

REPUBLIC OF KENYA
MINISTRY OF WATER, SANITATION AND IRRIGATION



ATHI WATER WORKS DEVELOPMENT AGENCY

BIDDING DOCUMENT

National competitive Bidding

**FOR PROCUREMENT OF WORKS
CONTRACT FOR**

**REHABILITATION AND EXPANSION OF DANDORA
ESTATE WASTE WATER TREATMENT PLANT**

NCB NO: AWWDA/GOK/DESTP/W-04/2020-2021

IFB No: AWWDA/GOK/DESTP/W-04/2020

Employer: ATHI WATER WORKS DEVELOPMENT AGENCY

Issued on: JULY 2020



**MINISTRY OF WATER, SANITATION AND IRRIGATION
ATHI WATER WORKS DEVELOPMENT AGENCY**

RE-ADVERTISEMENT

Invitation for Bids

**REHABILITATION AND EXPANSION OF DANDORA ESTATE WASTE WATER
TREATMENT PLANT**

National competitive Bidding

NCB NO: AWWDA/GOK/DESTP/W-04/2020-2021

1. The Government of Kenya through the Ministry of Water, Sanitation and Irrigation has allocated funds for Rehabilitation and Expansion of Dandora Estate Waste Water Treatment Plant (DEWWTP) in Ruai to Improve Sanitation Services in Nairobi City and the Environs.
2. The Athi Water Works Development Agency now invites sealed bids from eligible citizen contractors for the works contract for Rehabilitation and expansion of Dandora Estate Waste Water Treatment Plant.
3. The following are mandatory requirements that must be submitted together with the Bid document:
 - Proof of registration as a water and sewerage contractor with the Ministry of Water, Sanitation and irrigation under Category B
 - Proof of Registration with National Construction Authority category NCA 2.
 - Certified copy of Certificate of Incorporation, Business Permit, CR 12 and a Valid Tax Compliance Certificate,
 - Firm's Audited Accounts for the last Three (3) years

Further information will be in the Bidding Document.

3. Interested eligible bidders may obtain further information from **Athi Water Works Development Agency, Chief Executive Officer, info@awwda.go.ke** and inspect the bidding documents during office hours from 0800 hours to 1700 Hours local time from Monday to Friday, except during lunch hour (1300 hours to 1400 hours), during weekends and public holidays at the address given below.
4. A complete set of bidding documents in English may be purchased by interested eligible bidders upon the submission of a written application to the address below and upon payment of a nonrefundable fee of KShs. 1,000 (Kenya Shillings One Thousand). The method of payment will be cash or banker's cheque. The documents may also be downloaded from the AWWDA website: www.awwda.go.ke and www.tenders.go.ke for free, Bidders who

download the bidding document from the website **MUST** forward their particulars immediately to procurement@awwda.go.ke, for records and any further clarifications and addenda. Further information may be obtained from the address below:

5. All bids must be accompanied with a bid security in the form of an unconditional Bank Guarantee of **Kshs. 2,000,000.00 (Kenya Shillings Two Million Only)** or from an insurance company registered by IRA and approved by PPRA.
6. Bids must be delivered to the address below on or before **12.00pm East African Time on 4th September, 2020**. Late bids will be rejected. Bids will be publicly opened in the presence of the bidders' designated representatives and anyone who choose to attend at the address below on **4th September, 2020 at 12.05pm** East African Time.
7. Opening of bids will be in line with the PPRA Guidelines as stipulated in the circular no.02/2020 which can be accessed from their website www.ppra.go.ke

Chief Executive Officer
Athi Water Works Development Agency
3rd Floor, Africa Re Centre,
Hospital Road, Upper Hill
P.O. Box 45283-00100
Nairobi, Kenya
Email : info@awwda.go.ke

SECTION II: INSTRUCTIONS TO TENDERERS (ITT)

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A.Introduction

1. Scope of Tender

- 1.1 The Procuring Entity indicated in the **Tender Data Sheet** (TDS) invites Tenders for the construction of works as specified in the **Tender Data Sheet** and Sections VI (Technical Specifications) and VII (Drawings).
- 1.2 The successful Tenderer will be expected to complete the works by the required completion date specified in the **Tender Data Sheet**.
- 1.3 The objectives of the works are listed in the **Tender Data Sheet**. These are mandatory requirements. Any subsequent detail is offered to support these objectives and must not be used to dilute their importance.

