be used for calculations as well as for indication of instrument scales, controllers and read out units:

- | | |
|-------------------------|---------------------------|
| • Temperature | °C (degrees centigrade) |
| • Static pressure | bar |
| • Absolute pressure | bar (a) |
| • Differential Pressure | bar, mbar |
| • Level | m, mm |
| • Flow | m ³ /hr, l/sec |
| • Velocity | m/s |
| • Vibration | mm/s |
| • Hydrogen ionactivity | pH |
| • Conductivity | µS/cm |
| • Chloride | mg/l(ppm) |
| • Turbidity | NTU |

Accuracy Requirements

The instruments shall guarantee the accuracy features being specified in this section. Accuracy will be expressed in percent of adjusted span as far as specified in percent of the measured value.

The given %-values contain the whole instrument loop including power supply units up to the output signal to the control system.

value	% of spanned	% of measure
-------	--------------	--------------

TRANSMITTERS (sensor, transmitter and converter)

- | | | | |
|------------------------|--------------------|------|------|
| • Pressure | bar | ±0.2 | |
| • Diff. pressure | bar | ±0.2 | |
| • Flow (magnetic type) | m ³ /hr | ±0.5 | |
| • Flow (other types) | | ±1.0 | |
| • Temperature | °C | ±0.5 | |
| • Level | m(mm) | ±1.0 | |
| • Hydrogen-ionactivity | pH | ±0.5 | |
| • Conductivity | µS/cm | | ±1.0 |
| • Chloride | mg/l | ±1.0 | |

INDICATORS (at panels)

General

Class 0.5

SWITCHES

- Pressure ± 1.0 2% Hysteresis
- Diff pressure ± 1.0 for all
- Level ± 1.0 switches
- Others ± 1.0

DIRECT TYPE INDICATORS

- | | | |
|------------------|--------------------|-----------|
| • Pressure | bar | class 1.0 |
| • Diff. pressure | bar | class 1.0 |
| • Flow | m ³ /hr | class 1.0 |
| • Temperature | °C | class 1.0 |
| • Level | m (mm) | class 1.0 |
| • Others | | class 1.0 |

Power Supply

Power supply of the entire instrumentation equipment shall be 24V DC + 10% - 15% supplied from the station DC distribution of 230 V AC + 10% - 15% with separate power supply unit and battery back-up.

Contract rating for all switches and contacts shall be generally suitable for the connected equipment load including appropriate safety margin,

Signals

Output signals for analogue instruments shall be general provided with 4 – 20 mA potential separated without reference to ground.

Signal repeater and power units shall be inserted in the measurement loop as per requirement.

Measurement signal from the elements to the transmitters and power units at a different signal Level than 4 -20 mA shall be minimized and used only for

- Temperature measurement (sensors)
- Level measurement (sensors)
- Flow measurement (sensors)
- In any case, the signal input/output to/from station control shall be provided with 4 – 20 mA, burden resistance shall be preferable 0 to 750 Ohm if no higher values are required.

Process Connection and Installation

In general, stainless steel materials shall be used for all parts of the instruments exposed to the process water. This includes all sensors, tubes, fittings, connectors, valves, etc.

Process connections shall depend on the instrument, either metric or NPT threaded taps or ANSI flanges shall be used, suitable for the required pressure class.

For process piping connection flare less tube fittings only shall be used.

Electric cable connections shall be provided with suitable sized stainless steel cable glands (pg type acc. To DIN or equivalent).

Instruments installed in outside and open areas or in exposed locations shall be installed in suitable instrument boxes or cabinets with opaque window covers. Such instrument cabinets/boxes must be provided with anti-condensate heaters. For further details see “installation and Hook-up of Field Instrumentation”.

Grounding

Potential equalizing cable and/or any other recommended and required grounding rings to guarantee proper and trouble free operation of the measuring units must be defined and supplied by the manufacturer, depending on the actual installation conditions.

Hazardous Locations

For all instruments installed in hazardous locations the respective explosion protection requirements must be fulfilled. Preferably equipment with the intrinsic safety class (Exi) with safety barriers or other approved electronic safety circuit separators shall be installed in the control room/instrumentation cabinets.

Instrument Identification

All instruments and associated equipment shall be provided with identification label containing the TAG No. of the instrument as per the respective P & I – diagram.

1.13.1.2 Instrument Characteristics

The following Chapter describes the main characteristics of the different instruments.

Flow Measurement

Flow meters shall be selected as per the specific system requirements. Preferably the following types shall be used only:

- Magnetic type
- Ultrasonic type
- Rotameter (also referred to as Woltman) type

The internal bore lining and the electrodes shall be of the field replaceable type. The internal bore shall be lined with hard rubber, PTFE or neoprene, and the electrodes shall be stainless steel or approved equal, depending on media. Measure range according to measure point.

Flow/level Measurement with ultrasonic transmitter, The accuracy of the measurements shall be $\pm 3\%$ of actual flow.

Flow Signal Converter

The flow signal converter shall be either primary head mounted or separated with file casing for wall mounting.

Distance between the primary head and the separated signal converter shall be possible u to 20m. The cable type shall be specified by the flow meter manufacturer depending on the actual installation conditions.

The signal converter shall be micro processor based including all necessary features for monitoring and control of the flow meter units, with analogue signal output for flow value and scalable frequency output for tatalised flow.

In addition the following auxiliary output options shall be available

- Reverse flow detection
- Zero flow detection
- Low flow cut-off
- Status signals, adjustable

Flow Switches

Mechanical or electrical operated insertion types shall be used.

Depending on location a threaded or a flanged connection might be foreseen. All part of flow switches which come into contact with water should be of high corrosion resistant stainless steel material.

Pressure Measurement

Manometer

Generally, Bourdon type pressure gauges filled with flui shall be used. Design in compliance with operational safety requirements of DIN 16006.

Differential pressure manometers shall be of Bourdon cell type and also liquid filled.

Nominal size;	160mm	for main process system
	100mm	for utility and auxiliary systems

All parts which are in contact with the water shall be selected as per the specified requirements; stainless s steel materials shall be used only.

The manometer shall be provided with overpressure protection.

Required accuracy: class 1.0

Manometer with Contacts

Pressure indicators (manometers) with integrated magnetic spring contacts shall be used for pressure switch application.

Depending on the requirement either single or double contact systems shall be used.

Set point adjustment from the outside by adjusting red pointer(s).

Contacts(s) rating shall be as specifications above.

Pressure Switches

Pressure switches with integrated SPD contacts shall be used.

Set point adjustment shall be possible depending on the selected characteristic, either low or high function.

Contact(s) rating shall be as per item specifications above.

Pressure Transmitter

Transmitters with well proven pressure measuring elements of the latest up-to-date technology only shall be used. Smart series is preferred.

2-wire-DC transmission with no need of a separate field power supply shall be used.

High over range protection and easy access for zero and span adjustment is required.

The instrument body and all parts being in contact with the water must be of corrosion resistant material, at least CrNi-steel shall be used for the body and the process connection part.

Required accuracy: better than $\pm 0.2\%$ of span

(including effects of hysteresis, repeatability and linearity.)

Differential Pressure

Manometers and transmitters for differential pressure shall be in principal in conformity with the requirements of above specifications

Measurement of Temperature

Temperature Indicator

Dial or tube thermometers with quick response time may be used for local indication

Depending on application, either directly mounted thermometers or capillary type thermometers shall be used, In general, suitable thermo-wells shall be provided.

Required accuracy: Class 1.0

Temperature Elements/Transmitters

Temperature elements for remote indication shall be of high repeatable and stable resistance type sensors with quick response time, preferably Pt 100 elements.

With the exception of special application inside machines or equipment, the temperature elements shall be generally installed in suitable thermo-wells.

All temperature elements shall be wired from the sensor terminal head up to the temperature transmitter in 3 –wire connection. If the cable distance between the sensor head and the transmitter is more than 20 m, the wiring must be performed in 4-wire connection.

Thermo-wells and temperature element tubes shall be generally made of stainless steel, CrNi-material. Suitable thermal paste shall be filled into the thermo well before insertion of the temperature element in order to avoid air pockets.

The temperature transmitters shall be installed in instrument cabinets and shall be of fully electronic type with 3-wire or 4-wire Pt 100 input and 4 – 20 mA 2 –wire signal output. Power supply preferably 24 V DC.

Level Measurement

Ultrasonic level Transmitter

If not otherwise specified ultrasonic level transmitter/sensors shall be used for contactless level measurement.

The sensor shall be temperature compensated and shall be connected to the central unit by two-core cable.

The central unit shall be microprocessor based, fully programmable by incorporated function keys.

The central unit shall be installed in the control cabinet or control panel front side.

The accuracy of the level measurement shall be in the range of $\pm 2 - 5$ mm.

Output for free adjustable level alarm contacts as well as analogues 4 – 20 mA signal and alarm relay output shall be provided on the central unit.

Hydrostatic Level Transmitter

Hydrostatic level transmitter/sensors shall convert the pressure of the liquid column into the level signal. Depending on the height of the reservoir or well the length of the probe and the connection to the sensor head must be selected. The pressure probe and the wall mounted supporting tube or rope shall be of high corrosion resistant material.

In case of pressurized vessels or tanks the pressure on top of the water level must be considered.

The electronic signal converters shall be wither installed in field boxes or in the instrumentation cabinets in the control room.

Output for free adjustable level alarm contacts as well as analogues 4 – 20mA signal and if required alarm relay output shall be foreseen.

Level Switches

Depending on location, float type or conductive sensing type, level switches shall be used. All parts of the level switches coming in contact with process

fluid shall be of high corrosion resistant material. The monitoring electronic unit for the conductive sensing type shall be provided as close as possible to the sensing element or incorporated.

Vibration level switches

The vibrating fork and socket shall be of stainless steel and without movement parts and shall be free of wear and maintenance. The sensor shall not be connected to a supply of voltage higher than 24 V.

Float switches

The construction of their suspension structures shall facilitate the simple height adjustment of the float switches. The positions of the float switches shall be allocated in such a way that there is no possibility of the float being trapped or caught by other moving parts. The float switches shall not be connected to a supply of voltage higher than 24 V.

Other measuring systems

All necessary analogue and discrete measuring devices are part of the contract and shall be mounted according to the manufacturer's standard.

Auxiliary Plant Instruments

For all auxiliary systems and plants all required instrumentation equipment shall be provided. Instrument characteristics shall be selected by the plant manufacturer in order to guarantee good and safe operation and performance of the system/plant. As far as applicable instruments with the same main characteristics as described shall be used.

1.13.2 Instrumentation and Hook Up

1.13.2.1 General

This chapter describes the requirements for the design, manufacturing and installation of instrument hook-up material, including the installation, calibration and testing procedures of all field instrumentation and associated equipment.

1.13.2.2 Standards and Codes

For the installation and testing of the instrumentation equipment the codes and standards as indicated in Specification.

1.13.2.3 Design Requirements

For the design, supply and installation of all field instrumentation hook-up material the maximum possible uniformity and interchangeability shall be considered in order to minimize different spare parts.

This specification will be also valid for the applicable instruments of the utility systems.

The used materials for all equipment, process connection tubes, fittings, valves and mounting supports shall be selected to withstand the water and the environmental conditions for the life-time of the instruments without corrosion and any negative effect.

In general, stainless steel or other suitable non corrosive materials shall be used for all equipment and components contacting the water.

1.13.2.4 Installation

General Requirements

The Contractor shall execute the installation. Calibration and the testing works for all field instruments in compliance with the scope of contract, including all associated equipment and works.

As far as possible the instruments shall be provided as pre-fabricated, work-shop tested and calibrated package units.

Process Connections

Generally all connections shall comply with the mechanical and piping requirements and as required by the equipment manufacturers.

Process connections on underground pipes shall be carried out in shafts with suitable space and access covers.

Process connections shall be at least ½” taps for pressure measuring. Type of connections shall depend on the instruments – either metric or NPT threads or ANSI flanges in accordance with the required pressure class.

For vendor packages and instrumentation at utility systems the approved manufacturer standard practice shall be applied.

Each instrument shall have its own main process connection, except the combination of transmitter, switches and gauge.

Each instrument shall have its own isolating 3-way valve including the appropriate test connections for calibration and testing of transmitter, gauge or switch.

Each instrument or instrument combinations shall have vent connections either separate or integrated in the instrument isolating valves.

All manometers shall be equipped with shock absorbers.

Local Instrument Cabinets (if applicable)

Instruments installed outside in open areas or at other exposed locations shall be mounted in suitable instrument boxes or cabinets. These cabinets shall be of high quality, resistant against corrosion and weather, consisting preferably of glass-fibre reinforced polyester resin.

Each cabinet shall be equipped with a thermostatically controlled electric heater in order to be protected against condensation. Electrical power

supply with 230V, 50 Hz from the instrument cabinet in the control room shall be provided.

Generally the cabinets shall have front access doors with observation windows. The front doors shall be designed sufficiently large enough to enable routine maintenance and the removal of instruments without dismantling other equipment.

Inside the cabinets mounting rails with C-profile or equivalent shall be provided, which allows fixing of the instruments and isolating valves. All instrument manifold valves shall be located inside the boxes.

A large number of different sizes of cabinets should be avoided and standard boxes shall be preferred.

The whole hardware needed for mounting and fixing, such as C-profiles, bolts, nuts, washers, screws, etc shall be of stainless steel material.

Instruments and hook-up materials within the instrument boxes shall be completely factory assembled or at least pre-mounted and pre-tested before installation on site.

All process line entries shall be provided with watertight seals. All electrical cable entries shall be carried out by suitable cable glands.

The instrument boxes shall be mounted directly on walls or on separate free-standing and stable galvanized steel supports.

Instrument Location

Instruments shall be mounted in such a position as to guarantee the specified accuracy of measurement, easy access for maintenance³, good visibility of indicating instruments and standardization of installation.

All instruments and associated equipment shall be mounted at such an elevation from the ground or service platform that no scaffolding is necessary for routine inspection and maintenance.

If not specified otherwise, instruments shall be mounted about 1.6m above the level of the operating platform or finished floor level of the building.

Specific Installation Requirements

All specifications, recommendations and mounting instruction of the instrument manufacturer must be considered in addition to the requirement listed here.

Flow Meters

Generally, all flow meters are located in underground shafts or in pump houses or reservoir chambers.

In all cases the installation of the flow elements shall be in accordance with the pressure class of the connected pipe work.

The power supply unit for the flow meter, incorporating the signal converter shall be either wall-mounted, direct sensor mounted or mounted in the control cabinet.

Grounding of the flow element is to be carried out by grounding rings at each end of the measuring tube. In addition, each flange of the connecting pipe must be equipped with a special grounding connection and shall be connected together with the earth strips of the metering tube to the common station grounding system. A grounding bus bar is to be provided in each flow meter shaft.

The cabling between the sensing elements and the transmitter (if separated) shall be carried out with special shielded cables, which are part of supply of the flow element. The prefabricated cables shall not be cut; excessive lengths shall be secured in a cable ring close to the flow element.

The flow meters shall be flanged. If necessary due to hydraulics in system pipe shall have shut off valve(s), gate valve type, on each side of the meter. Magnetic flow meters exceeding DN300 shall be equipped with dismantling joints. A replacement pipe section shall be stored for each dimension.

Measurement of Pressure

Generally, process connections shall be ½"-taps and include a block valve as part of the piping erection. For utility systems either 1" or ¾" –taps shall be used also with a block valve.

Each pressure measuring instrument as well as local indicators, pressure transmitters, pressure switches or indicators with contact shall have their own isolating valve (3-way-manifold valve) and shall be equipped with appropriate test connections for calibration.

For delta P instruments block valve combination or a 5-way multi block manifold valve shall be positioned directly at the pressure instrument connections. It shall also be equipped with a test connection and it shall be possible to shut off the test connection without isolating the service pressure for the instrument.

Each instrument or instrument combinations shall have separate vent piping with valve.

The dimension of the pressure piping shall be either ½" or 12mm. If pulsating pressure is to be assumed, generally pulsating dampers shall be installed. In case of possible vibrations special compensation loops shall be foreseen.

Continuous Measurement of Level

In general, all level measurements in tanks, reservoirs or structures shall be carried out by using level transmitters based on the ultrasonic or the delta-p measuring principle.

The sensors shall be situated in such a position that maintenance works and calibration can be carried out safe and easily. The sensors shall be installed close to the access openings.

Level Switches

Fixed installed level switches, operating on the capacitive principle or float type switches shall be provided accessible near and maintenance star/ladder.

1.13.2.5 Checking and Test in Completion

General

All checking and testing works during the final stage of construction of installations as well as during start-up and tests on completion have to be performed carefully and in accordance with the manufacturer's instructions.

Checking during Erection

The following checks shall be carried out continuously during the entire erection and installation period:

- Conformity of the works with the approved drawings, specifications and standards
- Proper execution of the works, especially protection of equipment during construction period
- The corrosion preventive paintings of all parts not accessible after installation.

Test on Completion of Installation

After completion of the installation works, tightness tests and pressure tests shall be performed by the Contractor. The object of these tests is to ensure that there are no leaks of threads, flanges or unions on piping connections and/or instruments.

The pressure tests shall be carried out at the design pressure of the instruments. The instruments shall be drained carefully after tests.

All these tests shall be recorded in lists containing the test pressure, the TAG number and the date of test and shall be signed by the responsible test engineer.

All possible precautions shall be made to avoid deterioration of the whole equipment during the test procedures.

Temporary Installation

Some instruments (control valves, flow meters) may be mounted temporarily to permit tie-ins of the instrument connections and the further pipe work. In

this case the equipment must be dismantled and protected during flushing and hydrostatic tests of the process piping system.

If necessary, such items shall be replaced by special spool pieces to permit the flushing and pressure testing of the piping without damaging the instrument equipment.

Protection during Painting

It is Contractor's responsibility to protect all the instrumentation during the site sand-blasting and painting of the associated station piping system.

In order to avoid destroying or damaging all instruments shall be dismantled or suitable covered.

Dismounted process connections have to be closed carefully to prevent entering of dust or paint.

Rating plates and labels shall be carefully covered if the equipment is not dismantled.

1.13.2.6 Calibration

General

Generally, all calibration and pre-settings shall be performed as far as possible either at the manufacturer's workshop or laboratories independently from the assembling operations. Pre-setting and re-calibration on site shall be performed after final installation of instruments. The instruments are to be kept sealed after calibration.

All apparatus necessary for a good quality calibration must have a higher precision than the instruments being calibrated and must be provided by the Contractor.

A check-out sheet shall be prepared for each instrument, containing TAG-number, the service, the type and characteristics of each instrument or element, the measuring range and limit values as well as the calibration results.

The instrument car shall carry also the following items:

- Date of inspection/calibration
- Name and legible signature of the person who performed the inspection/calibration
- Remarks on the detected defects, if any
- The register shall have two spaces for date and signature beside each item. Defective instruments must be returned to the manufacturer and are to be replaced by new instruments.

Local Adjustment

All instrumentation equipment, such as primary elements, transmitters, as well as panel mounted instrumentation, for the plants of the entire pipeline shall be finally adjusted on site with the most suitable apparatus, at least involving the following procedures:

- Zero and span adjustments for mechanically operated equipment (i.e. level gauging)
- Zero and span adjustment for transmitter with checking of intermediate valves at 0 – 25 – 50 – 75 – 100% of the span

In particular, the zero output signals sent to the control rooms shall never be less than the normal operating output.

In case of small deviation, a value above zero is preferred.

- Set point adjustment of all switches or alarms with accuracy control in increase and decrease, with three consecutive variations from minimum to maximum span of the switches. The set point absolute value must not deviate for more than 1% of the adjusted value after these variations.
- Checking of the polarities and voltage at terminals of each electrical or electronic instrument.
- Calibration of temperature instruments by use of calibrated test thermometers and thermostatic bath.
- Calibration of the receivers, recorders, controllers and indicators by means of calibrated precision current, voltage and resistance generators/bridges.
- Checking of all electrical circuits related to their primary elements, as transmitters, receivers, indicators, control and regulating valves
- Checking of the alarm and safety circuits.

Generally, the final testing and calibration shall be carried out by qualified instrument specialists and/or test engineers only.