2. Source of Funds

- 2.1 The Government of Kenya has set aside funds for the use of the Procuring Entity named in the **Tender Data Sheet** during the Financial Year indicated in the **Tender Data Sheet**. It is intended that part of the proceeds of the funds will be applied to cover eligible payments under the contract for the works as described in the **Tender Data Sheet**.

Or

The Government of Kenya through Procuring Entity named in the **Tender Data Sheet** has applied for/received/ intends to apply for a [loan/credit/grant] from the financing institution named in the **Tender Data Sheet** towards the cost of the Project named in the **Tender Data Sheet**. The Government of Kenya intends to apply a part of the proceeds of this [loan/credit/grant] to payments under the Contract described in the **Tender Data Sheet**.

- 2.2 Payments will be made directly by the Procuring Entity (or by financing institution specified in the **Tender Data Sheet** upon request of the Procuring Entity to so pay) and will be subject in all respects to the terms and conditions of the resulting contract placed by the Procuring Entity.

3. Eligible Tenderers

- 3.1 A Tenderer may be a natural person, private or public company, government-owned institution, subject to sub-Clause 3.4 or any combination of them with a formal intent to enter into an agreement or under an existing agreement in the form of a joint venture, consortium, or association. In the case of a joint venture, consortium, or association, unless otherwise specified in the **Tender Data Sheet**, all parties shall be jointly and severally liable.

- 3.2** The Invitation for Tenders is open to all suppliers as defined in the Public Procurement and Disposal Act, 2005 and the Public Procurement and Disposal Regulations, 2006 except as provided hereinafter.
- 3.3** National Tenderers shall satisfy all relevant licensing and/or registration with the appropriate statutory bodies in Kenya, such as the Ministry of Public Works or the Energy Regulatory Commission.
- 3.4** A Tenderer shall not have a conflict of interest. All Tenderers found to have a conflict of interest shall be disqualified. A Tenderer may be considered to have a conflict of interest with one or more parties in this Tendering process, if they:
- a) Are associated or have been associated in the past directly or indirectly with employees or agents of the Procuring Entity or a member of a board or committee of the Procuring Entity;
 - b) Are 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 works under this Invitation for Tenders;
 - c) Have controlling shareholders in common; or
 - d) Receive or have received any direct or indirect subsidy from any of them; or
 - e) Have the same legal representative for purposes of this Tender; or
 - f) Have a relationship with each other, directly or through common third parties, that puts them in a position to have access to information about or influence on the Tender of another Tenderer, or influence the decisions of the Procuring Entity regarding this Tendering process; or
 - g) Submit more than one Tender in this Tendering process, however, this does not limit the participation of subcontractors in more than one Tender, or as Tenderer and subcontractor simultaneously.
- 3.5** A Tenderer will be considered to have a conflict of interest if they participated as a consultant in the preparation of the design or technical specification of the project and related services that are the subject of the Tender.

- 3.6 Tenderers shall not be under a declaration of ineligibility for corrupt and fraudulent practices issued by the Government of Kenya in accordance with GCC sub-Clause 3.2.
- 3.7 Government owned enterprises in Kenya may participate only if they are legally and financially autonomous, if they operate under commercial law, are registered by the relevant registration board or authorities and if they are not a dependent agency of the Government.
- 3.7 Tenderers shall provide such evidence of their continued eligibility satisfactory to the Procuring Entity, as the Procuring Entity shall reasonably request.