1.14 Plant and Equipment Identification

The contractor shall prepare comprehensive plant identification schedules showing the name and number of each item of plant and its respective arrangement drawing number and add any additional items necessary to fully identify the plant which are subject to works under this contract. The identification and numbering of equipment, systems, items etc. provided, as well as all documents and drawings, shall be in accordance with existing numbering and the Engineer's instructions. In other works, all important parts of plant and equipment must be described to such an extent, that an identification by the operating staff (not only specialists) would be easy possible. The Contractor shall supply all labels, nameplates, instructions and warning plates necessary for the identification and safe operation of the plant and all inscriptions shall be in English. All labels, nameplates. Instruction and warning plates shall be securely fixed, all appropriate items of plant and

equipment with stainless steel or aluminium with a matt or satin finish and engraved with black capital lettering of a size which is legible from the working level.

Outdoor warning plates shall be manufactured from stainless steel with a matt or satin finish, engraved with red lettering and sited in a position which affords maximum personnel safety.

Indoor labels, nameplates and instruction plate shall be manufactured from synthetic material (e.g laminated rigid plastic labels) with the same substantial requirements as above mentioned. All equipment within panels and desks shall be individually identified by proper labels.

Each valve shall be fitted with a stainless steel nameplate with the number according to "Classification System for Plant and Equipment" indicating the valve schedules as approved by the Engineer.

Where possible valve nameplates shall be circular and fitted under the handwheel captive nut. On check valves and small valves the Contractor may provide rectangular nameplates fitted to brackets on the valve or attached to a wall or steelwork in a convenient position adjacent to the valve.

1.15 Pre-Service Cleaning and Protection of Plant and Equipment

1.16 General

This clause covers mechanical and chemical pre-service cleaning and protection of the plant items and equipment that are not subsequently to be painted.

Cleaning of fabricated component items shall be carried out after fabrication and final heat treatment or welding at manufacturer's works or at site, as appropriate.

Mechanical cleaning as opposed to alternative chemical cleaning is the preferred method for works cleaning except where this is precluded by design or access considerations.

Machined surfaces shall be protected during the cleaning operations.

In the event of the surfaces not being cleaned to the Employer's satisfaction, such parts of the cleaning procedures or agreed alternatives as are deemed necessary to overcome the deficiencies shall be carried out at the Contractor's sole expense.

For reclining small areas, hand cleaning by wire brushing may be permitted. Wire brushes used on austenitic materials shall have austenitic steel bristles. Austenitic stainless steels, copper and aluminium alloys, cast iron, bimetallic/plastic items and components fabricated by spot welding or reversion shall not be chemically cleaned. All weld areas shall be suitable stress relieved before chemical cleaning.

The date and place at which works cleaning will be carried out shall be notified to the Employer or its Consultant at least six weeks in advance for witnessing and inspection.

The Contractor shall take all responsibility for the treatment and disposal of waste according to the law, in agreement and to the satisfaction of the Employer.

1.16.1 Mechanical Cleaning at Manufacturer's Works

Mechanical cleaning shall preferably be carried out by abrasive blasting. The Employer is prepared to consider alternative methods provided they achieve the necessary surface condition.

Surface Condition:

The metal surfaces shall be clean and free of mill scale, rust dirt, grease and any other deleterious matter.

Where metal surfaces are to be painted, the surface profiles shall conform with the painting specification requirements.

Where this does not apply surfaces shall have a surface text or not coarser than Grade 80 abrasive paper.

Abrasives:

Abrasives containing silica, silicates or slag residues shall not be used for water/steam side surfaces of plant except for cleaning sand castings, where hydro blasting with sand may be used.

1.16.2 Protection at Manufacturer's Works

As soon as all items have been cleaned and within four hours of the subsequent drying, they shall be given suitable anti-corrosion protection, of sufficient quality to protect the materials and equipment for an extended period of time, in case of delayed dispatch or commissioning.

All water, air and oil side surfaces shall be protected by the application of approved water soluble corrosion inhibitors, or at site the plant shall be made available for inspection. In the event that the surfaces are not cleaned to the Engineer's satisfaction such parts of the cleaning procedure or agreed alternative as are deemed necessary to overcome the deficiencies shall be carried out at the Contractor's sole expense.

1.17 Signs

1.17.1 General

Safety colours, safety symbols and safety signs must comply in construction, geometrical form, colour and meaning with the ISO Recommendation 507 of the ISO committee TC 80 "Safety Colours".

Signs of plant identification during the erection period are subject to the Engineer's approval.

The signs shall be of a material which is weather-resistant and has sufficient longevity under the conditions prevailing on site.

The position for the signs must be chosen so that they are within the field of vision of the persons to whom they apply. The signs shall be permanently attached. Temporarily dangerous areas (e.g construction) sites, assembly areas) may also be marked by portable signs. The safety signs must be mounted or installed in such a manner that there is no possibility of misunderstanding.

All sites subject to any rehabilitation and renewal works shall be properly equipped with signs as specified under this clause.

1.17.2 Information Signs

Information signs shall supply the necessary information to acquaint personnel with the physical arrangement and structure of site, buildings and equipment.

For example:

Floor numbers, load-carrying capacities including marking of floor areas, working loads of cranes, lifting gear and lifts, room identification, etc.

In the choice of information signs for applications where nothing is specified by ISO Recommendation 507 the possibility of using pictograms shall be considered.

Pictograms are particularly suitable for the identification of rooms, area and buildings in the non-technical areas of the plant, sanitary and amenities buildings, etc.

1.17.3 Signs for Emergencies

In the event of accidents, all necessary information should be available immediately to those affected. Therefore a sufficient number of signs of appropriate size shall be installed such as, for example:

Escape routes (including marking of floor areas), emergency exits, fire alarms, fire extinguishers, instructions for special fire extinguishing agents, warnings against fire-extinguishing agents (CO₂), first aid points, accident-reporting points, telephones, etc.

1.17.4 Signs to be Obeyed

Signs to be obeyed must be installed wherever certain action is necessary, for example:

Do not obstruct entrance, keep right, etc.

Signs to be obeyed should also indicate when the wearing of protective clothing and equipment is necessary, for example:

Protective goggles, protective clothing, helmets, head guards, breathing equipment, ear muffs, etc.

1.17.5Warnings Signs

Warning signs should refer to the existence or possible existence of danger, such as:

Inflammable substances, explosive substances, corrosive or noxious substances, suspended loads, general danger, width/height restriction, danger or trapping, steps, slipping, falling, etc.

In addition to warning signs, appropriate black and yellow stripe markings shall also be used where necessary.

1.17.6Prohibition Signs

Prohibition signs are as follows, for example;

No smoking; no fires; no naked lights or smoking; no entry to pedestrians; use no water; no entry; do not start; etc.

1.18 Fire Protection Equipment

In each pumping station and buildings of the various treatment works CO₂ gas fire extinguishers shall be provided. The portable fire fighting equipment shall be in accordance with codes of practices, BS 5306, BS 7863 and BS EN 3.

The equipment shall be portable and have a minimum of 5kg capacity. It shall be of rechargeable metal body type.

If not otherwise specified in the particular specifications or the BoQ, 2 no. fire extinguisher shall be provided in each building.

The fire extinguishers shall be mounted on the wall with brackets where directed by the Engineer. The location shall be indicated with proper signs above the units.

The units shall be simple to operate with controllable discharge and shall be fitted with rotary non-conductive and anti-static distributor horns.

2 GENERAL ELECTRICAL REQUIREMENTS

2.1 General

2.1.1 Field of application

General specifications apply to supply, installation and operation of particular electrical and mechanical devices and systems, including detail design-especially the electrical single line diagrams-, software, documentation, spare parts and all associated items to be delivered within the frame of this contract.

The work under this contract involves the provision of all labour, materials and equipment required for the installation, testing and commissioning of complete and functioning system as specified herein and any other items of plant, equipment or materials required to form a complete installation.

The general Specifications are an integral part of the Contract Documents, and shall be read accordingly, comply with the requirements of the Conditions of contract and general Requirements.

2.1.2 Relation to other Sections

This Section includes specifications for products, common criteria and characteristics and methods of execution that are common to one or more Sections of the Electrical Division, and it is intended as a supplement to the required unit of work of each section and shall be read accordingly.

2.1.3 Uniformity of Products

Coordinate with the sections of this Division and other Divisions of the Specification to supply products of the same manufacturer when these products have similar functions and characteristics. When the same manufacturer cannot be used by all sections for a similar product, and the product is installed in finished areas, the products shall be similar in style and finish as directed by the Specification.

Following are examples of products which should be coordinated with other sections:

- High and low voltage energy and control cables
- Lighting
- Switches and sockets
- Products with special surface treatment or finish and colour
- Motor starters, soft starter and frequency inverter
- Disconnect switches and circuit breaker
- Contactors
- Control and protection relays
- Programmable control relays
- Analogue and digital instruments

- Command equipment installed in switchboards

-

2.1.4 Quality of Products

Manufactured products supplied and installed under Work of Section of this Division shall be new, the best of their respective kind available on the international market, free of all defects, and in accordance with Contract Documents.

Fabricated products shall be assembled from new materials, and in accordance with Contract Documents. All products to be located in non-air-conditioned areas shall be approved for use in 50°C ambient and 100% R.H. non condensing unless specified otherwise, including sunshine effect where exposed outdoors.

2.1.5 Qualifications of manufacturers

Products specified in this Division shall be manufactured by manufacturers regularly in the production of the specified product.

2.1.6 References

All products shall be in accordance with Section “*standards and approvals for electrical installations and equipment*” as well as to other governing bodies acceptable to the local Authorities.

2.1.7 Test reports and acceptance procedures

Submit product factory test reports when requested for review a minimum of four weeks prior to installation of the product.

Inform the Consultant latest fourteen days prior to a product factory test being performed. The Engineer shall be given the opportunity to witness the tests as his discretion.

Submit to the Consultant copies of Inspection and Completion Certificates as prescribed in the applicable Regulations of the IEE and responsible Electrical Authority.

Apply for, obtain and pay for all permits, licences, inspections, examinations and fees required.

Before starting any work, submit the required number of copies of drawings and specifications to the Authorities for their approval and comments. Comply with any changes requested as part of the contract at no cost to the Client, but notify the consultant immediately of such changes, for proper processing of these requirements. Prepare and furnish any additional drawings, details or information as may be required.

20.1.8 Letters of Satisfaction

Submit originals of letters from the manufacturers of products listed, indicating that their technical representatives have inspected and tested their

respective products and are satisfied with the methods of installation, connection and operation.

These letters shall state the names of person present at time of testing, the methods used, a list of functions performed and the location and room number where applicable. Submit such letters for equipment as specified in the Particular Specifications, but in principle for:

- High/medium voltage switchgears
- Low voltage switchboards and sub-panels
- Pump motors
- Pumps
- Circuit breaker
- Soft starter
- Frequency inverter
- Standby generator
- Transformer

2.1.8 Instructions to Client`s/Employer`s staff

Instruct the Client`s representatives in all respects of the operation and maintenance of system and equipment, listed in the relevant Sections of Particular Specification. Obtain in writing from the Consultant a list of the Client`s Representative qualified to receive instructions.

Arrange and pay for services or service engineers and other manufacturer`s representatives required for instruction on specialized portions of installation.

2.2 Standards and Approvals for Electrical Installation and Equipment

2.2.1 General

In general great importance is attached to accurate execution of works so that the installation permanently withstands the environmental stress and that reliable function is guaranteed.

It is under the responsibility of the contractor to ensure that all electrical and mechanical devices are constructed in accordance with the pertinent specifications and that import, installation and operation is permitted. The contractor is responsible for any kind of legal obligation to obtain official approval.

2.2.2 Standards and approvals

The design, the contractor`s documents, the execution and the completed works shall comply with the country`s technical standards, building, construction and environmental laws, laws applicable to the product being produced from the works, and other standards specified in the employer`s requirements, applicable to the works, or defined by the applicable laws.

In general all electrical and mechanical devices and installations shall conform not only to effective national standards and approvals but also to the Harmonized European Standards (IEC/EN). The devices must be marked accordingly. It concerns such as installations, operation, installation materials, methods and specific climatic and safety conditions as well as electric devices such as low and high voltage switchgear, switchgear assemblies, motors, cables, transformer, softstarter, relays, frequency inverter, panels, earthing, lightning protection devices, etc.

To reach the specified requirements concerning quality, function, safety, reliability, compatibility and Employer`s requirements, electrical equipment and installations shall comply with the Harmonized European Standards (IEC/EN is not appropriate or not sufficient). The devices must be marked accordingly.

All electrical devices to be provided shall also conform to the European low-voltage directive and must be provided with a CE-mark (Conformite' Europe'en). Other standards approved to be equal to have to be accepted by the Client. The bidder is obliged to point out variances.

All electrical devices and installations to be provided must comply with the Electromagnetic Compatibility (EMC) Directive.

The technical instructions of National and Local Electricity Authorities (power utilities) shall be considered. Special attention shall be paid to the connections to the public grid. Selection of material and devices as well as the dimensioning and construction of the grid connections shall correspond to the instruction of the power utility as well as to relevant IEC/EN standards and instructions given by manufacturers. All relevant installations shall be clarified in co-operation with the power utility; their written authorization shall be obtained before devices are delivered and before construction works start.

If appropriate technical instructions of the power utilities are not available or not sufficient to reach the specified requirements concerning quality, function, safety, reliability, compatibility and Employer`s requirements, electrical equipment and installations shall comply with the Harmonized European Standards (IEC/EN) and not least with DIN VDE (German Industrial Standards), if IEC/EN is not appropriate or not sufficient. The devices must be marked accordingly.

Regulations and instructions of the relevant power utility for putting devices and plants in operation shall be observed. If not specified differently, the Contractor is in general responsible for relevant applications and permissions.

2.2.3 Circuit documents

Provided circuit documents of all types, tables, diagrams and descriptions are to be in accordance with IEC 113-1.

Circuit documents are to be supplied for the complete electrical system being supplied. They have to explain the function of circuits or power connections and provide information for the construction, installation and maintenance of the electrical installations. All diagrams show the voltage-free or current-free status of the electrical installation.

2.2.4 Marking of electrical equipment

All marking, including code letters for type of equipment and for general functions shall be to IEC 750.

The marking appears in an appropriate positions as close as possible to the circuit symbol. The marking forms the connection between the equipments in the installation and the various circuit documents (diagrams, part lists, circuit diagrams, instructions).

2.2.5 Protective measures

Selection of appropriate protection against shock currents shall be to IEC 364-4-41. It includes protection against direct and indirect contact.

The Protective device must automatically disconnect the faulty part of the installation. At no point of the installation may there be a touch voltage or an effective duration larger than permitted to IEC standard. The internationally agreed limit voltage with a maximum disconnection time 5 seconds is 50V a.c. or 120V d.c. Selection of type of system shall be to IEC 364-3 (e.g. TN-system, TT-system, and IT- system).

2.2.6 Overcurrent Protection of Cables and Conductors

Wiring and cables must be protected by means of overcurrent protective devices against excessively high temperature rises, which can result from operational overloading as well as short circuits.

2.2.7 Arrangement of Protective Devices for Short-Circuit Protection

Protective devices for short-circuit protection must be fitted at the start of every circuit, as well as at every point at which the current-carrying capacity is reduced, if a protective device connected upstream cannot ensure the required protection.

2.2.8 Protection of the Phase Conductors

Overcurrent protective devices must be provided in all phase conductors. They must cause disconnection of the conductor in which the overcurrent occurs, but not necessarily disconnection of the other live conductors. If the

disconnections of an individual phase conductor could cause danger, suitable precautions have to be taken.

Already in the detail design phase the proof has to be given, that all protective measures are in accordance with the above given conditions and standards.

2.2.9 Protective In The Event Of A Power Failure

Design of equipment and protection functions must be in accordance with IEC204-1 individual machines or parts thereof are only allowed to restart automatically on return of the voltage after a supply failure, if no danger can be caused to persons or the machine. Additionally the plant must be switched to automatic mode of operation.

2.2.10 Protection in the event of a fault

External influences or the failure of components can cause unwanted operation of the electrical equipment or a machine. As this might result in the safety circuits being rendered ineffective, appropriate measures, such as additional safety circuits and redundancy connected downstream, should be taken to prevent any possible dangers arising.

2.2.11 Wiring

The minimum cross-section for single core and multi-core copper conductors inside control panels is **1.0mm²**.

Cables which are not laid in ducts must be adequately supported. Control circuits should be laid in separate ducts res. In case one common duct is used, they should be separated from power cables by separating strips.

2.2.12 Technical standard of control circuit devices

All control circuit devices used for flush mounting, surface mounting or rear mounting in switchboard panels or insulated enclosures must be in accordance with IEC/EN 60 947. The function is guaranteed for an ambient temperature of Min/Max. -25/+40°C. The rated insulation voltage is 500V. The climatic proofing must be in accordance with damp heat, constant, IEC 60 068-2-3 and damp heat, cyclic, to IEC 60 068-2-30.

Required minimum degree of protection:

- For contact elements and lamp sockets; IP 20
- For switches, push button and key-operated actuators and indicator light: IP65

a) Colour coding for Push-buttons

The colour coding must be in accordance with IEC 73.

colour	Meaning of colour
red	Action in case of emergency STOP OR OFF
yellow	Intervention to suppress abnormal conditions or to avoid unwanted changes
Green	Start or On
Blue	Any specific meaning not covered by the above colours
White	No specific meaning assigned

b) Colour coding for Indicator Lights

The color coding must be in accordance with IEC 73.

Colour	Meaning of Colour
Red	Danger or Alarm, Warning of potential danger or a situation which requires immediate action
Yellow	Caution; change or impending change of conditions
Green	Safety; Indication of a safe situation or authorization to protect, clear way
Blue	Specific meaning assigned according to the need in the case considered
White	No specific meaning assigned

c) Control transformer

IEC 204 requires the use of a control transformer on machines or separate parts of the electrical system with more than five electro-magnetic coils. It must be connected downstream of the main switch to allow for its isolation, and preferably between two phase conductors. The incoming supply cables to the primary terminals of the control transformer must be protected against short circuits. On the secondary side, a short-circuit protective device is required in the non-earthed conductor.

Preferred secondary voltages are 24V, 48V, 110V, 220V, at 50Hz. Before using low voltages, it must be checked whether fault-free operation is possible.

The control transformer must be adequately rated to keep the voltage-drop within permissible limits even under adverse conditions.

In non-earthed control circuits and insulation monitor must be fitted to indicate earth faults and to initiate disconnection. In earthed systems, the auxiliary circuits must be earthed on one side and one side of the coils must be directly connected to the earthed conductor.

d) Measuring and recording instruments

All kind of instruments shall provide safe, proper and accurate functions. Last calibration shall be done not more than one year before supply. Testers

and recorders for voltage, current, frequency, polarity, isolation, loop resistance, etc. shall be acc. To EN 61557.

2.3 Important Criteria for Selection of Electric Devices and Installation Material

All electrical devices, such as low and high voltage switchgear, switchgear assemblies. Motors, cables, transformer, softstarter, frequency inverter, panels, earthing and lightning protection devices, etc shall be selected under consideration of the criteria as given in the General and Particular Specifications and under consideration of the following criteria.

2.3.1 Overcurrent Protective Devices

Fuses shall be avoided as far as possible and if not specified in particular, Circuit-breaker and motor-circuit-breaker shall be selected as these devices can be immediately re-closed once a fault has been cleared. Moreover the high stripping accuracy makes them suitable for selective operation. The preferential use of circuit-breakers is a major design criteria. It reduces the problem with replacement of parts as they have no consumables such as fuses.

2.3.2 Motor Protective Circuit Breakers

Inherently short-circuit-proof switches capable of coping with the highest prospective fault levels at the point of installation without the need for back-up protection shall be selected.

2.3.3 Circuit breakers

Fuseless installation shall be selected, as it offers greater safety and reliability in plant operation. By the use of circuit breakers the required selectivity criteria can be realized.

Circuit-breaker with visible contacts shall be selected in compliance with local accident prevention regulations, requiring visible contacts is to be considered.

Quick-make and quick-brake operation shall be standard. Current-limiting, circuit-breakers shall be used where the prospective fault level is high. Effects of short-circuits must be reduced to a minimum, as great store is set by the long term reliability of the single devices installed and the plants as a whole.

Use selective operating circuit-breakers for time-selective progression of systems. In general selectivity must ensure, that in the event of a fault arising, only the faulty section of the system shall be isolated.

2.3.4 Contactors

Contactors shall be selected whose entire range provides consistently reliable operation in the event of voltage drops – down to 80% U_N should be aimed for – and whose contact system will not assume an indeterminate position, either on closing or opening, in such conditions.

In the course of selection and detail design of the electrical and mechanical system the Contactor shall consider that it is probable that the voltage stability will – at least for some time – leave much to be desired in many applications, as a result of long spur lines, small local generators or under dimensioned respectively overloaded transformer substation. Moreover regular and long lasting power failures shall be considered.

2.3.5 Main switches and safety switches

Devices with positive contact separation and clear switch position indication shall be selected. The mechanical coupling of the actuating element with the contacts must ensure, that the OFF-position is indicated only when all main contacts are separated by the prescribed distance, and only in this position can the switch be padlocked. Safety must be guaranteed when maintenance or repair works are carried out on the installation or machinery.

2.3.6 Emergency-stop control devices

Design and function of all emergency-stop control devices to IEC 204-1. When operating these devices, all current loads might lead to danger to personnel or damage to machinery, must be disconnected indirectly by de-energization. For direct manual operation, emergency-stop control devices must have mushroom-head push-button with pull to release function. The button must have a minimum diameter of 25mm.

Emergency-stop actuators for mounting in front panels must be designed to IP 65 and tamper-proof to EN 418. They must have a yellow base and a red button with pull to release function. The button must have a minimum diameter of 25 mm.

2.3.7 Enclosures

In buildings with difficult environmental conditions, such as drip water, splashed water, humidity and unusual high or low temperatures totally insulated enclosures with transparent covers shall be selected. Consider special conditions in chemical environment.

In all other rooms enclosures according to the following specifications shall be supplied:

Heavy-duty indoor enclosures, capable of withstanding the most severe conditions to be expected, such as drip water, splash water, constant

humidity and low temperatures. The enclosure complies with EN 60439.1 and IEC 439.1. It is preferably made of self-extinguishing halogen free polycarbonate or, if this type is not available on the market, made from steel sheet with anti corrosion protection and polyester-epoxy coating inside. Degree of protection is IP 54 or higher to IEC 529. The degree of protection against mechanical impacts as per EN 50102 is IK10. Installations inside the enclosure shall provide protection in accordance to IP32 or higher. Protection class 2. Wall fixing shall be made by adjustable wall fixing lugs. The enclosure is equipped with one gland plate with gasket, mounted on the bottom side only. All cables lead into the enclosure through metric cable glands is IP55 or higher. Each gland contains one cable only. A reserve of at least four tight glands for later installation shall be installed. The rigid door is reversible and opens 120°. The thickness of the cover/door allows the installation of indicating lights, push buttons, instruments, etc. Doors shall be equipped with a lock. Earthing is provided by welded studs in the enclosure and on the door. The enclosure shall be equipped with one mounting plate made from galvanized steel or insulating material for free installation of devices. All equipment to be installed inside the enclosure shall be mounted on mounting rails to EN 50 022. The enclosure shall be directly fixed to the wall using fixing straps.

Cables and devices inside the enclosure, such as fuses and terminals shall be marked accordingly. Single line diagrams shall correspond to this marking.

2.3.8 Automation devices

No PLC device shall be installed in any plant, where not in particular specified, permitted to unavoidable. The specified automation level must be observed. The switchgear shall be constructed in well-trying and reliable but simple design, using standard wiring. Trained operators must be able to detect and clear faults within a short time, without special instruments and without consultation of an external specialist.

Only programmable control relays, which do not require the use of a computer for programming are permitted. The relays shall be programmed directly on the device by use of tabulators (e.g. Siemens Logo, Moeller Easy, Mitsubishi Alpha, etc.) Programming by computer can also be enabled in parallel, but not exclusively. Each relay shall be equipped with a display, providing essential process information. Relays and accessories shall be with a display, providing essential process information. Relays and accessories shall be with a display, providing essential process information. Relays and accessories shall be dimensioned with a reserve of at least 5 digit input, 5 output relays and once analogue input.

In general the operation programme of each programmable control relays shall be available in one printed version on paper, on two memory cards and on two CD-ROM.

Only one type of programmable control relays from one manufacturer shall be provided.

Programmable control relays which are available with technical documentation in local language shall be preferentially selected. Programme and documentation shall be worked out in the contract language and in English.

Only relays shall be supplied of which the manufacturer guarantees the supply of spare parts and service for at least 5 years. If not specified differently the Contractor must guarantee the supply of spare parts within 10 days.

2.4 Execution

2.4.1 Measurements

Accurate measurements required for the roughing in of electrical wiring, and the laying out of electric equipment, shall be taken by actual site measurement or from architectural drawings if available.

2.4.2 Supports

Wall mounted equipment, where shown on the tile wall, or other inadequate to support the equipment, shall be complete with a mounting frame manufactured of angle iron or channel supports, which shall be capable to support the equipment independent of the wall. Outlet boxes shall be adapted to their respective locations and fastened to a rigid support independent of conduit.

2.4.3 Inserts and sleeves

Where required for the installation of wiring and equipment supplied under this Division, provide all inserts and sleeves, or drill for expansion anchors. Powder activated fasteners shall not be used.

2.4.4 Location of outlets and devices

Location of switches. Thermostats, outlets and control devices are shown diagrammatically only. Location of outlets is subject to change without extra cost to Client, providing information is given prior to installation. Outlets may be relocated up to 5 meters from original location, without change in price.

Keep all switches, thermostats and other controls as close to door jambs and other openings as possible and check door swings prior to installation to locate switches on lock side of door.

All under surface boxes in finished areas shall be mounted so that covers will fit flush with the finished surfaces. Where several separate boxes are mounted in a group, they shall be aligned vertically and horizontally and a uniform parallel spacing shall be maintained.

Mounting heights shall be as shown on drawings and/or as specified under “Mounting Heights”. Where the location of any item is shown on any architectural details or elevations, these locations shall govern. No change to contract sum will be allowed for relocation of any item improperly installed or because of failure to check all such details prior to installation of same.

2.4.5 Mounting Heights

If not specified differently in the Particular Specifications, mounting heights for outlets and local devices shall be as follows and shall be from centre line of outlet box to finished floor.

- Light switches, combinations and thermostats: 105 cm above ground level
- Sockets and cooker low level, connection outlet: 45 CM ABOVE GROUND LEVEL.
-

2.4.6 Identification of cables and equipment

Cable and wiring shall be identified by means of clip-on type wire markers of rigid PVC construction. Markers colour shall be WHITE or YELLOW with BLACK engraved letters or numerals.

A number shall be installed on each cable junction point. Number control wires to coincide with equipment shop drawings.

Nameplates in English and local language shall be provided for all pieces of electrical equipment including panel-boards, motor control centres, terminal cabinets, disconnect switches, motors starters, contactors, push button stations, junction boxes and pull boxes.

Nameplates shall be laminated rigid plastic on interior items and stainless steel in exterior items with 5mm high engraved letters. Nameplates shall be fastened to equipment in a conspicuous location. In case of flush mounted panels in finished areas, nameplates shall be submitted to the Consultant for approval.

Buried cables and conduits shall be identified by cover plates with appropriate markings.

2.4.7 Installation of conduits

Conduits, in all finished areas, shall be run concealed in ceiling spaces, walls, partitions, or in floor slabs. Where conduits are run in floor slabs, they shall be laid between the layers of reinforcing steel or wire mesh. Obtain structural engineer approval for conduits laying pattern.

Conduit ends shall be reamed and open ends capped with proper conduit caps immediately after installation.

Flexible conduit shall be used only for final connections, as to motors and lighting fittings. Such flexible conduits out to exceed 2 meter in length for motors lighting fixtures. For liquid pumps and damp locations liquid-tight flexible conduit shall be used complete with insulated watertight connectors.

Where conduits are run exposed, they shall be installed accurately in line and level and parallel to building lines. Where run exposed on concrete or masonry walls, conduits inserts and where run on building steel, beam clamps shall be used. Where conduit runs cross building expansion joints, expansion couplings shall be installed. Where conduits are installed as part of an empty race way system, conduits shall have sweep bends with a minimum bending radius of six (6) items conduit diameter where change of direction occurs. No empty conduit run shall have more than two (2) 90 degree bends between pull boxes. All empty conduits shall contain a draw wire.

Where necessary for proper pulling of wiring, pull boxes shall be installed and located so as to be accessible after completion of building.

Suspended conduits shall be supported from ceiling or roof slabs above with galvanized steel threaded rods and fasteners on U channel brackets. Conduit clamps shall be heavy duty cadmium plated steel or PVC with adjustable saddles. Wire as used for ceiling suspension and perforated pipe straps with not be accepted. Cover screws on all conduit fittings and junction boxes shall be carefully cut to lengths to avoid damage to wires.

2.4.8 Wire and cable installation

All new equipment shall be supplied and installed in accordance with environmental conditions, especially considering wet atmosphere and chemical influence

Power cables shall be installed either on cable trays or on surface throughout in rigid cable conduit. A PVC –corrugated pliable conduit for heavy gauge (750N) to IEC 325-EN 3341 shall be installed. Temperature range: -10°C up to +60°C. Only approved and suitable fittings shall be installed and clips for installation on surface shall be used. The fittings shall be water and sand tight. For connection to the switchboard pliable conduit glands shall be used. The conduit shall be to IP 54. The protective cable conduit shall be marked in a regular distance of 3 meters by use of water and UV resistant markers. The cables shall be marked on both ends.

Splicing of conductors shall not be done unless approved by the Consultant and permitted by regulations. Conductors shall be joined at a single or multiple connector blocks in boxes, cabinet or fittings.

Exposed cables shall be installed in accordance with relevant Approvals and Standards as well as manufacturer's instructions and recommendations using manufacturer's approved installations tools.

Where a number of cables on cables trays follow same general route, they shall be fixed on the tray beside each other only. Single and multi-conductor cables shall be spaced to avoid de-rating the conductor current carrying capacity. Cables shall not be bundled up anywhere. Signal, data and telephone cable trays. The cables shall be fixed to the tray with suitable supporting clamps or cable straps in line parallel to run off track.

Termination of metallic sheath and interlocked armored cables shall be in accordance with the manufacturer's recommendations and instructions. Termination and connectors shall be dust and moisture tight and be shrouded with a heat shrinkable tubing of appropriate size, shrunk tight with a heat gun as per manufacturer's instructions. Shrunk tubing shall cover connectors completely, such that no exposed metal shall show between connectors and box or wiring device. Tubing shall also cover cable leading to connectors for a minimum length of 25 mm. Flexible conduits motor connections shall include a green earth wire, bonding motor box to metal conduit.

Cables shall terminate through brad compression-type glands which grip the sheath, clamp the armouring and seal the gland and outer sheath.

In case of aluminum single conductor sheathed cable, load end shall terminate in as insulating plate (ferrous enclosure shall be slotted to prevent a closed magnetic loop), and a copper bonding wire shall be installed from supply end to load end.

Cable tails shall be adequately insulated and identified.

Cables shall be carefully taken from spools and reels, in manner recommendation by manufactures to avoid kinks and twisting. Bends must be made with minimum bending radii recommended by manufactures, with all bends measured to inside diameter.

Cables shall be run in single continuous lengths as no splices will be allowed.

Particular consideration shall be given to pulling tensions and cable lubricants during installation of cable, which shall be in accordance with the cable manufacturer's recommendation and instructions.

Attach cables to cable trays with cable ties or clamps. On cable trays energy and control cables shall be fixed in a distance of >100mm. If metal separators are installed between the cables in the tray, the distance is not required any more.

2.4.8.1 General instruction for outdoor installation

Outdoor the contractor shall lay all power and control cables as far as possible in a trench together with pipes. Co-ordinate the lines of the cable trenches with pipe trenches. For specifications of trenches see separate item of General Specifications.

Before execution of works the Contractor shall fix the exact trench line and measure the exact cable length required. Cables longer than 50 meter and/or with a bigger diameter than 20mm shall be supplied in a cable drum. In general all cables shall be installed in one unit. No cable joints or terminal boxes are permitted.

Power control cables shall be installed throughout in separate protective cable conduits. Inside the cable trench cover plates shall protect cable and cable conduit. The Contractor shall supply and install these plates in accordance with effective Specifications and Standards.

A galvanized round earthing wire 10mm² shall be laid in each trench in the sand above the cable cover plates. The wires shall be connected to the Local Equipotential Bonding Bars at both ends.

Latest one day after cable installation in the trench an insulation test of all cores to each other and to earth and a resistance measurement of all cores shall be made. Within this test the phase sequence of power cables shall be fixed. The cores shall be labeled accordingly with "L1"/"L2"/"L3". The tests shall be executed with professional instruments and in accordance with relevant Standards. A protocol shall be issued and handed over to the Engineer. The protocol contains a description of the test method, the test results (measured data), time and date of test, name and signature of the Contractor.

Protective cable conduits for underground installation in trench shall have the following minimum internal diameter:

- a. Cable with a diameter from 41mm to 50 mm: $\geq 90\text{mm}$
- b. Cable with a diameter from 26mm to 40mm: $\geq 75\text{mm}$
- c. Cable with a diameter from 10 to 25mm: $\geq 50\text{mm}$
- d. Cables with a diameter up to 10mm: $\geq 30\text{mm}$

2.4.9 Dimensioning of power cables

Power and control cable connections to motors shall be in accordance with these specifications for cable installations. Connections up to a cable size of 10mm² shall either be done with a cable type YSLYQY (LSYYQvY) or PVC Insulated Single Core Cable type NYY (E-YY). Connections bigger than 10mm² shall be done with type NYY only. All cores and cables shall be installed throughout short circuit-protected. Maximum distance between cable fixing devices shall be two meter. Only short circuit-proof and antimagnetic

fixing devices which can withstand the environment conditions shall be used.

Single core cables must be identical length for each phase and for neutral. Unbalanced load conditions are not permitted. Dimensioning shall be in accordance to relevant Standards, operating conditions and especially considering the starting conditions. The maximum permitted voltage drop between the switchboard and the terminals of the motor shall be 0,5% during nominal operations. The contractor shall provide a calculation prior to supply and installation.

In principle all cores and cables shall be installed in one unit only. Cable joints and/or terminal boxes are not permitted. Too short or damaged cables must either be extended not being repaired but have to be replaced.

Cables shall be supplied and installed in principal in own unit: no cable joints are permitted.

Dimensioning of cables shall be done according to the maximum power consumption of the connected device respectively of the connected system under consideration of the cable length and including a reserve capacity of at least 20%. The voltage drop between the low voltage terminals of the transformer and the connected devices shall not exceed 3% of the nominal voltage during operation with rated power. Provide calculations for approval to the Engineer.

2.4.10 Mounting of starters

Separately mounted starters shall be mounted in enclosures according to environmental conditions and relevant specifications. Panels shall be made of self-extinguishing halogen free polycarbonate and supplied complete with wire trough, and all necessary fittings and labeling.

2.4.11 Services for Other Divisions

Work under this section of the specification shall be fully co-ordinated with the requirements of equipment specified and other applicable Division/sections of this contract.

2.4.12 Earthing

2.4.12.1 General Specification

Equipment requiring earthing by relevant Standards (IEC, IEE Electrical Code, National and Local Standards) and regulations of Local Electricity Utility shall be earthed accordingly and included in the work under this section of Specification regardless of whether it has been shown on drawing or called for in these Specifications.

Installation shall be made in accordance with Type of system (e.g. TC-C-S). New buildings and constructions shall be equipped with a foundation earthing. Galvanized flat or round iron including suitable accessories in

accordance with present-day installation standard shall be used for installation on the foundation. In foundations the earthing iron shall be connected to the reinforcement in a regular distance of at least 2 meter. Connection flags and local equipotential bonding bars shall be provided wherever switchboards, sub-panels, enclosures, machines, motors or other installations requiring grounding and/or local equipotential bonding with electric installations are being installed. PE-conductors shall be green-yellow colour coding only and directly grounded.

In principle 10mm round steel conductor with zinc coating = 50µm mean value or 30 x 3.5mm steel tape with zinc coating = 70µm mean value shall be supplied and installed.

The earth resistance shall not be higher than 10 Ohm. Great importance is attached to accurate execution of works so that the installation permanently withstands the environmental stress and that reliable protection and system function is guaranteed.

Arrange earthing system in such a way that under normal operating conditions no injurious amount of current will flow in any earthing conductor. Single phase loads shall be connected so that there is least possible unbalance of three phase supply.

Earth lead-ins shall be corrosion protected. The protective coating shall be of bitumen or shrink sleeve. The protection shall reach for a minimum of 0.3m above and below the earth point.

Deep driven earth rods shall be made of hot-galvanized steel; they shall be joined together using spigot and hole. Minimum rod length shall be 1.500m; minimum cross section shall be 25mm. use impact tips and driving leads for driving down the rod.

Connections of components /conductors made of different material such as steel or aluminium with copper require additional measures against corrosion. Use bimetallic connectors or isolating clamps or inlays made of double metal(copper-plated aluminium sheets or sleeves) according to requirements. Intermediate lead layers are not permissible.

2.4.12.2 Foundation Earthing

Foundations shall be equipped with a earthing device. Supply and install either a round galvanized wire 10mm² or a galvanized flat iron 30 x 3.5mm. fix the earthing iron vertically inside the reinforcement and connect it in a regular distance of max 2 meter to the reinforcement. Connections shall be made with special connectors and/or cross clamps suitable for this purpose. Install isolated connection flags type “NYY1 50 mm²” and lead them close to the outside wall to all four corners of the building. The flags shall be the connection point for the external lightning protection device.

The connection to the inside of the building shall be made with fixed earthing terminals. Provide and install three units. Exact location is subject to detail planning of contractor and requires approval of Consultant.

2.4.13 Local Equipment Bonding

All conductive steel parts such as water pipes, metal enclosures, railing and reinforcement shall be connected to local equipotential bonding bars. Only green-yellow NYM-J cable with a minimum size of 1X4 mm² shall be used. The static temperature range shall be -10°C up to +70°C. The installation including the contacts shall permanently withstand the environmental conditions. The cables shall be installed throughout in cable conduits or on cable trays. Cable glands shall be used for cable connections at switchboard or enclosure to ensure the required degree of protection (IP). Inside the enclosure each wire shall be connected either on a separate terminal or screwed to the local equipotential bonding bus bar.

Proper earthing shall be provided for bus bar risers, power panel boards, distribution equipment, metal conduits enclosures, main neutral bars, non-current carrying metal parts of fixed cabinets, motors, starters, socket outlets, lighting fittings, power and communication trunking, telephone equipment, signal equipment and the like. Bond separate equipment sections or items less than 2m apart to each other or to a common earth bar with Yf wire >10mm².

At completion of installation, tests shall be conducted under consideration of relevant Standards and as prescribed in Particular Specification. All tests in general shall include polarity, phasing, continuity, earth loop resistance, voltage tests and empty conduit tests. Date and time tests shall be announced at least one week in advance to the client and to the consultant. Correction shall be made necessary and as directed by the consultant

Resistance of earth electrodes shall not exceed the maximum permissible values for each type of installation or equipment concerned. If necessary change arrangement until satisfactory results are obtained, at no extra cost to client. Electrodes shall consist of sectional solid copper rods, with concrete inspection box and cast iron cover.

Voltage provided to equipment in this installation shall fall within minimum and maximum permissible limits for equipment. Make necessary adjustments such as changing of transformer taps to effect same, at no additional cost to Client. Maximum voltage drop between main new switchboard to any point shall not exceed 2.5 percent.

2.4.14 Lighting Protection

The external lighting protection shall be installed to IEC 62305 and DIN EN 50164. Only new components of industrial standards with origin from a

specialized manufacturer shall be supplied. Equipment and installation shall be the state of the art. Submit prior to supply and installation a detail design of the complete external lighting protection including specification and origin of equipment.