4. One Tender per Tenderer

- 4.1 A firm shall submit only one Tender, in the same Tendering process, either individually as a Tenderer or as a partner in a joint venture pursuant to ITT Clause 5.
- 4.2 No firm can be a subcontractor while submitting a Tender individually or as a partner of a joint venture in the same Tendering process.
- 4.3 A firm, if acting in the capacity of subcontractor in any Tender, may participate in more than one Tender but only in that capacity.
- 4.4 A Tenderer who submits or participates in more than one Tender (other than as a subcontractor or in cases of alternatives that have been permitted or requested) will cause all the Tenders in which the Tenderer has participated to be disqualified.

5. Alternative Tenders by Tenderers

- 5.1 Tenderers shall submit offers that comply with the requirements of the Tendering documents, including the basic Tenderer's technical design as indicated in the specifications and Drawings and Bill of Quantities. Alternatives will not be considered, unless specifically allowed for in the **Tender Data Sheet**. If so allowed, sub-Clause 5.2 and 5.3 shall govern.
- 5.2 When alternative times for completion are explicitly invited, a statement to that effect will be included in the **Tender Data Sheet** as will the method of evaluating different times for completion.
- 5.3 If so allowed in the **Tender Data Sheet**, Tenderers wishing to offer technical alternatives to the requirements of the Tendering documents must also submit a Tender that complies with the requirements of the Tendering documents, including the basic technical design as indicated in the specifications. In addition to submitting the basic Tender, the Tenderer shall provide all information necessary for a complete evaluation of the

alternative by the Procuring Entity, including technical specifications, breakdown of prices, and other relevant details. Only the technical alternatives, if any, of the lowest evaluated Tenderer conforming to the basic technical requirements shall be considered by the Procuring Entity.

6. Cost of Tendering

- 6.1** The Tenderer shall bear all costs associated with the preparation and submission of its Tender, and the Procuring Entity shall in no case be responsible or liable for those costs, regardless of the conduct or outcome of the Tendering process.

7. Site Visit and Pre-Tender Meeting

- 7.1** The Tenderer, at the Tenderer's own responsibility and risk, is advised to visit and examine the Site of Works and its surroundings and obtain all information that may be necessary for preparing the Tender and entering into a contract for construction of the Works. The costs of visiting the Site shall be at the Tenderer's own expense.
- 7.2** The Procuring Entity may conduct a site visit and a pre-Tender meeting. The purpose of the pre-Tender meeting will be to clarify issues and to answer questions on any matter that may be raised at that stage.
- 7.3** The Tenderer's designated representative is invited to attend a site visit and pre-Tender meeting which, if convened, will take place at the venue and time stipulated in the **Tender Data Sheet**.
- 7.4** The Tenderer is requested as far as possible, to submit any questions in writing or by electronic means to reach the procuring Entity before the pre-Tender meeting. It may not be practicable at the meeting to answer all questions, but questions and responses will be transmitted in accordance with sub-Clause 7.5.
- 7.5** Minutes of the pre-Tender meeting, including the text of the questions raised and the responses given together with any responses prepared after the pre-Tender meeting will be transmitted within the time stated in the **Tender Data Sheet** to all purchasers of the Tendering documents. Any modification of the Tendering documents listed in sub-Clause 8.1 that may become necessary as a result of the pre-Tender meeting shall be made by the Procuring Entity exclusively through the issue of an Addendum pursuant to ITT sub Clause 10.2 and not through the minutes of the pre-Tender meeting.
- 7.6** Non attendance during the site visit or pre-Tender meeting will not be a cause for disqualification of a Tenderer unless specified to the contrary in the **Tender Data Sheet**.