Using synthetic lighting protection components in connection with roof covers made of roof sheeting, the material compatibility (long term endurance) has to be checked with the manufacturer of the roof cover or with the manufacturer of the lighting equipment.

Connections of components/conductors made of different materials such as steel or aluminum with copper require additional measures against corrosion. Use bimetallic connectors or isolating clamps or inlays made of double metal (copper-plated aluminum sheets or sleeves) according to requirements. Intermediate lead layers are not permissible. Air termination Rods for protection of roof superstructures, chimneys, etc and also for installation with concrete bases shall be supplied and installed. The rods shall be chamfered, suitable for wedge concrete bases, made of AlMgSI 16mm or St/tZn 16mm. use connecting sleeves for connections of Air Termination Rods. Use roof bushing for penetrating and sealing flat roofs of gable roofs to install down conductors systems.

Use high voltage resistant insulating down conductor for keeping the separation distance from conductive parts to prevent dangerous flashovers among parts of external lighting protection systems and internal conductive parts (electrical installation, conduits, etc). Equivalent separation distance $s=0.75m$ The sketched show principal installation standards and techniques. New installation and repair works shall be made acc. To these installations and to relevant IEC standards.

2.4.15 Testing

At completion of installation, tests shall be conducted under consideration of relevant standards and as prescribed in Particular Specification. All tests in general shall include polarity, phasing, continuity, earth pool resistance, voltage tests and empty conduit tests. Date and time of test shall be announced at least one week on advance to the Client and to the Consultant. Correction shall be made where necessary and as directed by the consultant. Use a professional megger to measure lighting and power circuits and if resistance to earth is less than 5.0 megaohm such circuit shall be considered defective and shall be replaced at no cost to Client. This condition refers to installations provided under this contract.

Test all equipment installed under this division for mechanical and electrical defects. Make all adjustments necessary for such equipment. When

equipment has been placed in permanent operation, provide necessary tuition and instruction in operation and maintenance to Client's operating personnel. Test conduits which are required to be installed but left empty for clear approximately 85% of conduit inside diameter shall be used. Clear any conduit which rejects ball mandrel in an approved manner and without damage thereto.

Furnish labour, materials, instruments and bear other costs in connection with tests, obtain required certificates of approval, acceptance with compliance with regulations of agencies having jurisdiction. Work shall not be deemed complete, and final certificate of acceptance will not be issued, until such certificates have been delivered to consultant.

Forward three copies of all test certificates to the consultant for his retention but the submission of test certificates shall not relieve the contractor of his obligations. The installation will not be accepted, nor a certificate of Completion issued, until such tests have been approved by the consultant. As second series of similar tests shall be carried out to the satisfaction of the Consultant within fourteen days prior to the expiry of the maintenance period.

2.4.16 Underground ductwork

Standard rigid heavy-wall PVC duct lengths and fittings shall be used wherever applicable. When cutting is necessary, duct ends shall be cut square and clearly. Joints shall be made by standard coupling, ducts entering cable trenches, e.t.c shall be provided with end bells.

Excavation and backfilling work shall be carried out according to Specifications and to the approval of the engineer.

Ducts shall be thoroughly swabbed and cleaned by pulling through a cloth swap or large enough size to properly clean ducts, and shall be capped or plugged at both ends immediately after cleaning, to prevent entrance of foreign materials.

2.4.17 Bus Duct Installation

Install Bus Duct in strict conformance with manufacturer's instructions and to approval of responsible utility.

2.4.18 Excavation and backfilling

Do all excavation and backfilling for all electric power control and telecommunication cable, earthing and local equipotential bonding wires, earth electrode boxes, ducts for cables from public utilities, entry boxes and similar equipment. Work shall be performed to meet the specification requirements of other sections.

2.4.19 Concrete works

Do all concrete works for entry boxes and duct banks. Work shall be performed to meet the specification requirements of the respective General Civil Specifications. Concrete duct banks shall be coloured with red concrete additive over entire length. Place cable cover plates as specified over power ducts.

20.4.20 Lighting

2.4.19.1 Documents

This section of the specifications is an integral part of the contract documents and shall be read accordingly.

2.4.19.2 Extent of work

The contractor shall provide all labour, products, equipment and services to complete the work for lighting. Lighting , including wiring , appurtenance and other associated products, consists of, but is not necessarily limited to the following:

- Light fittings
- Accessories, hangers and supports
- Lamps and tubes
- Ballasts
- Lenses and louvers

2.4.19.3 Lighting fitting brochures

Provide complete lighting fitting brochures, which shall be bound and clearly indexed and included in the maintenance manuals

2.4.19.4 General Requirements

The contractor shall note the following general requirements applicable to the fixtures described:

a) General

The contractor shall supply and fix the lighting fittings and points as required complete with all accessories, wiring, trunking, conduiting, boxes, etc. Lighting fittings shall be complete with suspension system, tubes, ballasts and accessories as required for operation.

Fittings housing, frame or canopy shall provide a suitable cover for the fixture opening. Fittings shall be installed at mounting heights as detailed on the drawing, given in the particular specifications or instructed on site by the Consultant.

Fittings are shown in provisional position. They shall be exactly located in co-operation with the Client and/or the Consultant.

Fittings located on the exterior of the building shall be installed with non-ferrous metal screws finished to match the fittings.

Fittings and/or fitting outlet boxes shall be provided with hangers to adequately support the complete weight of the fitting. Design of hangers and method of fastening other than shown on the drawings or herein specified shall be submitted to the Consultant for approval.

Flush mounted recessed fittings shall be suitable for the type of false ceilings used, and shall be installed so as to completely eliminate leakage within the fitting and between the fitting and adjacent finished surface.

Pendant fittings within the same room or area shall be installed plumb and at a uniform height from the finished floor. Adjustment of height shall be made during installation. Fitting shall bear the manufacturer's name unless otherwise approved. Lighting fittings employing tungsten filament lamps and having metal back plates shall not be fixed direct to the boxes of thermo plastic material. Only metal boxes shall be used in such situations. Heat resistant type lamp holders shall be used with flexible cords and enclosed type lighting fittings regardless of the lamp cap position, i.e. cap-up or cap down.

Lamp holders incorporated in weatherproof fittings shall be porcelain or brass. Fittings installed externally shall be weatherproof and insect proof in general and shall conform to the specific IP ratings mentioned in the particular cases.

Fittings installed in damp locations shall be totally enclosed and shall prevent the ingress of moisture.

Fluorescent fittings shall contain all associated control gear within the fitting. All metal fittings or metal parts of fittings shall be effectively earthed. Fittings installed in positions subject to vibration shall be of the antivibration type.

Recessed fittings shall be constructed so as to fit into tile suspended false ceilings, the fixed to ceilings or other suspended false ceilings or plastered ceilings without distorting either the fitting or the ceiling and including all necessary labour for cutting and making good.

Fittings with hinged diffuser door shall be provided with spring clips or other retaining devices to prevent the diffuser from moving and the diffuser shall remain hanging, during relamping and maintenance.

Shop drawing for non standard fitting types shall be submitted for approval to the Consultant.

Detailed catalogue cuts for all fittings or if so required by the Consultant, sample fittings shall be submitted for approval to the Consultant before orders for the fittings are placed

b) Fluorescent Fittings

Wherever a fluorescent lighting fitting is located over an expansion joint, one end of the fitting shall be free to move or slide. Recessed fittings shall be constructed so that all components are replaceable without removing

housing from the ceiling. Each ballast shall be provided with external fuse rated in accordance with ballast manufacturer's lowest case temperature rise rating and shall be noiseless in operation. All ballasts shall conform to the IEC Standards. Ballasts shall be for operation at the voltages and frequencies indicated under fitting types and/or on the drawings, and under temperature conditions prevailing in the various locations of the site. Surface mounted fittings longer than 60cm shall have one additional point of support besides the outlet box fitting stud when installed individually.

c) **Incandescent Fittings**

Incandescent fittings shall be equipped with porcelain, medium lamp holder, bayonet type lamp holders for lamps up to and including 150 watts and right hand screws type lamp holders for lamps 200 watts and above. Replacing the lamp shall be possible without having to remove the fittings from its place.

2.4.19.5 Lamps

a) **general**

In general LV halogen lamps shall have individual or groups, step down transformers of dimmable or non dimmable and magnetic type as shown on the drawings. The step down transformers shall conform to relevant IEC Standards and marked in protective enclosures. Lamps shall be furnished and installed in all lighting fittings furnished under this contract. Lamps used for temporary lighting service shall not be used in the final lighting of fittings.

b) **Fluorescent Tubes**

Lamps shall be of type, wattage and colour rendering index as herein specifies unless otherwise indicated on drawing. All fluorescent lighting luminaries shall be provide with capacitors to give P.F in excess of 0.9 lagging. Capacitors shall comply with relevant IEC Standards.

c) **Incandescent lamps**

Lighting fittings shall be installed accurately in line and level. All fittings that are not, in the opinion of the consultant, installed properly shall be taken down and reinstalled to his satisfaction without cost to the client. Fittings shall be left clean, free from dirt, grease, fingerprints, e.t.c. upon completion of installation all lighting shall be checked by a qualified electrical technician employed by the contractor. Correct operation shall be demonstrated to those appointed, in the presence of the Consultant.

2.5Products

2.5.1 Wire and cable

2.5.1.1 General

- Abbreviations keys for wires according to harmonized requirements
- Building wire
- Wires installed outside of switchboard and enclosures shall be minimum size 1.5mm² single core unless shown otherwise. All conductors shall be stranded soft annealed copper of high purity with PVC, insulation. Notice particular specifications for wires and cables. No aluminium conductors shall be used.
- Conductors for lighting fixtures and wiring through fixtures channels shall be stranded copper with heat resisting insulation and glass braid or equivalent type approved for such duty, minimum 300/500V nominal voltage.
- MICC cable shall consist of copper conductors, mineral insulation and double copper sheath and shall be complete with manufacture's approval seals, gland and fittings. Follow manufacturer's instructions on cable installation and terminators. Use MICC cable for fire alarm circuits and any other essentials services subject to fire or explosion hazard
- Single core cables shall have non-ferrous armour
Single core cable shall be supported by non-ferrous clips.

2.5.1.2 NYM (PVC Sheath wire)

Solid or stranded copper conductor, conductor, core insulation of PVC, cores are stranded, common core covering, PVC outer sheath. Cable shall contain terminate protections.

The cables are suitable for use in, on and under the plasters, in dry, wet and damp rooms, as well as in brickwork or concrete, with the exception of direct laying of shaken, vibrated or compressed concrete and not suitable and not suitable for laying directly in earth.

Norminal voltage U_o/U: 300/500 V. Specific insulation resistance: 20 MOhm x km. conformity to EEC directive 73/23 (Low Voltage Directive) CE. Temperature range after installation: -10°C up to +70 °C. Test voltage: 4kV. Core ident code in acc. to VDE 0293.

2.5.1.3 YMS (PVC Sheathed Wire)

Adapted to DIN VDE 0821-5/ÖVE-K41-5

Construction: Fine stranded bare copper conductors. Cores are insulated with PVC and stranded. Reinforce outer sheath of PVC. Cable shall contain termite protection!

Application: For strong mechanical stress in dry and humid locations as well as outdoors.

Temperature range: -5°C till +70°C. Nominal voltage 450/750V.

2.5.1.4 NYY (PVC Insulated Multicore Cable)

According to DIN VDE 0276-603. Conformity to EEC directive 73/23 (Low Voltage Directive) CE.

Nominal voltage 0.6/1.0 kV. Single wire conductor of plain copper wires, PVC core insulation, cores twisted concentrically, various core colours according to VDE 0293, common core sheathing, outer sheath of PVC, standard colour black, flame retardant. Cable shall contain termite protection. Conductor configuration according to VDE 0295/IEC 60228; re=round conductor, single wire. Temperature range after installation: -40°C till + 70°C. cable shall contain termite protection.

2.5.1.5 YSLCY (PVC Control Cable with Copper Braiding)

Adapted to DIN VDE 0281-13

Construction: Fine stranded bare copper conductors, core insulation of PVC. Green –yellow core in the outside layer. All other cores are black with consecutive whole numbers (starting with 1 inside). Cores are stranded in layers and wrapped in a plastic foil. Braiding of oxidation protected tinned copper round wires. PVC outer sheath. Increased oil resistant and flame – retardant. Cable shall contain termite protection.

Application : Suitable as a signal and impulse cable in the control, measuring and signal technology. The copper braiding optimizes protection against external interferences, like electromagnetic fields and stray frequencies.

Nominal voltage U_0/U : 300/500V. temperature range for fixed installation: - 40°C till + 70°C. Core ident code: up to 5 cores coloured in acc. to VDE 0293. Seven or more cores: black with white numbers. Specific insulation resistance: 20 GOhm x cm. Test voltage: 2kV

2.5.1.6 YSLYQY (PVC Control Cable with Steel Wire Braiding)

Adapted to DIN VDE 0281-13

Construction: Fine stranded bare copper conductors, core insulation of PVC. Green-yellow core in the outside layer. All other cores are black with consecutive whole numbers (starting with 1 inside). Cores are stranded in layers, inner sheath of PVC. Braiding of galvanized steel wires. PVC outer sheath. . Increased oil resistance. Transparent. Cable shall contain termite protections.

Application: suitable as power and control cable with increased mechanical stress resistance for rough operating conditions. Temperature range for fixed installation: -40°C till +70°C. Nominal voltage 300/500V.

2.5.1.7 H07V-U (Ye), H07V-R (Ym) (PVC Insulated Single Core Wire)

According to DIN VDE 0281-3/ÖVE-K41-3

Construction: Solid or stranded copper bar conductor. Core insulation of PVC. Cable shall contain termite protection

Application: For indoor fixed installation in dry locations in switchboards and distributors, on surface mounted or embedded conduits or directly in suitable insulated objects. Temperature range for fixed installation: -5°C till + 70°C. Nominal voltage 450/750V.

2.5.2 Cable trenches

Notice: In general National Standards for cable trenches and cable installation are to be obeyed. As far as the National Standard do not require different solutions, the sketched and referring data and instructions as shown in this chapter of the Specification are to be considered as standard solutions. Notice, that the crossing of roads may – beside other measures – require a different depth of the trench.

2.5.2.1 Layout of standard cable trenches

Diagrams

- Excavate cable trench
- Refill bottom of trench with sand respectively screened filling material and compact with rammer
- Layout pipes respectively cables. Minimum distance between power cables shall be 20 cm. minimum distance between power and control cables shall be 100mm.
- Fill in the area around the pipes with screened filling and compact. If cables are without conduit, use sand for filling. A minimum of 10cm sand shall be around each cable
- Lay out cable cover plates
- Lay out earthing wire
- Refill the cable trench and compact backfill material

Notice: Installation of cable and refilling of cable trench has to be done on one day. Pull cable from lifted cable drum only. Torsion in the cable must be avoided. The contractor shall provide a area map of the site showing the exact path of all underground installed cables.

2.5.2.2 Protective cable conduit for underground installation in trench

Flexible twin walled cable conduit made from High Density Polyethylene (HD-PE) to BS EN 50086-2-4. The construction shall offer high flexibility and compression strength. The plain inner surface reduced friction when drawing the cable. The conduit shall provide a high degree of shock

resistance, even at low temperatures. Static temperature range: -40°C up to +100°C. Only approved and suitable fittings shall be used to connect the cable ducting. The fittings shall be water and sand tight.

2.5.2.3 Protective cable conduit for an surface installation in building and in walls outdoor.

Inside the building power cables shall be installed on surface throughout inside a cable conduit wherever they are not installed in cable trays.

Specification: Flexible PVC corrugated pliable conduit for heavy gauge (750N) to IEC 325-EN 334. Temperature range: -40°C up to +60 °C. Only approved and suitable fittings and clips for installation on surface shall be used. The fittings shall be water and sand tight. For connection to the switchboard in the storage reservoir and in the building No.3 PVC pliable conduit glands shall be used. The conduits shall be to IP 54. The protective cable conduits shall be marked in a regular distance of 3 meter by use of water and UV resistant markers.

2.5.2.4 Protective cable conduit for under surface installation

Conduits embedded in walls and floor slabs shall be in high impact PVC. Notice also General and particular specification for installation equipment

For cable installation in trenches use a cable protection system with high compression strength properties for multiple use. The conduits shall have a corrugated exterior and a smooth interior. Compression strength shall according to requirements but minimum 450N.

Ducting for Optical Fiber Cables shall be manufactured from high grade Polyethylene-high density (PE-HD) with smooth exterior, longitudinally grooved interior, UV stabilized.

Pressure connectors and fittings for OFC Ducting shall be pressure resistant up to 16 bar and consist of traction strength up to 5000N.

Transport : Ducts for fibre optical cables from PE-HD require transport in specially prepared trucks(clean loading space, no nails, screws or other objects that could harm the conduits) need to be loaded and unloaded by special lifting devices and fixtures (belts or hemp ropes). If the conduits are handled by means of a fork lift truck the forks shall be equipped with suitable protection (rubber or PE wrapping) to avoid any damage on the conduit. In no case the coils shall be thrown or pulled over the edge of the loading space. Dragging the coils over the floor or re-arranging coil piles may also cause harms on the conduit surface and it is advised to pay particularly attention to a careful moving of the coils at any time. Such harms could lead to a malfunctioning of the conduits when under pressure. Coils and drums shall be shipped on palettes. During transport the coils shall also be piled horizontally.

Storage: The conduits must be stored in an environment with extreme outer physical influences and temperatures(.e.g intensive sunlight.), which may result in changes of the microstructure of Polyethylene and deformation of the conduit profile. Pacable drums shall be stored on even and clean surface and shall be protected against weather influences.

Connection of conduits: worked have to be trained in correct handling of connectors and coupling of the conduits. All jointing methods have to be followed strictly to achieve a quality connection in the whole system. Ensure perfect tidiness as it is an important factor for the reliable and functioning conduit connections.

Connections of conduits: Workers have to be trained in correct handling of connectors and coupling of the conduits. All jointing methods have to be followed strictly to achieve a quality connection in the whole system. Ensure perfect tidiness as it is an important factor for reliable and functioning conduit connections.

2.5.2.5 Cable cover plates

Made from high impact resistant PVC resp. Polyrthylene. The cover plates shall be provided with interlocking fasteners which allow simple and effective connections on site. Temperature rating : -5°C to + 60°C Min width: 120mm, Min. thickness:1.8 mm.

2.5.2.6 PVC underground warning tape

Flexible polyethylene twin walled high density polyethylene tape for underground installation. Suitable for Identification and warning of a potential hazard of underground services during excavation works. Temperature range: -40 °C up to +75 °C, min. width: 35mm; min.thickness: 0.40mm. the tape shall contain termite protection.

2.5.3 Local devices

2.5.3.1 Outlets

Each light, switch, wall or floor receptacle (socket) or other outlet shall be provided with an outlet box. Outlets and local devices used in this installation shall conform with the following requirements.

All outlet and junction boxes shall be complete with an earthing terminal.

All boxes shall be minimum 75mm square or round boxes for attachment of fittings; they shall be complete with fittings stud or clamp if required to support safely the weight of the light fittings. Where the fitting weight is excessive for such devices, provide plates or channels fastened to ceiling structure.

Larger or extra deep boxes shall be used where required to accommodate the wiring and devices contained therein without strain or crowding. Using suitable system boxes where several switches are ganged and 2-gang boxes for twin socket outlets.

2.5.3.2 Raceways

Cable trays and ladders shall be of heavy duty galvanized steel or heavy duty GRC complete with fittings, accessories and supports. They shall be of “lay-in” type. Trays will be manufactured with a longitudinal T welded safety edge along the top edges. The tray shall be manufactured from steel wires, welded together and bent into a final U-shape. Straight sections shall be provided in at least 3000mm length. The cable tray shall be electroplated with at least 12 microns of zinc. The cable tray internal depth shall be 50mm +/-10mm.

Trays made of steel wires shall be made with a minimum wire diameter of 4.5 mm for widths from 50 to 200mm and 5mm from 300 to 450mm. Trays shall be constructed with a mesh configuration not wider than 50 mm x 100mm. All tray fittings (bends, risers, tees, crosses, reducers, etc) shall be constructed on-site using side action bolt croppers and fastened using 25mm and 30mm counter clamps with bolts and nuts, all surfaces shall be treated as noted above.

Trays will be coupled together using either fast spring couplers or counter clamp with bolt and nut combination with supporting fishplate is necessary, all surfaces shall be treated as noted above.

Trays shall be supported at 6-foot intervals by either trapeze, wall, floor or pendant mounting methods. All welds will be manufactured to a tensile strength of 700 kg per weld.

Metal separator shall be installed on the trays between power and control/telecommunication cables.

2.5.3.3 Conduits

Conduits shall be rigid heavy wall type, of high impact PVC. Minimum internal diameter shall be 20mm. Provide draw wires in all empty conduits.

2.5.3.4 Pull and junction bores

Indoor pull and junction boxes shall be of PVC only, complete with screw-on cover and conductor terminals. Pull boxes shall have a minimum length of 8 times the diameter of the largest conduit entering the box.

2.5.3.5 Outdoor enclosure

Enclosure made of weather and impact resistant PVC or, if not available on the international market, made of 2mm aluminium/zinc sheets, E-coat printed, powder painted. Frame made of PVC or stainless steel. Protection class IP55 or higher. Enclosure equipped with one PVC-mounting plate inside. All metal parts shall be connected to Local Equipotential Bonding. Enclosures tested in accordance with DN IEC 68, and IEC 721. Connection value acc. to nominal data of connected load. Consider also transformer overload capacity. Mains voltage 230/400V, 50Hz. Cable inlets only from bottom or backside. Cable glands made for exterior purposes, corrosion free, weather and impact resistant. Casting equipped with a PVC-mounting plate inside.

2.5.3.6 Sockets

Nominal data; 16a/240v A.C. Rectangular pin shuttered switched socket outlets, single or twin type as shown on drawings, to BS1363 in stainless steel plates with moulded plastic inserts in equipment rooms and in metallic plates in all finished areas. Protection against electric shock to IEC 536: Finger and back-of-hand proof. Type of protection: IP XI.

Cooker control unit outlet shall consist one flush mounted box and associated cooker connector unit with terminal block, cable clamp and cover plate to relevant Approvals and Standards.

Shaver supply unit outlet shall be complete with isolating transformer, on-off switch, pilot light, 230-120 selector and universal shuttered socket outlet, with matching mounting accessories. Engrave cover with “shaver only” in Local Language.

Cover plates for weatherproof outlets and devices shall be die cast aluminium with stainless steel fastenings of equivalent non-corrosive materials with spring-loaded covers where applicable.

2.5.3.7 Light switches and dimmer

Light switches shall be rated at 230V and shall be single pole 1-way, 2-way, intermediate or DP as shown on drawings and as required for proper operating of switched circuits. Switches shall be designed to safely carry inductive and resistive lighting loads up to their full ratings. Switches for incandescent lights shall be 6A, switches for fluorescent lights shall be 16A. Dimmer switch shall be full solid state, with rotary dia permitting smooth control from full brightness to complete “off” position, shall be equipped with RFI (radio frequency interference) filter to prevent interference with radio, TV or telephone circuits. Minimum load capacity 50% above connected nominal load.

2.5.3.8 Motor control centres

Motor Control Centres (MCC's) shall be from manufacturer only. The MCC's shall incorporate the following components if not specified differently in Particular Specification:

- Main ACB/MCCB with 3 phase indicating lights and 3 amperemeter (analogue or digital), one voltmeter with one 7 position selector switch.
- Motor protective relays according to requirements and relay specification
- D.O.L. or Star/Delta starters incorporating MCCB protection in line with the single line drawings and requirements of Electricity Utility.
- Softstarter and/or frequency inverter may be specified in the Particular Specification and require different control and protection devices.
- Run/trip pilot light for each motor
- Duty selector switch
- Emergency shut down device
- Over-/Under Voltage relay
- Single Phase protection device
- Power factor correction equipment if required according to Specification and regulations or Electricity Utility.

Note: If not specified differently in the Particular Specification the following starting devices shall be installed: motors with a nominal power of up to 11kW shall be started directly. Motors with a nominal power between 11kW and 90kW shall be started with Star-Delta Starters. Motors with a nominal power above 90kW shall be started with softstarter.

2.5.3.9 Disconnects

Disconnect switches shall be kW-rated, quick-make, quick-break, with handle interlocked so that switch door cannot be opened unless switch is in de-energized position. Switches shall be heavy duty, having visible blade constructions and silver plated current carrying parts. Ratings and number of poles shall acc. to requirements. Provision shall be made for padlocking switch to "Off" position. Where no rating is shown, they shall be sized as per manufacturer's recommendations for the load of the circuit. All enclosures shall be dust-tight and corrosion-resistant, rated for site conditions.

Miscellaneous equipment

Control circuit relays shall be with dust tight enclosure where mounted individually. Relays shall be robust construction heavy duty for long life, silver to silver contacts and shall have contact arrangements, time delay and current rating to suit control requirements.

Individually mounted control stations shall be complete with dust-tight enclosure and shall have engraved laminated rigid plastic nameplate to designate services. Push buttons and selector switches shall be double break silver contact unitized type, have readily interchangeable operators, contact

blocks and legend plates. Pilot lights shall be provided as required and shown on drawings. In finished areas control station shall be flush mounted. Starters shall be housed in industrial dust tight enclosures or grouped in motor control centres as shown. Starters for certain items of equipment will be provided as part of the equipment assembly, as identified in drawings and described in particular Specification section.

2.5.4 Switchboards, Sub-Panels and Sub-Main Distribution Boards

2.5.4.1 General

Distribution boards shall be factory assembled and confirm to relevant IEC Standard. Distribution boards shall be rated 400Va.c. services and current rating according to connected load including a reserve capacity of at least 30%. The main switchboard shall be constructed for safe, proper and reliable operation. The design and arrangement details of the equipment shall be to the approval of the Consultant. The switchboards shall consist of vertical sections joined together to form a free *standing cubicised*, rigid, floor fixing assembly which is extendable at either ends. Each vertical section shall have built-in rollers for easy section *aligning* and jointing. The design and construction of the switchboard shall be indoor floor type distributor and be of the size, rating and arrangement in accordance with Particular Specification and be manufactured in accordance with Standards as given in the table below. The cabling wells shall be provided with separate gland plates

Cubicle covers shall be fitted with a hinged over, to shroud all live parts, and be secured by thumb screws.

Each board shall be fitted with a solid removable neutral link for isolation and an earth bar assembly, TN-C-S-Type of System shall be installed, if not specified or required differently.

The arrangement of the equipment within the assemblies shall be such as to afford maximum accessibility to all parts, incoming and outgoing cables and bust ducts.

The switchboard shall be equipped with fingerproof terminals for all incoming and outgoing connections. Terminals for signal and command circuits shall be separated from power circuits and clearly marked as such. Terminals for signals and commends shall be equipped with disconnecting links. Consider the following terminal-colouring:

- Phases L1, L2, L3: grey
- Neutral:Blue
- Earth:Green/Yellow
- Signals and command: grey

The distribution boards shall incorporate a fully rated, vertical, tin plated copper busbar structure onto which MCCB's can be plugged. The plugging of MCCB's will enable easy rearrangement and addition of branch circuits. Spare ways on the vertical stack shall be fitted with SP or TP blank plates. Minimum spare ways per board shall be 20%. All plug on MCCB'S shall be 230/400V a.c;50Hz to relevant IEC rating. A sample of the MCCB shall be submitted to the Consultant for approval. A fully directory frame shall be fixed to the inside of the door.

Panels suitable for	<ul style="list-style-type: none"> • Low voltage power distribution • High current bus-bar distributor • Control panel
Material of frame and add-on pieces	Sheet metal
Mounting boards	Galvanised and varnish coated steel plate \geq 2.5mm
Protective coating of frame and add-on pieces	<ul style="list-style-type: none"> • Printing colour • Powder coating
Colour	RAL according to specifications; otherwise RAL7035
Degree of protection	Min. IP 54 according to IEC 529
Protection Class	1
Protection against direct contact	Protection of all live parts against direct contact by insulation
Protective Measures of installed electrical system	TN-C-S Type of System
Nomial Voltage	According to nominal voltage of installed energy and control system
Nominal insulation voltage	$U_i = 1,000V$
AC testing voltage	3.5 kV
Inside measurements	According to requirements incl. 20% reserve space per panel
Mounting options for built-in devices	35mm standard size fixing bar
Doors	Fixed on hinges; opening according to conditions in control room
Door lock	Prepared for assembling with profile cylinder lock
Cable entries	<ul style="list-style-type: none"> • For all incoming and outgoing cables through cable glands and over strain relief clamps

	<ul style="list-style-type: none"> • Numbered terminal blocks
Pedestal	Height in accordance to bending radius of cables and depth of cable duct under the switchboard
Depot for drawings	One depot per panel door drawings DIN A4
Eye-bolts	Four pieces per panel; only required for transport and installation at site
Cable and wire routing	Separate cable ducts and routing of energy, control and extra low-voltage cables
Air conditioning	<ul style="list-style-type: none"> • Panel heater incl. hygrometer • Ventilation unit with filter, controlled by a temperature control unit
Panel lighting	One florescent lamp per panel; controlled by door positioning switch
Protective measures	<ul style="list-style-type: none"> • Earthing of frame and all add-on parts • Shock hazard protection of bus-bar, terminals and all electric components
Short circuit withstand	<ul style="list-style-type: none"> • Proof according to IEC 439-1 for • Mechanical and thermic short circuit withstand • Nominal current and temperature rise at nominal load • Power dissipation
Bus bar	<ul style="list-style-type: none"> • Material:E-CU; size according to requirements • Shock hazard protection • Rated-short-time current (I_s) up to 50kA • Rated peak withstand current (I_s) up to 150kA • Rated-short-time current of distribution bus-bar (I_s) up to 30kA • 3 or 5-conductor system (TN-C-

	S-Type of System) <ul style="list-style-type: none"> • Bus bar shroud in accordance with VBG4 • Protection against direct contact • Type-tested to IEC 60 439-1, EN 60439-1
Marking of electrical equipment	In accordance with IEC 750
Delivery to place of installation	Ready for connection

2.5.4.2 Installations inside of switchboard, enclosures and distribution boxes

Wires. Cables and other devices such as fuses, relays, contactors, switches, terminals, etc. shall be marked accordingly. Terminals with universal foot for mounting on standard mounting rails shall be used for all ingoing and outgoing cables and wires. Installations inside the enclosure shall provide protection in accordance to IP32 or higher. The terminals shall be equipped with approved and suitable bridging material. End terminals shall be equipped with end plates. Phases, Neutral and Earth terminals shall be separated by partition plates for visual and electrical separation. The exact terminal dimension for the connected core shall be selected. Phase terminals shall be grey, terminals for Neutral shall be blue, terminals for Earth shall be green-yellow. All appliances such as terminals and fuses shall be mounted on mounting rails to EN 50 022. Terminals for signal and command circuits shall be separated from power circuits and clearly marked as such.

2.5.4.3 Feeder for stand by generator

Any switchboard or distribution board with a connection to a stand by generator shall be designed acc. to the following specification:

Marked terminal block shall be provided for the generator's power and control cables. The main fuse for the incoming power supply from the generator shall be of type h.r.c fuse switch disconnecter. On digital multi-function display shall be installed in the front door of the switchboard, indicating voltages and currents of all three phases and power factor. The system includes wiring and accessories such as transducer and fuses for measuring and control devices.

2.5.5 Electrical Switchgear

2.5.5.1 Low Voltage HBC Fuse Switch Disconnecter (single and three phase)

Standards: IEC/EN 60 947-3

Climatic proofing: Damp heat, constant to IEC 60 068-2-3. Damp heat, cyclical to IEC 60 068-2-30. Ambient temperature: Min./Max. -25°C.

Altitude: up to 1300 masl. Mounting position: Vertical, horizontal. Overvoltage category: III. Pollution degree: 3. Degree of protection from the front: Operational state IP 20; front cover open IP10. Mechanical lifespan (operations): 1.700.

Rated operational voltage of contacts: 500/690V AC. Rated operational current: acc. to connected load. Rated frequency: 40-60Hz. Rated conditional short circuit current AC: 50 kA_{rms} Rated insulation voltage of contacts: 750V AC.

2.5.5.2 Circuit breaker

Circuit breaker must be built and tested to IEC/EN 60947 and 60660.

The tripping characteristics of the circuit breaker must be in accordance with the operating characteristics of the connected application. All characteristics and standards must be guaranteed for the given altitude (m.a.s.l.) of the operating location.

Protective functions:

- 3-pole circuit breaker with protection characteristics of connected device (transformer, motor, etc)
- Short circuit protection
- Overload protection
- Earth-fault protection
- Differential indication of tripping due to overload, earth-fault or short circuit
- Main switch and isolation characteristics to IEC 947 and IEC 204
- Isolating characteristics including positive contact opening to IEC 204
- Isolating characteristics to IEC 408, over-dimensioned contact separation
- Quick-make, quick-break, irrespective of the actuating speed
- Clear indication of operating state
- Three switch positions: OFF / TRIPPED / ON
- Switching capacity independent of overload range, supply direction or enclosure
- Lifespan data valid without maintenance or changing of contracts, even as motor starter
- High tripping accuracy through long-term calibration
- Motor switching capacity AC-3 up to 660V to IEC 947
- Rated insulation voltage $U_i = 1.000 \text{ V}$, insulation group C to VDE 0110
- Finger-and back-of hand proof to IEC 536
- Climatic proofing, Damp heat, constant, to IEC 60 068-2-3; damp heat, cyclic, to IEC60 068-2-30
- Rated uninterrupted current: in accordance with selected motor and frequency inverter
- Minimum rated switching capacity $\geq 65 \text{ kA}$

- All circuit breaker shall be equipped with trip indicating auxiliary contacts
- Each breaker shall incorporate an electronic trip indicator on its front face.
- All MCCB's installed in main panels shall be fitted with auxiliary contacts for remote indication.
-

2.5.5.3 Motor-Protective Circuit-Breaker and Motor Starter Combinations

General standard of Motor-Protective Circuit-Breaker and Motor-Starter Combinations to IEC EN 60 947. They must fulfill the requirements for main switches to IEC 204.

In general they fulfill overload and short-circuit protection. The overload releases have single-phasing sensitivity and are temperature compensated. The degree of protection – including terminals - must be IP 20 or higher. The protection against electric shock to IEC 536 is finger- and back-of-hand proof.

The trip block must contain a temperature compensation range of Min./Max. -5/+40°C. The operating range must lay between -25/+50°C.

All motor-Protective Circuit-Breaker and Motor-Starter Combination must fulfill Coordination type “2” to IEC/EN 60 947-4-1:

- No risk to persons or installations
- Starter is capable of renewed operations
- No damage to the starter with the exception of a slight welding of the contacts, provided they can be separated without significant deformation.

The selection of the Motor-Protective Device shall be in accordance with the operating characteristics of the connected application. All characteristics and standards must be guaranteed for the given altitude (m.a.s.l.) of the operating location.

The following standards are obligatory:

- Motor switching capacity ..AC-3”
- Nominal operation voltage: adapted to connected device
- Rated short circuit breaking capacity: 100kA
- Instantaneous magnetic trip
- Type of protection: IP 20 or higher
- Incl. standard auxiliary contacts with one make contact and one break contact
-

2.5.5.4 Meter

a) General

The Contractor is responsible for calibration, sealing and inspection according to instructions of the responsible Electricity Utility. Meters shall be supplied and installed ready for operation. All cost are to be included under item “Metering”.

kWh-and kVarh-meters shall be supplied and installed according to the following specification, it not specified differently by the responsible Local Electricity Utility. **In any case the Contractor shall get approval for the type of meter from the Local Electricity Utility in advance.**

b) Specification for kWh-meter:

- Three phase, four wire
- For unbalanced load
- Nominal voltage: 230/400V, 50Hz
- Class 2 (if no higher class specified by Electricity Utility: e.g. class 1)
- Protection IP 40

C) Specification for kVarh-meter

- Three phase, four wire
- For unbalanced load
- Nominal voltage: 230/400 V, 50 Hz
- Class 2 (if no higher class specified by Electricity Utility, e.g. class 1)
- Protection IP 40

d) KWh-transducer metering

Provide transducer including preliminary works and terminals with test and disconnection function. Accuracy of transducer shall be to requirements of Local Electricity Utility.

2.5.5.5 Mains protection of equipment

Supply and install a co-ordinated lightning and surge protective system for power supply, signal and control circuits. The contractor shall provide a concept for approval prior to supply. Consider installed Type of System (E.G. tn-c-s). Supply a modular system of one manufacturer only. The provided system shall consist of harmonized lightning current arresters, which are responsible for the conducting of high energies without damage, and surge arrester protecting the terminal equipment. Lightning current arresters have to be installed as close as possible to the service entrance of the electrical system and surge arresters as close as possible to the equipment to be protected.

For the power supply, the potential short-circuit currents have to be especially taken into consideration. The lightning current arrester must safely disconnect prospective short-circuit currents of up to 25 kA and protect the employed back-up fuses against damage at the same time.

a) Lightning arrester Class B

Class B arrester for the integration of power lines in lightning protection equipotential bonding systems. For the protection of low voltage consumer's installations against surges, even at direct lightning strikes. Applicable for the protection of installations and equipment of Overcharge Categories 1 to IV in accordance with DIN VDE 0110-1:1997-04. Tested

with lightning currents (10/350) in accordance with DIN V ENV 61024-1 (VDE V 0185 Part 100), DIN VDE 0185 Part 103, SPD Class 1 according to IEC 61643-1:1997-02. SPD type 1 according to EN 61643-11:2001. Arrester according to E DIN VDE 0675-6:1989-11, - 6/A1:1996-03 and - 6/A2:1996-10.

- Encapsulated, non-exhausting creepage discharge spark gap
- Energy-coordinated with surge arrester, Class II and III directly with terminal units in Overvoltage Category 1 at UN=230V ac.
- Low voltage protection level
- Terminal for conductors and bus bars
- Nominal voltage: 230/400V AC
- Protection type to IEC 529/EN 60529:IP :20

b) Surge arrester Class C

Class C surge arresters for the use in the Lightning Protection Zones Concept at the boundaries of LPZ OB – 1 and more. For the protection of low voltage consumer`s installations against surges (Overvoltage Category III according to EN 611643-11:2001. Arrester according to E DIN VDE 0675-6:1989-11 and -6/A1:1996-03.

- Energy coordination possible with upstream lightning current arresters
- High discharge capacity
- Fault indication by mark in the inspection window
- Terminals for conductors and bus bars
- Nominal voltage: 230/400V AC
- Temperature range:-25°C up to +75°C
- Protection type to IEC 529/EN 60529 : IP 20.

2.5.5.6 Main Switch

Function: main rotary switch, It is used as On-OFF switch to connect/disconnect all three phases of the main power supply. The switch is dimensional according to the actual nominal power of the connected installations including a reserve capacity of at least 50%, Nominal voltage is 230/400V. The main switch is equipped with a front plate showing clearly the positions ON and OFF. Protection against electric shock to IEC 536: Finger and back-of-hand proof, Degree of protection shall be IP 65.

2.5.5.7 Miniature circuit breaker

- Characteristics: B or C acc. to requirements
- Standard: IEC/EN 60 898
- Protection against electric shock to IEC 536: Finger and back-of-hand proof
- Degree of protection (terminal): IP20
- Switching capacity to IEC/EN 60 898: 10kA

- Nominal voltage of single phase mcb: 230 V ac
- Nominal voltage of three phase mcb: 230/400 V ac

2.5.5.8 Residual current device

- Standard: IEC/EN 61 008
- Protection against electric shock to IEC 536: Finger and back-of-hand proof
- Degree of protection(terminal): IP40
- Ambient temperature: Min./Max.: -25°C - +40°C
- Rated operational voltage : 230/400 V ac
- Rated uninterrupted current : acc. to requirements
- Rated fault current: 0.03 A for installations in damp environment, bathrooms, private rooms and kitchen.
- Tripping time : 200ms
- 2.5.5.9 Compact starter

The reversing compact starters shall protect the motors against phase failure, overload and in the event of a short circuit. Preferably a tool-less plug connection consisting of motor-protective circuit-breaker and contactors shall be provided. Both of the switchgear devices are mechanically interconnected via a plug-in connection element. The compact starters must be equipped with the required manual and an automatic operation mode shall be provided. Reversing functions are to be provided according to requirements (e.g. to open and close valves). Provide wiring and accessories accordingly.