B. Tendering Documents

8. Content of Tendering Documents

8.1 The works required, Tendering procedures, and contract terms are prescribed in the Tendering Documents. In addition to the Section I Invitation for Tenders, Tendering documents which should be read in conjunction with any addenda issued in accordance with ITT sub Clause 10.2 include:

Section II	Instructions to Tenderers
Section III	Tender Data Sheet
Section IV	General Conditions of Contract
Section V	Contract Data Sheet
Section VI	Specifications
Section VII	Drawings
Section VIII	Bill of Quantities
Section IX	Forms of Tender
	<ul style="list-style-type: none">• Form of Tender• Appendix to Tender• Confidential Business Questionnaire• Integrity Declaration• Letter of Acceptance• Form of Contract Agreement
Section X	Forms of Security
	<ul style="list-style-type: none">• Tender Security Form• Tender Securing Declaration• Performance Bank or Insurance Guarantee• Advance Payment Guarantee
Section XI	Form RB 1 Application to Public Procurement Administrative Review Board

8.2 The number of copies to be completed and returned with the Tender is specified in the **Tender Data Sheet**.

8.3 The Invitation for Tenders (Section I) issued by the Procuring Entity is not part of the Tendering Documents and is included for reference purposes only. In case of discrepancies between the Invitation for Tenders and the Tendering Documents listed in sub-Clause 8.1 above, the said Tendering Documents will take precedence.

8.4 The Procuring Entity is not responsible for the completeness of the Tendering Documents and their addenda, if they were not obtained directly from the authorized staff of the Procuring Entity.

8.5 The Tenderer is expected to examine all instructions, forms, terms and specifications in the Tendering documents. Failure to furnish all information required by the Tendering Documents or to submit a Tender substantially responsive to

the Tendering documents in every respect will be at the Tenderer's risk and may result in the rejection of its Tender.

9. Clarification of Tendering Documents

- 9.1** A prospective Tenderer requiring any clarification of the Tendering documents may notify the Procuring Entity in writing, e-mail or facsimile at the Procuring Entity's address indicated in the **Tender Data Sheet**.
- 9.2** The Procuring Entity will within the period stated in the **Tender Data Sheet** respond in writing to any request for clarification provided that such request is received no later than the period indicated in the **Tender Data Sheet** prior to the deadline for the submission of Tenders prescribed in sub-Clause 22.1.
- 9.3** Copies of the procuring entity's response will be forwarded to all Purchasers of the Tendering documents, including a description of the inquiry, but without identifying its source.
- 9.4** Should the Procuring Entity deem it necessary to amend the Tendering documents as a result of a clarification, it shall do so following the procedure under ITT Clause 10.

10. Amendments of the Tendering Documents

- 10.1** Before the deadline for submission of Tenders, the Procuring Entity may, for any reason, whether at its own initiative or in response to a clarification requested by a prospective Tenderer, modify the Tendering documents by issuing addenda.
- 10.2** Any addendum issued shall be part of the Tender documents pursuant to sub-Clause 8.1 and shall be communicated in writing, by e-mail or facsimile to all who have obtained the Tendering documents directly from the Procuring Entity.
- 10.3** In order to allow prospective Tenderers reasonable time in which to take an addendum into account in preparing their Tenders, the Procuring Entity at its discretion shall extend, as necessary, the deadline for submission of Tenders, in accordance with sub-Clause 22.2

C. Preparation of Tenders

11. Language of Tender

- 11.1** The Tender, and all correspondence and documents related to the Tender exchanged by the Tenderer and the Procuring Entity shall be written in the Tender language stipulated in the **Tender Data Sheet**. Supporting documents and printed literature furnished by the Tenderer may be in another language provided they are accompanied by an accurate translation of the relevant

passages in the above stated language, in which case, for purposes of interpretation of the Tender, the translation shall prevail.

12. Documents Constituting the Tender

12.1 The Tender submitted by the Tenderer shall consist of the following components:

- a) The Form of Tender (in the format indicated in Section IX) completed in accordance with ITT Clause 15, 16 and 17;
- b) Information requested by Instructions to Tenderers ITT sub-Clause 13.2; 13.3 and 13.4;
- c) Tender Security or Tender Securing Declaration in accordance with Instructions to Tenderers ITT Clause 19;
- d) Priced Bill of Quantities;
- e) Qualification Information Form and Documents;
- f) Alternative offers where invited in accordance with Instructions to Tenderers ITT Clause 5;
- g) Written confirmation authorizing the signatory of the Tender to commit the Tenderer in accordance with Instructions to Tenderers ITT sub Clause 19.2; and
- h) And any information or other materials required be completing and submitting by Tenderers, as specified in the **Tender Data Sheet**.