- Equipped with one motor protection switch and one switching capacity contactor
- Coordination ..2”
- Rated operational current according to nominal data of connected motor
- Motor switching capacity ..AC-3”
- Short-circuit release
- Overload release, adjustable
- Single-phasing sensitive
- Nominal operation voltage: in accordance with connected device
- Rated short circuit breaking capacity : 100kA
- Instantaneous magnetic trip
- Adjustable overload release
- Type of protection: IP 20 or higher
- Incl. standard auxiliary contact with one make contact and one break contact
- Incl. trip indicator providing differential indication of short circuit and overload
- Standard auxiliary contacts for ON/OFF position

2.5.5.9 Soft Starter (Low voltage)

Soft starter shall be of one manufacturer only and of identical type and size as far as practically possible. Soft starter are used for controlled start up and stop of motors, especially of pumps. Nominal data shall be acc. to characteristics and nominal data of connected device.

Soft starter shall be of one manufacturer only and of identical type and size as far as practically possible. Soft starter are used for controlled start up and stop of motors, especially of pumps. Nominal data shall be acc. to characteristics and nominal data of connected device.

Each pump unit respectively the soft starter shall be equipped with a shaft power monitoring device. It shall provide preventive action by initiating a warning or stopping before the pump runs dry or in case a pipe is blocked respectively a valve is closed.

Each pump unit respectively the soft starter shall be equipped with a torque control. It shall provide constant acceleration rate, independent of motor load, significant lower start current compared to soft starters without torque control, torque control of acceleration and deceleration ramps. It shall maintain constant accelerating and decelerating torque. The entered torque ramp time enables to generate a desired motor torque. The motor torque shall be no longer dependent on an applied motor voltage and the speed torque characteristics of the motor, but is increased according to the timed ramp.

- Suitable for particular field of application
- Shaft power monitoring
- Torque control
- Current limitation
- High overload withstand capability
- All parameters individually adjustable
- Keypad with plain text display
- Mains supply voltage: nominal voltage +/-10%
- Standards: IEC/EN 60947-4-2
- Degree of protection. IP 20
- Approvals: UL,cUL
- Suppression of closing transients
- Overhead monitoring
- Underload monitoring
- Thermistor input
- Faulty memory
- Pre-programmed parameter sets: at least three different standard applications
- Suppression of DC components on motors

- Potential isolation between power section and control section
- Interface: according to particular specification
- Filter for reduction of voltage peaks, capacitive currents, bearing currents and EMV-emission acc, to manufacturer recommendations and instructions
- Ambient temperature: 0...+50°C
- Relative humidity: according to tropical operation conditions, minimum 95%
- Climatic proofing to IEC 60 068-2-3
- EMC compliant operation
- Enclosed cabinet for indoor installation
- Potential isolated control terminals
- Electrical isolation between power and control sections
- Protection provided against under-/overvoltage, overcurrent and phase failure, if no separate motor protective relays is being installed.

2.5.5.10 Single-phase control transformer

- Use: Power supply for control circuits
- Type: Single phase control transformer
- Nominal primary voltage: nominal voltage $\pm 5\%$
- Nominal secondary voltage: nominal voltage $\pm 5\%$
- Standard in accordance to EN 60 989

2.5.5.11 Digital display

- Type: surface mounted in front door of switchboard
- Display: ≥ 10 mm; 3 $\frac{1}{2}$ -digits
- Input: in accordance with signals from connected devices
- Accuracy: 0.1%

2.5.5.12 Voltage meter

- For surface installation in front door of switchboard panel
- Range: 0-400 V A C
- Linear scale 90°
- Class 1.5

2.5.5.13 Actuators and selector switches

a) General

Supply industrial switching devices such as selector switches, push-buttons, key operated actuators, indicator lights, etc. confirming to EN 60 947. The devices shall be of degree of protection IP 65 and wear-resistant. Supply only standard installation diameter 22.1 mm.

- Type: for surface mounting

- Colour of indicator lights: in accordance with IEC 73
- Contact elements with at least two contacts
- Standards in accordance to IEC /EN 60 947
- Nominal operation voltage: 230V a.c.
- Climatic proofing: in accordance to IEC 60 068-2-3
- Ambient air temperature: ≥ -25 / $+60^{\circ}\text{C}$
- Suitable for use with electronic devices

b) Key operated actuators

- Two key-position with stay put / spring return function and removable
- Stay put / spring return function and removable
- Nominal operation voltage: 24V DC
- Supply including three keys per actuator

c) Emergency-stop actuator

- Type: for surface mounting
- Plunger red, body yellow
- Snap action and positive non-leave action
- After actuation, plunger remains in the actuated position, pull to release
- Contact elements with at least two contacts
- Type of protection: IP 65
- Nominal operation voltage: 230V a.c.

2.5.5.14 Horn – alarm siren

- Degree of protection: $\geq \text{IP } 54$
- For on surface installation
- Nominal voltage 230V a.c
- 90-100 dB

2.5.5.15 Hydrostatic level measurement

- Measuring of hydrostatic pressure of water
- Measuring range according to requirements
- Permanent hermetically sealed cable probe
- Meeting all required approvals for drinking water
- Protection: $\geq \text{IP } 65$
- High-precision and long-term stability measuring sensor
- Integrated overvoltage protection devices
- 4-20 mA output signal for hydrostatic pressure measured value
- Accuracy: Linearity including hysteresis and repeatability as per DIN EN 60770: $\pm 0.2\%$ of full scale
- Thermal change in zero signal and output span for the typical temperature range $0^{\circ}\text{C} - 30^{\circ}\text{C}$: $\pm 0.6\%$
- Minimum ambient temperature range: $-10^{\circ}\text{C} \dots +50^{\circ}\text{C}$

- Electromagnetic compatibility (EMC): Interference emission to EN 61326
- Interference immunity to EN 61326 for industrial range
- Integrated overvoltage protection to EN 61000-4-5 \geq 1.2kV
- Screened cable, long-term withstanding the environmental conditions; approved for the use with the specified water level probe
- Protective tube for probe and signal cable
- Only one cable connection via terminals between level probe and new switchboard inside terminal housing IP66
- Approval of all relevant CE directives
- Standard DIN EN 60770 (IEC 60770): Transmitter for use in industrial environment
- Installation, setting – and operation manual in English language

2.5.5.16 Floating Switch

- Level switch suitable and approved for installation and function according to requirements
- Function: Control of maximum water level in water chambers
- Equipped with one micro switch with one change over contact, 3 wire
- Two switching points with different upper and lower switching angles
- Switching capacity up to 150V DC
- Approval of all relevant CE directives
- Minimum ambient temperature range: -20°C.....+60°C (use appropriate cable material)
- Only one cable connection via terminals between level probe and new switchboard inside a terminal housing IP66
- Installation-, setting- and operation manual in Bosnian and English language

2.5.5.17 Isolating amplifier

- Use: galvanic isolation and signal processing of the analogue standard signal from the Hydrostatic Water Level Indicator 4 – 20 mA
- Burden: PLC-input and electronic display for water level indication
- Channels according to particular requirements
- Installation according to manufacturer`s instructions
- Contactor for power circuits
- Standards: IEC 947
- Climatic proofing: Damp heat, constant and cyclic, to IEC 68
- Protection: Finger – and back-of-hand proof
- Equipped with suppressors
- Rated operational voltage: standard 230/400V a.c., if not specified differently in Part Spec.
- Incl. standard auxiliary contact with one make contact and one brake contact

- Rating date: in accordance with requirements of connected device

2.5.5.18 Tableau for fault indication

- Use: Indication of faults
- Industrial Standard
- Surface mounted in door of switchboard cabinet
- Equipped with red LED`s for fault indication
- Reset-device for acoustic alarm
- Aggregate fault report
- Push button for reset of faults and for lamp function test

2.5.5.19 Analogue measuring instruments

- Analogue instruments shall be designed for installation in the front door of switchboard cabinets
- Class 1.5
- Quadratic size NW 72 or NW 96 (according to requirements of Client)
- Scale 90°
- Protection class \geq IP 55

2.5.5.20 Operation time counter

The counter shall be used for counting of operation hours. Designed for front mounting in front door of sub-panel. Protection class \geq IP 55. Operation hours counter may alternatively be an application of the control relays.

2.5.5.21 Meter Protective relays

The motor protective relays shall be of type “Thermal Overload Relay” or, if the motor is equipped with thermistors (e.g.) fan motor), of type Thermistor Overload Relay”.

The relays shall be ambient temperature compensated and provided overload and short-circuit protection. They shall be of type “2” coordination. Tripping characteristics and setting range of the overload release shall be according to the connected type and size of motor. The relays must also supply comprehensive protection for the connected motor in coordination with circuit breaker and frequency inverter. Single phasing monitoring and protection shall be provided by the motor protective relay or a separate protection device. All types of motor protective relays shall be to IEC/EN 60 947, VDE 0660. Climatic proofing shall be to damp heat, constant, to IEC to 60 068-2-3 and damp heat, cyclical, to IEC 60 068-2-30. Ambient temperature from -25°C to +60°C open and -25°C to +45°C enclosed. Protection against direct contact from front shall be to IEC 536 finger and back hand proof. All motor protective relays shall be equipped with

auxiliary contacts. They shall indicate fault and position of the main contacts. Thermistor trip shall always be indicated separate from other faults.

Additional protective functions for motors with a nominal power of more than 2kW:

- Under – and Overvoltage protection for all phases
- Phase loss protection
- Locked rotor/stall protection
- All protective functions with alarm and trip

2.5.5.22 PTC – Thermistor Relay

- Suitable for the connection of selected PTC sensors
- Selector switch without automatic reset
- Manual resetting
- Test button
- Zero voltage proof
- Tripping also in the event of a short circuit in the sensor
- Mains and fault LED display

2.5.5.23 Mains decoupling relay

The mains decoupling relay is used for independent 3-phase voltage and frequency supervision of the power supply from the public grid. The relay is used for the control system of the Stand By Generator.

Required design standards are IEC 255-4: BS 142:VDE 0160. If the measuring voltage drops below 70% U_n , supervision of the frequency is blocked. The relay must be equipped with a test push button for test tripping of the unit. Switching hysteresis can be set to the required value for the proposed use.

- Rated Frequency range of measuring input circuit: nominal frequency (50Hz) $\pm 20\%$
- Minimum response time: 50ms
- Two output relays; one changeover contact for each trip relay
- Temperature range: -25°C to $+50^{\circ}\text{C}$
- Constant climate class F according to IEC 68: more than 56 days at 40°C and 95% relative humidity
- Electrical fast transient acc. to IEC 801: 4kV/2.5kHz, 15ms
- Repeat accuracy: 1% $^{\circ}\text{C}$

2.5.5.24 Programmable Control Relay

The relay shall provide electronic “wiring” by keystroke. It shall be equipped with an LCD(minimum 4 lines of 12 characters) and a keypad. In parallel programming via software from PC shall be enabled. The relay shall provide a zero-voltage safe internal and external circuit configuration storage in EEPROM memory.

Moreover the relay shall provide the following features and standards:

- Temperature range -2 °C to +55 °C
- Integral password protection for circuit configuration and relay value presets
- Current flow display for circuit configuration testing
- Selection option from at least the following languages: English, German, French
- Integrated timing relays , including delay functions
- Integrated up and down counter relays
- Integrated timers
- Integrated analogue value comparators
- Separate or integrated LCD display
- At least 16 auxiliary relays
- Integrated interface for network connection with other relays of same type
- Integrated interface for connection to a PC
- Degree of protection \geq IP 20
- Accuracy of timing relays $\pm 1\%$
- Resolution in range “seconds”: 10 ms
- Resolution of analogue and digital signals: 0:1V
- Bit resolution: 10
- Accuracy of actual value: $\pm 2\%$

2.5.5.25 24V DC Power Supply Unit

- Type : compact primary switched-mode power supply unit
- Approved for industrial use
- Suitable for supplying power to electrical and electronic components as to be provided and operated
- Installation on 35mm mounting rail inside of enclosures and switchboards
- Input voltage : 230 V AC
- Permitted voltage operation range: 187-264V AC
- Frequency range: 47 to 63 Hz
- Equipped with one input fuse
- Input and output equipped with surge voltage protection (e.g varistor)
- Nominal output voltage; 24 V DC
- Tolerance : $\pm 3\%$

- Nominal output voltage : 24V DC
- Tolerance : +/-3%
- Nominal output current: according to conneted load including reserve capacity of 30%
- Function display via LED
- Efficiency >85%
- Limiting of line current harmonies to EN 61000-3-2
- Ambient operation temperature : 0° C.....+45 °C
- Permitted humidity: up to 95% at 25°C
- Electrical safety acc.to EN60950/VDE 0805
- Electromagnetic compatibility (EMC): in conformance with EMC directive 89/336/EEC
- Emitted interference: EN50 081-1
- Type of protection \geq IP 20
- Class of protection: I
- MTBF > 500 000 hours

2.5.5.26 Data logger

- Accuracy : +/- 1%
- Power supply: 24 V DC
- Minimum four analogue 4-20 mA inputs
- Minimum eight digital common point inputs
- Memory capacity: >60.000 readings
- Recording interval: 1 second to 60 minutes (on configuration)
- Starting recording on programmed date and time
- Stop on memory full of alternatively overwrite oldest records
- Possible to download while still recording
- Real time clock
- Interface of PC(USB and/or RS 232)
- Ambient operation temperature : -20°C.....+ 50°C
- Software for configuration and data evaluation in English and suitable for PC with windows XP Operating system
- Graphical display
- Statistical calculations
- Export of the data to EXCEL and/or LOTUS
-

2.5.5.27 Axial fans

- Cased axial fans, cylindrical duct; for direct in-line installation in ducting
- Casing made of galvanizes steel
- IP 55 terminal box on outer casing

- Suitable for air flow temperature from -40°C to 60°C
- Protection against accidental contact to VDE 0700 and EN 294
- Air flow direction: pulling air over the motor
- The fan shall be equipped with anti vibration mounts and flexible connectors. Vibration transmission to building and technical equipment must be avoided
- Motor protection to IP55
- Motor standards to IEC 2J and IEC 61
- Motor casing made of aluminium or cast iron, totally enclosed with cooling fins
- Motor bearings maintenance free (sealed for life) and dust proof
- Full immersion, tropical moisture protection to motor windings, insulations class F
- Motor equipped with thermal contacts
- If condensation is to be expected, the fan must be installed with condensation pores facing downwards and must be open
- Fans must be equipped with guards, made of spot welded zinc plated wire mesh

2.5.6 Power factor compensation

The power factor compensation unit shall be of industrial standards. It shall compensate the reactive electrical energy used by the inductive receivers in order to reach a $\cos \phi > 0,90$. The unit shall be build in one separate panel of the switchboard. It shall be dimensioned exactly according to requirements and provide as follows:

- Reactor-protected automatic capacitor banks in compact design, encapsulated for switchboard mounting, 230-690 V, 50/60Hz
- Contactors for leading load
- Three phase condensers
- Overload protection unit
- Timer-regulator of adjusting stages with sufficient steps(minimum 4 steps)
- Collector bar system for reactive currents
- Main switch
-

2.5.7 Multi actuators for OPEN-CLOSE duty

- Notice also technical specification for mechanical equipment
- Type of duty: short time S2-15 min
- Output speeds according to particular requirements (e.g of 4 to 180 rpm and 50Hz supply)
- 3-ph AC motor in insulation class F, with motor protection by three thermo-switches placed in the windings

- Counter gear limit switching for end positions CLOSED/OPEN
- Tripping torque for closing /opening direction adjustable at calibrated torque dial and directly readable in daNm
- Anti-condensation heater in switch compartment
- Precision potentiometer with reduction gearing for position monitoring
- Handwheel for manual operation, which does not rotate during motor operation
- Valve attachment according to ISO5210
- Connection actuator – controls via plug/socket connectors
- Reversing contactors mechanically and electrically interlocked
- Four inputs OPEN-STOP-CLOSE-EMERGENCY galvanically isolated via opto-isolators
- Relays for output signals, freely programmable
- Programmable emergency operation function
- Galvanically isolated position feedback signal 0/4....20 mA
- Electronic name plate and logging of operating data
- Controls/ local controls can be positioned as every 90°
- Permissible ambient temperature – 25°C to +70°C, enclosure protection IP 67, corrosion protection KN(Suitable for atmosphere with low level of pollution)
- Finish coating: two component iron –mica combination, colour: silver-grey(similar to RAL 9007)

2.5.8 Lighting

2.5.8.1 Indoor lighting

- Twin –lamp moisture proof diff.luminary

For all indoor and outdoor applications without exposure to chemicals luminaires acc.to the following specification shall be selected.

- Moisture proof diffuser luminary (e.g 2 x 58W or 1 x58 W)
- Duo circuit
- Type of protection IP 65
- For T26, low –loss conventional ballast
- Housing made of unbreakable polycarbonate
- One piece diffuser made of polycarbonate with internal prismatic structure
- Reflector made of galvanized sheet steel, painted in white
- Through wiring using standard cable shall be possible
- 5 pole push in terminal
- Installed on ceiling, wall or trunking. Can also be suspended on chain using chain suspension brackets.

For applications involving exposure to chemical as well as moisture luminaries acc.to the following specification shall be selected

- Moisture proof diffuser luminaries 2 x 58W or 1 x 58W
- Duo circuit
- For T26, low loss conventional ballast
- Rugged diffuser in conjunction with stainless steel catches shall be used
- Type of protection IP 65
- Housing made if halogen free glass fibre reinforced polyester
- Non-ageing polyurethane foam seal
- Diffuser made of either PMMA or PC with internal prismatic structure
- Installed directly on ceiling or mounting track
- Can be installed on trunking
- Luminary consists of roll formed reflectors made of galvanized sheet steel, painted in white, can be hinged
- Reflector made of white glass fiber reinforced polyester
- 5 pole push in terminal
- Heat stability with PM 650⁰C with PC 850⁰C

Louvre luminaries

Surface mounted luminary for individual and continuous row installation

Use this type of luminaries in dry and continuous clean rooms only

Surface mounted luminaries with matt and semi-matt optic 2 x 58W, duo circuit, for T 26, with low loss conventional ballast. Surface mounted housing made sheet steel white stove-enamelled, with plasma welded edges. Bivergent reflectors optic made of matt anodized pure aluminium with transverse vanes curved in V shaped, incl. optic; glare limitation $L < 1000 \text{cd/m}^2$ at 65⁰C. Wired ready to connect.

- Lamp flux: 5200lm
- Colour rendering index: 1B
- Connected load: 134W, Lambda0.99
- Compensation: D
- Type of protection IP20

Surface mounted luminary with prismatic diffuser

Diffuser luminary for individual installation with prismatic controller, for T 26, with loe-loss conventional ballast. Made of sectional sheet steel, whote stove enameled. Single piece diffuser, extruded, in transparent PMMA with prismatic structure for precise direction of light.

Round transparent diffuser luminary

Transparent diffuser luminary, round; protection \geq IP 65; with high frequency ballast; round housing made clear unbreakable transparent polycarbonate UV stabilized with internal prisms, translucent whire reflector; 850⁰C glow wire tested lamp flux $\geq 4000 \text{lm}$;

Emergency luminary

Ceiling mounted emergency luminary with separate battery; in non-maintained mode, without monitoring, with T16 8 watt with 410lm. The light emitted from the underside of the luminaries provides improved escape route illumination.

Polycarbonate housing. Minimum recognition range 25m; test key integrated in housing; electronic ballast with integral emergency lighting control unit; hot start; deep discharge protection; reclosing interlock; NiMH battery; voltage : individual battery supply 220/240C AC(local). Temperature range -5⁰C up to + 35⁰C.

Luminaries and cover comply with EN 60598-2-22, DIN 4844, EN 1838, VDE 0108. Minimum dimensions; 300mm x50mm x 70 mm. protection type: IP 40.

Protections class:SC2

2.5.8.2 Outdoor lighting

a) Road Lighting luminaries

services friendly fluorescent road lighting luminaries. Sealed construction resistant to weather and impact, vandal resistant polycarbonate refractor bowl. Mounting – module in non-corrosive, die cast aluminum. Degree of protection IP 65.

Luminaries shall be designed for lamps according to particular specification

Starting time of fluorescent lamps shall be maximum one second. From manufacturers guaranteed average lamp life shall be minimum 10,000 hours. Lamp shall be accordance with IEC 968 and 969.

b.) Lighting poles

steel poles, pot-galvanized inside and outside. Construction in accordance with EN 402. Provided with earth connection screw or strap and cable inlet. Poles can be one with arm or separately equipped with arms for luminaries.

c.) Pole arms

Pole arms to be mounted separately on the pole shall be in accordance with the design as shown in the drawing. The arms shall be made of steel, pot-galvanized inside and outside. Construction in accordance with EN40/2. Standard gradient of 15° if not differently required by luminaries. Screws made of stainless steel.

d.) Fluorescent lamps

starting time of fluorescent lamps shall be maximum one second. From manufacturers guaranteed average clear tubular outer bulb. Monochromatic yellow colour with non-existent colour rendering.

e.) Low pressure sodium vapour lamp SOX-E

Low pressure sodium vapour lamp with a U-shaped discharge tube containing sodium, enclosed in a vacuum clear tubular outer bulb. Monochromatic yellow colour with non-existent colour rendering.

f.) Twilight switch

in weatherproof casing IP 54; With threaded joint; nominal operation voltage 230V a.c switching capacity 10A/230V a.c adjustable illumination: ON at appr.10 1X/OFF at appr. 50lx.

switching of outdoor lighting shall be optional manually by off switch and/or automatically by dimmer switch. Installation of dimmer switch on appropriate location outside of Operation Building.

g.) Cabling of lighting poles

The electric circuits of the outdoor lighting shall either be connected to the Main Switchboard in the pumping Building or to the Sub-panel in the new service building. Install a suitable fuse in the switch board.

The shortest possible way for the cable trenched shall be preferred. Co-ordinate the line of the cable trenches with pipe trenches.

Before execution of works the Contractor shall fix the exact trench line in co-operation with the Engineer and the Employer and measure the exact cable length required.

The lighting poles shall be connected with a cable type N-YY. Between the poles cable shall be installed in one unot. No cable joints or terminal boxes are permitted.

Power and control cables shall be installed throughout in separate protective cable, conduits. Notice General Specification for cable trench.

Inside the cable trench cable cover plates shall protect cable and cable conduit.

The Contractor shall supply and install these plates in accordance with effective Specifications and Standards.

A galvanized round earthing wire 10mm² shall be laid in each trench in the sand under the cable cover plates. The wires shall be connected to the earth screws and/or straps of the lighting poles and one end to a Local Equipotential/Bonding Bar inside a building.

Latest one day after cable installation in the trench as insulation test of all cores to each other and to earth and resistance measurement of all cores shall be made. The cores shall be marked. The tests shall be executed with right instruments and in accordance with relevant Standards. A protocol shall be issued and handed over to the Engineer. The protocol contains a description of the test method, the test results (measured data), time and date of test, name and signature of the contractor.

2.5.9 Mobile Measuring Instruments

2.5.9.1 Multimeter

- True RMS measurements
- 0.7% basic accuracy
- 6000 count resolution
- Digital display with analog bargraph
- AC/DC current measurements
- Backlight display
- Manual and automatic ranging
- Display Hold
- Frequency and capacitance measurements

- Resistance, continuity and diode measurements
- Min-max average recording
- Easy battery exchange without opening the case
- Compact case with separate holster
- EN61010-CAT III 600V
- Three year warranty
- Safety conformance: All inputs are protected to IEN61010-1 CAT III 600V. UL, CSA TUV listed and VDE Pending
- Voltage AC: Max. Resolution 1 mV, Maximum 600V
- Current AC: Accuracy* $\pm(1.5\% + 3)$, Maximum 10 A, Max. Resolution 10Ma
- Resistance: Accuracy * $\pm(0.9\% + 1)$ Max. Resolution 0.1, Maximum 40M
- Frequency: Accuracy* $\pm(0.1\% + 2)$. Max. Resolution 0.01 Hz
- Operating temperature: -10⁰C to +50⁰C

Note: Last calibration shall be made no more than 6 months before. Provide a certificate from the manufacturer with approval of calibration.

2.5.9.2 Thermal imager

Fully radiometric infrared camera for thermal check of electrical installation, electromechanical equipment, process equipment and HVAC/R equipment

- Infrared and visual (visible light) images
- Optimized for field use in harsh work environments
- Tested to withstand a 2m (6.5ft) drop
- Withstands dust and water- tested to an IP54 rating
- Spatial resolution: 2.5 mrad
- Min focus distance : 15cm
- Thermal sensitivity: <0.2⁰C at 30⁰C
- Focus: manual
- Minimum focus distance : 50 cm
- On camera operating modes: full picture in picture and full screen IR
- Temperature range:- 10⁰C to + 250⁰C
- Accuracy: +/- 5⁰C or 5%

2.5.9.3 Three phase induction motor (pump motor)

2.5.9.3.1 Standards

All electrical motors shall comply in general with the latest IEC and EN Standards, in particular with

Electrical Standards

- IEC/EN 60034-1
- IEC/EN 60034-2
- IEC 60034-8

- IEC 60034-12

Designation system concerning methods of cooling refers to standard IEC 60034-6. For IP code classification of degree of protection provided by enclosures of rotating machines refer to Standard IEC 60034-5 or EN 60529

Mechanical Standards

IEC 60072

IEC/EN 60034-5/6/7/9

IEC 60034-15

Balancing

Vibration acc.to Grade A (IEC 60034-14).

All electric motors shall be certified to ISO 9001 international quality standard

Only absolutely new and factory tested motors shall be supplied

All new motors for pumps shall be of the same manufacturer. Insert manufacturers data in corresponding data sheet

All electrical motors shall be fitted with a transport lock to prevent damage to the bearing due to vibration during transport

All motors shall be delivered with bearing grease for use at temperatures as usual for tropical climate (humid environments) and lubricated for ambient temperature 50°C

Lubrication intervals and grease quantities shall be specified on a plate on the motors as well as in the manual supplied with motor.

The following documentation shall be supplied for each type of motor

- Test confirmation
- Type test report
- Routine test report
- Torque/speed curve

Type of bearing

Anti-friction bearing with lubricator; D-end; grooved ball bearing; N-end : pre-loaded grooved ball bearing; in case of particular high radial loads motors shall be provided with cylindrical roller bearing at the D-end.

Bearing re-greasing: Grease nipples.

Shaft seals

Shaft seals shall be maintenance free; they shall protect the bearings reliably against the ingresses of dust and spray water to degree of protection IP 55; minimum standard: shaft seals with felt ring on the bearing inside, outside a labyrinth seal.

Paint system

For long term protection; to be chosen in accordance with site conditions to meet the requirements of climate, groups worldwide to DIN IEC 721; resistant to light and temperatures up to 120°C, non-porous and resistant to impact abrasion.

Painting aluminium stator: two –pack epoxy paint, thickness $\geq 70\mu\text{m}$

Painting cast iron stator: Two-pack Acid Polyurethane Lacquer Enamel, thickness $> 60\mu\text{m}$

Three phase induction motors	Obligatory standard specification
Type of motor	Totally enclosed squirrel cage induction motor
Material specification for aluminium motors	Stator framework, bearing shields, feet, terminal box made of extra corrosion resistant aluminium alloy
Duty	SI (Continuous duty)
Cooling system	Standard cooling according to IC411
Rated voltage for rated power above 90kw	Minimum rated voltage 690V
Frequency	50 Hz
Degree of protection	Minimum standard IP 55
Design	Reinforced tropicalisation
Altitude	1,000 masl
Environmental conditions	Tropical climate
Special equipment	Drain holes
Non-sparking	To IEC79-15
Impulse withstand level of windings	Above minimum $4X_{uN}+5K_v$
Terminal box	Box shifted subsequently from left to right or vice versa, even at site; Equipped with openings for cable glands
Terminal block	Terminals for connection of Cu-cables
Motor mounting arrangements (M)	Acc.to pump requirements
Earthing device	External earthing bolt. Earthing screw for connection of external protective earth
Heating device	Heating element 230V
Core	Corrosion protected stator and rotor core

2.5.10 Auto transformer

These general specifications refer to auto transformer means electrical transformer with only one winding. The single coil has one or more extra taps or electrical connections in various positions along the winding. Each tap corresponds to a different voltage so that effectively a portion of the same inductor acts as part of both the primary and secondary winding.

In some rural applications deliberate –incorrect voltage may occasionally appear. The autotransformer shall be used to provide a slight boost(or step-up) to correct an undervoltage condition or buck (step-down) to correct an overvoltage condition. Automatic voltage regulations function in not applied.

The contractor investigates within the frame of the detail planning if “zig zag” autotransformer are being required to provide grounding (earthing) on three phase systems that otherwise have no connection to ground (earth). A “zig zag”-transformer provides a path for current that is common to all three phases (so called “ zero sequence” current).

In general each starter shall be dimensioned to start the connected pump motor respectively the strongest of all pump motors connected. The cubicle shall be a free standing version arranged with access doors in front.

- Protection \geq IP 23
- Ambient temperature: 50°C
- Cable inlet: according to particular requirements
- Starter functions: start procedure, interlocking
- Termistor protection Relay for start- transformer
- Minimum 4 starts each hour

2.5.11 Transformers

The transformer to be supplied and installed as part of this contract shall be according to the following general specification. All transformers must be suitable for the climate and site conditions prevailing at the location of installation.

It is the responsibility of the contractor to check the existing transformer sheds, houses, base plates or similar regarding their suitability to install new and bigger equipment. If required, the contractor has to modify the existing structures at this own costs to fit the equipment he intends to install.

Type of transformer	Three phase oil cooled transformer with expansion tank or hermetic type
Oil	PCB- free insulation oil
Standards	Latest IEC
Nominal power	According to Part. Spec.
Primary voltage	According to Part. Spec.
Secondary voltage	According to Part. Spec.
Taps (\pm)	$\pm 2.5\%$, $\pm 5\%$
Routine tests acc.	To IEC Standards
Type and special tests acc.	To IEC standards
Dial type thermometer	1 unit obligatory
Temperature alarm device	1 unit obligatory
Magnetic oil level indicator	1 unit obligatory
Protection device	1 unit obligatory
Insulating liquid	Mineral oil
Cover and tank	High quality steel
Corrosion protection	Two component painting
Assembly	Short-circuit proof including support

	to coils
Windings primary and secondary voltage side	Copper
Loss values	According to DIN 42500
Efficiency	$\geq 98.5\%$

3 INSPECTION AND TESTING

3.1 Inspection and Tests at Manufacturer's Premises

All items of plant shall be subject to inspection and testing before dispatch. The Contractor shall arrange routine and functional tests to demonstrate conformity with the Specification. Inspection at manufacturer's premises will be carried out by an independent inspection agency, or by such person or persons that the Engineer or Employer appoints.

The Tenderer shall list in the Technical Schedules Form I the names of principal manufactures and the locations at which inspections will take place.

No material shall be delivered at the Site without inspection having been carried out or waived in writing by the Engineer.

For the large pumps factory tests will be witnessed by representatives from the Client and Engineer. The Contractor shall notify the Client four weeks in advance of when they are ready to carry out factory testing.

Calibration certificates for instruments used for such tests shall be produced for the Inspector's approval, and if necessary, instruments shall be recalibrated before the commencement of the tests.

In case of failure to prove compliance during the (first) Factory test, all non-compliances are to be remedied and the testing is to be repeated. All Employers' and/or Engineers costs related to the witnessing of the repeated testing are to be borne by the Contractor and will be claimed back from him.

Details of tests to be carried out on particular items of Plant are as follows:

21.1.1. Pumps

Factory acceptance test (FAT)

Each pump shall be individually tested to grade 2 standard, in accordance with ISO9906:2000.

Site-conditions shall be simulated as near as possible, particularly the minimum Site NPSH condition.

Each pump shall be tested complete with all shaft bearings, thrust bearings and any directly driven auxiliaries.

Each pump shall be tested with its own motor. It shall be tested particularly at the warranted performance duty point and over its full working range where possible from its closed valve condition to 30% in excess of its warranted quality.

Head/flow curves and overall efficiency/flow curves shall be drawn for each pump.

The curves produced shall be used to demonstrate that the Plant will be capable of meeting the full range of operating conditions at Site.

Pump casing shall be pressure tested to one and a half times the pressure obtainable using full size impellers against a closed delivery valve. The positive suction head shall be taken into account in deciding this pressure.

Site acceptance Test (SAT)

All pumps shall be properly assembled with the connecting pipe-work and tested, complete with all shaft bearings, thrust bearings and any directly driven auxiliaries. Each pump shall be tested with its own motor. It shall be tested particularly at the warranted performance duty point and over its full working range, where possible from its closed valve condition to 30% in excess of its warranted quantity.

Head/flow curves and overall efficiency flow curves shall be drawn for each pump. The curves shall be used to demonstrate that the pump is capable of meeting the full range of operating conditions at site.

21.1.2. Pumpsets

The results of the above described tests on motors and pumps shall be used by the Inspector to determine whether each pumpset has achieved the performance warranted by the Contractor. If a pumpset fails in any respect to achieve the warranted performance, the Contractor shall carry out such further work as he considers necessary and shall arrange the tests to be repeated. This procedure shall be continued until the engineer is satisfied that the pumpset performs as warranted. Provided always that in the case of pumpset failing to pass a test of guaranteed overall efficiency, the pumpset will be rejected, except if the Employer accept the equipment. In this case, the penalty of EUR 1,000, - per additional kW consumption at the design point shall be applied.

3.1.1 Motors

All motors (except small motors less than 1kW) shall undergo the following routine tests and performance tests. The tests shall be carried out at normal speeds, the normal speed being the warranted performance speed. Vibration shall be observed at all speeds and the test certificate endorsed accordingly:

- Running light current
- Locked rotor current
- Winding resistance
- High potential
- Temperature rise
- Bearing inspection
- Noise
- Vibration

3.1.2 Circuit breakers, Contactors, Starter Panels and Fuse Switch Units

3.1.2.1 Routine tests

Power frequency high voltage withstand pressure test with all breakers, and contactors racked in and closed, between phases and from phase to earth.

Milli volt drop (doctor) test across circuit breaker contactor, contacts and between extreme terminals on individual panels (for comparison purposes, the manufacturer shall state design values for each size and rating class).

3.1.2.2 Operational closing test

These tests are to ensure the operation of solenoid closing coil or spring release coil and satisfactory closing of the circuit breaker with the voltage on the coil down to 80% of its rated voltage and to ensure that mal operation does not occur, with a voltage at the coil (solenoid closing) of 120% of its rated voltage.

On electrically held in contactors, these tests are to ensure capability of the ac operation coil to pick up and seal in at voltage down to 85% of the rated voltage.

3.1.2.3 Operational opening tests

These tests are to ensure the satisfactory operation of the shunt trip circuit and the tripping of the circuit breaker at no load conditions with the trip coil energized at 50% of its rated voltage.

On electrically held in contactors, these tests are to ensure that the contactor coil drop off voltage is not greater than 66% and satisfactory opening of the contactor at this voltage and voltages below.

3.1.2.4 Mechanical tests

All mechanical interlocks on the switchgear panels shall be thoroughly tested to ensure their correct operation, together with mechanical tripping opening and isolating devices.

3.1.2.5 Interchangeability

On withdrawable circuit breaker panels identically equipped, units such as incoming feeder panels shall be capable of interchanging of circuit breaker trucks. This facility is to be proved.

3.1.2.6 Heat run tests

Heat run tests will not be required on panels manufactured under this Contract. Type test figures for heat runs carried out on identical panel types shall be made available for inspection by the Engineer if requested.

3.1.2.7 General operation tests

In addition to the tests given above, test shall be conducted where applicable for the following purposes:

- To ensure the satisfactory tripping of the circuit breaker/contactors with the closure coil energized,
- To prove satisfactory mechanical behavior of the circuit breaker when the closing coil is energized with the tripping coil also energized
- To prove that the operation of the power closing device when the circuit breaker/contactors is already closed causes neither damage to the circuit breaker/contactors nor danger to the operator.

3.1.2.8 Protection and control circuits

For all forms of protection current transformer, the following information shall be made available to the Inspector prior to the time of inspection:

- Current transformer magnetizing curve
- Recommended relay setting
- Calculated primary operating current at this setting
- Calculated through fault stability values, where applicable
- Values of any stabilizing and setting resistors (if any) employed in the scheme

As far as possible, based on the completeness of the circuits in the final manufactured form within the Manufacturer's premises, the satisfactory operation of associated control and protection circuits shall be proved by the following tests:

- To ensure the correct operation of all current operated protection relays and direct acting coils at the recommended setting by current injection.
- High voltage ac insulation test to the specified level
- To ensure the correct polarity between current and voltage elements of power relays, meters and instruments,
- To ensure the correct operation of all auxiliary protection relays, such as Buchholz protection relays, at normal operating voltage by simulated operation of associated remote relays,
- To ensure the correct operation of control circuits at normal operating voltage by operation of local control switches and Simulation of operation from remote control positions.

Note: The checking of the operation of all protection relays and control circuits is to be carried out with all closing and tripping circuits energized at their normal rated voltage

3.1.2.9 Instrument and metering equipment

Indicating ammeters

Indicating ammeters shall be checked for calibration at one quarter, one half and full scale deflection by primary current injection testing if possible.

Indicating voltmeter

Indicating voltmeters shall be checked for normal voltage readings by secondary voltage application.

Integrating kWh meters

Where possible kWh meters shall be tested for correct rotation. Creep tests shall be carried out to ensure that the meter is inoperative with voltage alone, if the secondaries of current transformers are left connected with the primary current interrupted.

3.1.2.10 Cabling services and auxiliaries

All cables supplied under the Contract shall be subject to routine tests in accordance with the requirements of the relevant Standard. Each drum of cable supplied to the Site shall be complete with a certificate which shall give proof of compliance with this part of the Specification and the date of such tests. Cable will not be accepted on the Site for installation until these certificates are received and approved by the engineer.

The tests that shall be carried out on every drum of cable shall include:

- High voltage ac insulation withstand test to the specified level, between cores and from individual cores to the earth, metallic sheath or armour as appropriate
- Insulation resistance test
- Core continuity and identification
- Conductor resistance test

3.2 Installation Inspection

During erection of the Plant, the Engineer will inspect the installation from time to time in the presence of the Contractor's Supervisor to establish conformity with the requirements of the Specification.

3.3 Tests at the Site

For the purpose of carrying out tests on the Plant at the Site, the Thika Water & Sewerage Company Ltd will provide free of charge, pursuant to the Conditions of Contract, a supply of electricity, water etc., as appropriate.

3.4 Leakage Tests

Leakage tests at maximum working pressure shall be carried out on all erected pipework and valves as soon as possible after erection. The Contractor shall advise the Engineer when these tests are to be carried out.

3.5 Tests on Completion

After the Plant has been set to work and the Contractor has ascertained that the Plant is working correctly the Tests on Completion shall be carried out.

These tests will require a high degree of cooperation between the Contractor and the Employer and it will be deemed that this has been taken into account in the rates and sums entered in the Schedules.

On satisfactory completion of these tests the Taking Over Certificate will be issued.

Details of tests are as follows:

3.5.1 Pumpset and Water Metering Equipment

The test of the main pumps shall be carried out in accordance with BS599, Clause 8f and shall demonstrate that the Plant has been correctly installed, is reliable, in operation under the conditions at Site and is able to operate over its whole working range as far as is possible in the circumstances existing at the Site at the time. Each pump shall be tested at the warranted duty and the minimum and maximum duties as specified. The values obtained will be compared with the values obtained during the tests on the Contractor's premises and any discrepancy shall be rectified. Volumetric measurement of pump discharge will be employed as far as possible for both pump test and water metering equipment tests.