13. Documents Establishing Eligibility and Qualifications of the Tenderer

13.1 Pursuant to ITT Clause 13, the Tenderer shall furnish, as part of its Tender, documents establishing the Tenderer's eligibility to Tender and its qualifications to perform the contract if its Tender is accepted.

13.2 In the event that pre-qualification of potential Tenderers has been undertaken, only Tenders from pre-qualified Tenderers will be considered for award of contract. These qualified Tenderers should submit their Tenders with any information updating the original pre-qualification applications or, alternatively, confirm in their Tenders that the originally submitted pre-qualification information remains essentially correct as of the date of Tender submission. The update or confirmation should be provided in Section IX.

13.3 If the Procuring Entity has not undertaken pre-

qualification of potential Tenderers, to qualify for award of the contract, Tenderers shall meet the minimum qualifying criteria specified in the **Tender Data Sheet**:

13.4 Tenders submitted by a joint venture of two or more firms as partners shall comply with the following requirements, unless otherwise stated in the **Tender Data Sheet**:

- a) The Tender shall include all the information listed in the **Tender Data Sheet** pursuant to sub-Clause 13.3 above for each joint venture partner;
- b) The Tender shall be signed so as to be legally binding on all partners;
- c) One of the partners will be nominated as being in charge, and this authorization shall be evidenced by submitting a power of attorney signed by legally authorized signatories of all the partners;
- d) The partner in charge shall be authorized to incur liabilities and receive instructions for and on behalf of any and all partners of a joint venture and the entire execution of the Contract, including payment, shall be done exclusively with the partner in charge;
- e) All partners of the joint venture shall be liable jointly and severally for the execution of the contract in accordance with the contract terms and a statement to this effect shall be included in the authorization mentioned under (c) above as well as in the Tender and in the Agreement (in case of a successful Tender); and
- f) A copy of the joint venture agreement entered into by all partner shall be submitted with the Tender. Alternatively, a Letter of Intent to execute a joint venture agreement in the event of a successful Tender shall be signed by all partners and submitted with the Tender, together with a copy of the proposed Agreement.
- g) The Tender Security and Tender Securing Declaration as stated in accordance with ITT Clause 19, and in case of a successful Tender, the Agreement, shall be signed so as to be legally binding on all partners.

14. Lots Package

14.1 When Tendering for more than one contract under the lots arrangements, the Tenderer must provide evidence

that it meets or exceeds the sum of all the individual requirements for the lots being tendered in regard to:

- a) Average annual turnover;
- b) Particular experience including key production rates;
- c) Financial means, etc;
- d) Personnel capabilities; and
- e) Equipment capabilities.

14.2 In case the Tenderer fail to fully meet any of these criteria, it may be qualified only for those lots for which the Tenderer meets the above requirement.

15. Form of Tender

15.1 The Tenderer shall fill the Form of Tender furnished in the Tendering Documents. The Form of Tender must be completed without any alterations to its format and no substitute shall be accepted.

16. Tender Prices

16.1 The Contract shall be for the whole Works, as described in sub-Clause 1.1, based on the priced Bill of Quantities submitted by the Tenderer.

16.2 The Tenderer shall fill in rates and prices for all items of the Works described in the Bill of Quantities. Items for which no rate or price is entered by the Tenderer will not be paid for by the Procuring Entity when executed and shall be deemed covered by the other rates and prices in the Bill of quantities.

16.3 All duties, taxes and other levies payable by the Contractor under the Contract, or for any other cause, as of the date 15 days prior to the deadline for submission of Tenders, shall be included in the rates, prices and total Tender price submitted by the Tenderer.

16.4 The rates and prices quoted by the Tenderer shall be subject to adjustment during the performance of the Contract if provided for in the **Tender Data Sheet** and the provisions of the Conditions of Contract. The Tenderer shall submit with the Tender all the information required under the **Contract Data Sheet**.

17. Tender Currencies

17.1 The unit rates and prices shall be quoted by the Tenderer in the currency as specified in the **Tender Data Sheet**.

17.2 Tenderers shall indicate details of their expected foreign currency requirements in the Tender, if any. The rates of exchange to be used by the Tenderers in arriving at the local currency equivalent shall be the selling rates for similar transactions established by the authority specified

in the **Tender Data Sheet** prevailing on the date 28 days prior to the latest deadline for submission of Tenders. These exchange rates shall apply for all payments so that no exchange risk will be borne by the Tenderer. In any case, payments will be computed using the rates quoted in the Tender.

- 17.3** Tenderers may be required by the Procuring Entity to clarify their foreign currency requirements and to substantiate that the amounts included in the rates and prices and in the Contract Data Sheet are reasonable and responsive to sub-Clause 17.1.

18. Tender Validity Period

- 18.1** Tenders shall remain valid for the period specified in the **Tender Data Sheet** after the Tender submission deadline prescribed by the Procuring Entity, pursuant to ITT Clause 22. A Tender valid for a shorter period shall be rejected by the Procuring Entity as non responsive.
- 18.2** In exceptional circumstances, prior to expiry of the original Tender validity period, the Procuring Entity may request that the Tenderers extend the period of validity for a specified additional period. The request and the Tenderers' responses shall be made in writing or by cable. A Tenderer may refuse the request without forfeiting its Tender Security or causing to be executed its Tender Securing declaration. A Tenderer agreeing to the request will not be required or permitted to otherwise modify the Tender, but will be required to extend the validity of its Tender Security or Tender Securing declaration for the period of the extension, and in compliance with ITT Clause 19 in all respects.
- 18.3** In the case of fixed price contracts, if the award is delayed by a period exceeding sixty (60) days beyond the expiry of the initial Tender validity period, the contract price will be increased by a factor specified in the request for extension. The Tender evaluation shall be based on the Tender price without taking into consideration on the above correction.

19. Tender Security and Tender Securing Declaration

- 19.1** Pursuant to ITT Clause 12, where required in the **Tender Data Sheet**, the Tenderer shall furnish as part of its Tender, a Tender Security in original form and in the amount and currency specified in the **Tender Data Sheet**.
- A Tender Securing Declaration as specified in the **Tender Data Sheet** in the format provided in section X shall be provided as a mandatory requirement.

- 19.2** The Tender Security or Tender Securing Declaration is required to protect the Procuring Entity against the risk of Tenderer's conduct which would warrant the security's forfeiture, pursuant to ITT sub-Clause 19.9.
- 19.3** The Tender Security shall be denominated in the currency of the Tender and shall be in one of the following forms:
- a) Cash;
 - b) A Bank Guarantee;
 - c) An Insurance Bond issued by an insurance firm approved by the PPOA located in Kenya;
 - d) An irrevocable letter of credit issued by a reputable bank.
- 19.4** The Tender Security shall be in accordance with the Form of the Tender Security included in Section X or another form approved by the Procuring Entity prior to the Tender submission.
- 19.5** The Tender Security shall be payable promptly upon written demand by the Procuring Entity in case any of the conditions listed in sub-Clause 19.8 are invoked.
- 19.6** Any Tender not accompanied by a Tender Security in accordance with sub-Clauses 19.1 or 19.3 shall be rejected by the Procuring Entity as non-responsive, pursuant to ITT Clause 28.
- 19.7** The Procuring Entity shall immediately release any Tender Security if:
- a) The procuring proceedings are terminated;
 - b) The Procuring Entity determines that none of the submitted Tenders is responsive;
 - c) A contract for the procurement is entered into.
- 19.8** The Tender Security shall be forfeited and the Tender Securing Declaration executed if the Tenderer:
- a) Withdraws its Tender after the deadline for submitting Tenders but before the expiry of the period during which Tenders must remain valid;
 - b) Rejects a correction of an arithmetic error pursuant to

sub-Clause 29.2;

c) Refuse to enter into a written contract in accordance with ITT Clause 40;

d) Fails to furnish the Performance Security in accordance with ITT Clause 41.