3.5.2 Switchgear and Starter Panels

3.5.2.1 Power frequency pressure test

This test shall be carried out with all circuit breaker/contactors closed and racked in.

3.5.2.2 Mechanical test

All mechanical tests specified for conducting on Manufacturer's premises are to be rechecked to ensure satisfactory operation of the plant in the final erected state.

3.5.2.3 Protection and control circuits

The satisfactory operation of all current operated protection circuits over their whole operating range shall be tested by secondary current injection, where primary injection tests have been previously carried out on Manufacturer's premises.

3.5.2.4 Instrument and metering equipment

Tests shall be carried out to ensure the correct operation of current and voltage operated indicating instruments and energy meters, when energized by the actual supply system.

3.5.2.5 Continuity of earth conductors

Continuity tests shall be carried out on the earth conductor of the switchboard, such tests being by heavy current injection.

This does not include the earth resistance test of the station earthing system which shall be tested as detailed below.

3.5.3 Cables

Every cable shall be subjected to a high voltage withstand test after installation and termination. The test voltages given below shall be applied either alternating current or direct current, and shall be maintained at full value continually for 15 minutes for PILC cables and for 5 minutes for PVC cables. Direct current test voltages shall be 50% higher than arms values of alternating current voltages.

600/1000V	5000V grade mains cable
Between cores	Between cores
Between cores and armour	Between any core and armour
2500AXC	3500AV

Witnessed high voltage pressure tests are not required to control cables, but it shall remain the responsibility of the Contractor to test the insulation of these cables both between cores and from cores to earth during the installation with a Portable 500 Volt insulation tester such as a “Megger” or equivalent.

The Contractor shall test all cables after installation and termination to ensure the correct phasing out of cores and the continuity of the cores, sheath and armour over the whole length of the cable, including cable termination glands for the latter.

3.5.4 Earthing System

After the completion of the earthing installation, the Contractor shall demonstrate to the Engineer that the resistance of the electrodes to earth and the continuity of the earth conductors is within the limits of the Specification.

The earth contact resistance and the earth conductor continuity from each major piece of plant, i.e. main switchboards and power transformers, etc shall be measured by using a suitable testers.

3.5.5 Supervisory System Equipment

The Contractor shall demonstrate the correct operation and accuracy of the equipment supplied under the Contract in the manner indicated below or as otherwise directed by or agreed with the Engineer:

- **Pressure instruments**

A deadweight tester shall be applied to each pressure transmitter at points equivalent to 25%, 50%, 75% and 100% full scale for rising and falling pressure to prove that a correct output signal is produced at these values,

- **Pressure Switches**

A deadweight tester shall be applied to each pressure switch at points equivalent to 25%, 50% and 75% full scale to prove correct operation when present to switch at these values.

- All push buttons, control switches and equipment state indicating lamps shall be shown to function correctly utilizing the actual plant concerned wherever possible.
- All alarms and trips shall be tested by operation of the primary initiating device.
- All receiving instruments, analogue and digital displays, data loggers, lamp and alarm indications, control functions, etc., and transmission systems shall be shown to operate correctly utilizing the plant or equipment concerns.

If line monitoring equipment is not included in telemetry equipment, the contractor shall provide such equipment and connect so that the performance of the communication link may be observed during the test.

Any equipment supplied under the Contract that requires readjustment during the above tests shall alter readjustment, again be demonstrated by the Contractor to the satisfaction of the Engineer.

After the engineer has signified his approval of the complete control and instrumentation installation, The Contractor shall demonstrate that the equipment operates continuously in the satisfactory manner for a period of seven consecutive days or for any other such period as may be previously agreed with the Engineer. During the whole of this period, the Contractor shall operate and adjust the Plant supplied under the Contract as instructed by the Engineer.

The seven day period of operation shall complete the Tests on Completion for these sections of the Plant involved.

3.6 Test Certificates

The results of all works and site tests carried out by the Contractor, in accordance with the requirements of Clauses 12.2 and 12.5 shall be recorded, certified and submitted to the Engineer in triplicate.

The cost of providing all certificates and reports shall be deemed to be included in the rates and sums listed in the Schedules.

3.7 Erection, Setting to Work and Maintenance

The Contractor shall provide at least three (3) skilled working erectors to supervise the installation, erection, commissioning and running maintenance of the plant. At least one skilled erector shall be provided with suitable qualifications to supervise each of the following major work components:

- Pumps, motors and piping installations
- Instrumentation installation
- Electrical equipment installations and wiring
- Plant works (installation of lamella separator, sludge scrapers,)
- Civil works

The Contractor shall not remove his supervisor/erectors from the site without prior approval in writing from the Engineer.

3.8 Instrument Installation

All measuring instruments shall be installed in accordance with the recommendations or instruction of the instrument manufacturer. Each mounting position shall be chosen to give correct operation of the equipment, faithful reproduction of the quantity to be measured, ease of operation, reading, maintenance and servicing, and freedom from any condition which could have adverse effects.

3.9 Connection of Electrical Power

The Contractor shall check all items of electrical plant for correct phasing and insulation resistance. Motors and control equipment shall be dried out and checks on the insulation resistance shall be made at regular intervals. Drying out shall continue until the insulation resistance reaches a ready value. After all drying out and checking of insulation resistance is complete the Contractor shall check that all electrical connections to his equipment are correct, and errors shall be corrected immediately.

3.10 Setting to Work

After the equipment has been erected to the satisfaction of the Engineer, the Contractor shall set the equipment to work and shall continue to operate it for a period of one week.

When the Contractor is satisfied that the equipment is working correctly he shall inform the Engineer that he is ready for the Tests on Completion.

3.11 Period of Instruction and Running Maintenance

The maintenance period will start after issuing the Taking Over Certificate.

The first four weeks of the maintenance period shall be a “period of instruction and running maintenance” during which time the Contractor shall provide for 40 hours each week the services of his erection in order to instruct the Employer’s own operators to operate and maintain the equipment. Verbal instructions relating to operating procedures additional to any given in the instruction manuals shall be confirmed in writing. The Manual shall be updated respectively in order to contain all relevant information after the training period is finished.

The requirements of this clause shall not limit the Contractor’s obligations under the Conditions of Contract.

4 ENVIRONMENTAL GUIDELINES FOR CONTRACTORS

These Environmental Guidelines for Contractors are prepared for all the contractors to be engaged for the NWDPII construction activities. The guidelines include provisions for proper management of construction sites, safe storage of construction materials and safe disposal of wastes including asbestos wastes.

4.1 General Considerations

- The contractor shall, in all his activities ensure maximum protection of the environment and the socio-economic wellbeing of the people affected by the project, whether within or outside the physical boundaries of the project area.
- Before any construction works begin, the contractor shall ensure that the relevant environmental and land acquisition certificates of authorization for the works have been obtained from the Director of Environmental Affairs and/or the Commissioner for Lands.
- In general, the contractor shall familiarize himself with the ESMF and the RPF for the NWDP II. Specifically, the contractor shall make every effort to follow and implement the recommendations and mitigation measures of the EMP and the RAPs or ARAPs, to the satisfaction of the MoIWD and the EAD, or any such persons or agencies appointed by the MoIWD or the EAD, to inspect the environmental and social components of the NWDP II.
- The contractor shall work in cooperation and in coordination with the Project Management Team and/or any other authority appointed to perform or to ensure that the social and environmental work is performed according to the provisions of the ESMF, RPF, RAPS, ARAPs and EMP for the NWDP II.
- The contractor shall always keep on site and make available to Environmental Inspectors or any authorized persons, copies of the EMPs, RAPs and ARAPs for the monitoring and evaluation of environmental and social impacts and the level or progress of their mitigation.

4.2 Acquisition of Construction Materials

The contractor shall ensure that construction materials such as sand, quarry stone, soils or any other construction materials are acquired from approved suppliers and that the production of these materials by the suppliers or the contractor does not violate the environmental regulations or procedures as determined by the EAD.

4.3 Movement and Transportation of Construction Materials

The movement and transportation of construction materials to and within the construction sites shall be done in a manner that generates minimum impacts on

the environment and on the community, as required by the EMPs and the RAPs or ARAPs.

4.4 Storage of Construction Materials and Equipment

Construction materials shall be stored in a manner to ensure that:

- There is no obstruction of service roads, passages, driveways and footpaths;
- Where it is unavoidable to obstruct any of the service paths, the contractor shall provide temporary or alternate by-passes without inconveniencing the flow of traffic or pedestrians;
- There is no obstruction of drainage channels and natural water courses;
- There is no contamination of surface water, ground water or the ground;
- There is no access by public or unauthorized persons, to materials and equipment storage areas;
- There is no access by staff, without appropriate protective clothing, to materials and equipment storage areas;
- Access by staff and public or unauthorized persons, to hazardous, corrosive or poisonous substances including sludge, chemicals, solvents, oils, asbestos cement dust or their receptacles such as boxes, drums, sacks and bags is prohibited;

4.5 Safe Disposal of Construction Waste

Construction waste includes but is not limited to asbestos pipes combustion products, dust, metals, rubble, timber, water, waste water and oil. Hence construction waste constitutes solid, liquid and gaseous waste and smoke.

In performing his activities, the contractor shall use the best practical means for preventing emissions of noxious or offensive substances into the air, land and water. He shall make every effort to render any such emissions (if unavoidable) inoffensive and harmless to people and the environment. The means to be used for making the emissions harmless or for preventing the emissions shall be in accordance to the RAPs, ARAPs or the EMPs and with the approval of the relevant Local Authority or the Environmental Affairs Department.

The contractor shall, in particular, comply with the regulations for disposal of asbestos cement pipes, construction/demolition wastes, wastewater, combustion products, dust, metals, rubble and timber. Wastewater treatment and discharge will conform to the applicable regulations by the relevant Local Authority and Ministry of Irrigation and Water Development. Asbestos wastes, and other hazardous wastes shall be treated and disposed of in conformity with the national regulations and where applicable, with the supervision of qualified personnel.

4.6 Health and Safety of Workers

The contractor shall protect the health and safety of workers by providing the necessary and approved protective clothing and by instituting procedures and practices that protect the workers from dangerous operations. The contractor shall be guided by and shall adhere to the relevant national Labour Regulations for the protection of workers.

4.7 Chance Finds Procedures for Physical Cultural Resources

If, during project construction, the contractor or project workers encounter archaeological relics, fossils, human remains, or other items of historical or other cultural value, the contractor shall (1) temporarily suspend any works which might damage these items and (2) inform the Client, or other competent authority, for instructions or guidance regarding the appropriate next steps to evaluate, salvage, recover, protect, and/or document the items found.

SECTION VI - STANDARD FORMS

1. Form of tender
2. Price schedules
3. Contract form
4. Confidential Questionnaire form
5. Tender security form
6. Performance security form
7. Bank guarantee for advance payment
8. Declaration form

FORM OF TENDER

Date _____

Tender No. _____

To.....

.....

[Name and address of procuring entity]

Gentlemen and/or Ladies:

1. Having examined the tender documents including Addenda Nos.. *[insert numbers,*
the of which is hereby duly acknowledged, we, the undersigned, offer to provide.
[description of services]
in conformity with the said tender documents for the sum of . *[total tender amount in words and figures]*
or such other sums as may be ascertained in accordance with the Schedule of Prices attached herewith and made part of this Tender.
2. We undertake, if our Tender is accepted, to provide the services in accordance with the services schedule specified in the Schedule of Requirements.
3. If our Tender is accepted, we will obtain the tender guarantee in a sum equivalent to _____ percent of the Contract Price for the due performance of the Contract, in the form prescribed by (Procuring entity).
4. We agree to abide by this Tender for a period of *[number]* days from the date fixed for tender opening of the Instructions to tenderers, and it shall remain binding upon us and may be accepted at any time before the expiration of that period.
5. Until a formal Contract is prepared and executed, this Tender, together with your written acceptance thereof and your notification of award, shall constitute a binding Contract between us.

Dated this _____ day of _____ 20
[signature] *[In the capacity of]*

Duly authorized to sign tender for and on behalf of _____

CONTRACT FORM

THIS AGREEMENT made the ____day of ____20____ between.....[name of procurement entity] of[country of Procurement entity](hereinafter called “the Procuring entity”) of the one part and[name of tenderer] of[city and country of tenderer](hereinafter called “the tenderer”) of the other part.

WHEREAS the procuring entity invited tenders for certain materials and spares. Viz.....[brief description of materials and spares] and has accepted a tender by the tenderer for the supply of those materials and spares in the sum of[contract price in words and figures]

NOW THIS AGREEMENT WITNESSETH AS FOLLOWS:

1. In this Agreement words and expressions shall have the same meanings as are respectively assigned to them in the Conditions of Contract referred to.
2. The following documents shall be deemed to form and be read and construed as part of this Agreement, viz.:
 - (a) the Tender Form and the Price Schedule submitted by the tenderer;
 - (b) the Schedule of Requirements;
 - (c) the Technical Specifications;
 - (d) the General Conditions of Contract;
 - (e) the Special Conditions of Contract; and
 - (f) the Procuring entity’s Notification of Award.
3. In consideration of the payments to be made by the Procuring entity to the tenderer as hereinafter mentioned, the tenderer hereby covenants with the Procuring entity to provide the materials and spares and to remedy defects therein in conformity in all respects with the provisions of the Contract
4. The Procuring entity hereby covenants to pay the tenderer in consideration of the provision of the materials and spares and the remedying of defects therein, the Contract Price or such other sum as may become payable under the provisions of the contract at the times and in the manner prescribed by the contract.

IN WITNESS whereof the parties hereto have caused this Agreement to be executed in accordance with their respective laws the day and year first above written.

Signed, sealed, delivered by_____the _____(for the Procuring entity)

Signed, sealed, delivered by_____the _____(for the tenderer)

in the presence of_____.

CONFIDENTIAL BUSINESS QUESTIONNAIRE

You are requested to give the particulars indicated in Part 1 and either Part 2 (a), 2(b) or 2(c) whichever applied to your type of business.

You are advised that it is a serious offence to give false information on this form.

Part 1 General

Business Name.....
 Location of Business Premises
 Plot No.,.....Street/Road.....
 Postal addressTel No.Fax Email
 Nature of Business
 Registration Certificate No.
 Maximum value of business which you can handle at any one time – Kshs.
 Name of your bankers
 Branch

Part 2 (a) – Sole Proprietor

Your name in full.....Age.....
 Nationality.....Country of Origin.....
 Citizenship details

Part 2 (b) – Partnership

Given details of partners as follows

Name	Nationality	Citizenship details	Shares
1.			
2.			
3.			
4.			

Part 2 (c) – Registered Company

Private or Public

State the nominal and issued capital of company

Nominal Kshs.

Issued Kshs.

Given details of all directors as follows

Name	Nationality	Citizenship details	Shares
1.			
2.			
3.			
4.			

Date.....Signature of Candidate.....

TENDER SECURITY FORM

Whereas [*name of Bidder*] (hereinafter called <the tenderer> has submitted its bid dated [*date of submission of bid*] for the provision of insurance services (hereinafter called <the tender>

KNOW ALL PEOPLE by these presents that WE [*name of bank*] of [*name of country*], having our registered office at [*name of procuring entity*] (hereinafter called <the procuring entity> in the sum of [*state the amount*] for which payment well and truly to be made to the said procuring entity, the Bank binds itself, its successors, and assigns by these presents. Sealed with the Common Seal of the said Bank this _____ day of _____ 20 ____

THE CONDITIONS of this obligation are:-

1. If the tenderer withdraws its tender during the period of tender validity specified by the procuring entity on the Form; or
2. If the tender, having been notified of the acceptance of its tender by the procuring entity during the period of tender validity
 - (a) fails or refuses to execute the Contract Form, if required; or
 - (b) fails or refuses to furnish the performance security, in accordance with the Instructions to tenders.

We undertake to pay to the procuring entity up to the above amount upon receipt of its first written demand, without the procuring entity having to substantiate its demand, provided that in its demand the procuring entity will note that the amount claimed by it is due to it, owing to the occurrence of one or both of the conditions, specifying the occurred condition(s)

This tender guarantee will remain in force up to and including thirty (30) days after the period of tender validity, and any demand in respect thereof should reach the Bank not later than the above stated date.

[Authorized Signatories and official stamp of the Bank]

(Amend accordingly if provided by Insurance Company)

PERFORMANCE SECURITY FORM

To:

[name of the Procuring entity]

WHEREAS.....[name of tenderer]

(hereinafter called "the tenderer") has undertaken, in pursuance of Contract No. _____ [reference number of the contract] dated _____ 20____ to

supply.....

[Description services](Hereinafter called "the contract")

AND WHEREAS it has been stipulated by you in the said Contract that the tenderer shall furnish you with a bank guarantee by a reputable bank for the sum specified therein as security for compliance with the Tenderer's performance obligations in accordance with the Contract.

AND WHEREAS we have agreed to give the tenderer a guarantee:

THEREFORE WE hereby affirm that we are Guarantors and responsible to you, on behalf of the tenderer, up to a total of
[amount of the guarantee in words and figures],

and we undertake to pay you, upon your first written demand declaring the tenderer to be in default under the Contract and without cavil or argument, any sum or sums within the limits of

[amount of guarantee] as aforesaid, without your needing to prove or to show grounds or reasons for your demand or the sum specified therein.

This guarantee is valid until the _____ day of 20_____

Signature and seal of the Guarantors

[name of bank or financial institution]

[address]

[date]

(Amend accordingly if provided by Insurance Company)

BANK GUARANTEE FOR ADVANCE PAYMENT

To.....

[name of tender].....

Gentlemen and/or Ladies:

In accordance with the payment provision included in the special conditions of contract, which amends the general conditions of contract to provide for advance payment,

.....

[name and address of tenderer][hereinafter called “the tenderer”] shall deposit with the Procuring entity a bank guarantee to guarantee its proper and faithful performance under the said clause of the contract in an amount of
[amount of guarantee in figures and words].
We, the

[bank or financial institution], as instructed by the tenderer, agree unconditionally and irrevocably to guarantee as primary obligator and not as surety merely, the payment to the Procuring entity on its first demand without whatsoever right of objection on our part and without its first claim to the tenderer, in the amount not exceeding
[amount of guarantee in figures and words].

We further agree that no change or addition to or other modification of the terms of the Contract to be performed thereunder or of any of the Contract documents which may be made between the Procuring entity and the tenderer, shall in any way release us from any liability under this guarantee, and we hereby waive notice of any such change, addition, or modification.

This guarantee shall remain valid and in full effect from the date of the advance payment received by the tenderer under the Contract until [date].

Yours truly,

Signature and seal of the Guarantors

[name of bank or financial institution]

[address]

[date]

LETTER OF NOTIFICATION OF AWARD

Address of Procuring Entity

To:_____

RE: Tender No._____

Tender Name _____

This is to notify that the contract/s stated below under the above mentioned tender have been awarded to you.

1. Please acknowledge receipt of this letter of notification signifying your acceptance.
2. The contract/contracts shall be signed by the parties within 30 days of the date of this letter but not earlier than 14 days from the date of the letter.
3. You may contact the officer(s) whose particulars appear below on the subject matter of this letter of notification of award.

(*FULL PARTICULARS*)_____

SIGNED FOR ACCOUNTING OFFICER

REPUBLIC OF KENYA
PUBLIC PROCUREMENT ADMINISTRATIVE REVIEW BOARD

APPLICATION NO.....OF.....20.....

BETWEEN

.....APPLICANT

AND

.....RESPONDENT (*Procuring Entity*)

Request for review of the decision of the..... (*Name of the Procuring Entity*) of
.....dated the...day of20.....in the matter of Tender No.....of
.....20...

REQUEST FOR REVIEW

I/We.....,the above named Applicant(s), of address: Physical
address.....Fax No.....Tel. No.....Email, hereby request the Public Procurement
Administrative Review Board to review the whole/part of the above mentioned decision on the following
grounds , namely:-

- 1.
- 2.
- etc.

By this memorandum, the Applicant requests the Board for an order/orders that: -

- 1.
- 2.
- etc

SIGNED(Applicant)

Dated on.....day of/...20...

FOR OFFICIAL USE ONLY

Lodged with the Secretary Public Procurement Administrative Review Board on day of
.....20.....

SIGNED
Board Secretary