19.9 The Tender Security and Tender Securing Declaration of a joint venture must be in the name of the joint venture submitting the Tender.

19.10 A Tenderer shall be suspended from being eligible for Tendering in any contract with the Procuring Entity for the period of time indicated in the Tender Securing Declaration:

a) If the Tenderer withdraws its Tender, except as provided in ITT sub-Clauses 18.2 and 29.2; or

b) In the case of a successful Tenderer, if the Tenderer fails within the specified time limit to:

(i) Sign the contract; or

(ii) Furnish the required Performance Security.

20. Format and Signing of Tender

20.1 The Tenderer shall prepare one original of the documents comprising the Tender as described in ITT Clause 12 of these Instructions to Tenderers, with the Form of Tender, and clearly marked “**ORIGINAL**”. In addition, the Tenderer shall submit copies of the Tender, in the number specified in the **Tender Data Sheet**, and clearly marked as “**COPIES**”. In the event of discrepancy between them, the original shall prevail.

20.2 The original and all copies of the Tenders shall be typed or written in indelible ink and shall be signed by a person or persons duly authorized to sign on behalf of the Tenderer. This authorization shall consist of a written confirmation as specified in the **Tender Data Sheet** and shall be attached to the Tender. The name and position held by each person signing the authorization must be typed or printed below the signature. All pages of the Tender, except for un-amended printed literature, shall be initialled by the person or persons signing the Tender.

20.3 Any interlineations, erasures, or overwriting shall be valid only if they are initialled by the person or persons signing the Tender.

- 20.4** The Tenderer shall furnish information as described in the Form of Tender on commissions or gratuities, if any, paid or to be paid to agents relating to this Tender and to contract execution if the Tenderer is awarded the contract

D.Submission of Tenders

21. Sealing and Marking of Tenders

- 21.1** 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 securely sealed in such a manner that opening and resealing cannot be achieved undetected.
- 21.2** The inner and outer envelopes shall:
- a) Be addressed to the Procuring Entity at the address given in the **Tender Data Sheet**; and
 - b) Bear the Project name indicated in the **Tender Data Sheet**, the Invitation for Tenders (IFB) title and number indicated in the **Tender Data Sheet**, and a statement: “**DO NOT OPEN BEFORE,**” to be completed with the time and the date specified in the **Tender Data Sheet**, pursuant to ITT sub-Clause 22.1.
- 21.3** In addition to the identification required in sub-Clause 21.2, the inner envelopes shall also indicate the name and address of the Tenderer to enable the Tender be returned unopened in case it is declared late, pursuant to sub-Clause 22.1 and for matching purpose under ITT Clause 23
- 21.4** If the outer envelope is not sealed and marked as required by ITT sub clause 21.2, the Procuring Entity shall assume no responsibility for misplacement or premature opening of the Tender.

22. Deadline for Submission of Tenders

- 22.1** Tenders shall be received by the Procuring Entity at the address specified under ITT sub-Clause 21.2 no later than the date and time specified in the **Tender Data Sheet**.
- 22.2** The Procuring Entity may, in exceptional circumstances and at its discretion, extend the deadline for the submission of Tenders by amending the Tendering documents in accordance with ITT Clause 9, in which case all rights and obligations of the Procuring Entity and Tenderers previously subject to the deadline will thereafter be subject to the new deadline.

22.3 The extension of the deadline for submission of Tenders shall not be made later than the period specified in the **Tender Data Sheet** before the expiry of the original deadline.

23. Late Tenders

23.1 The Procuring Entity shall not consider for evaluation any Tender that arrives after the deadline for submission of Tenders, in accordance with ITT Clause 22.

23.2 Any Tender received by the Procuring Entity after the deadline for submission of Tenders shall be declared late, rejected and returned unopened to the Tenderer

24. Modification, Substitution and Withdrawal of Tenders

24.1 A Tenderer may modify or substitute or withdraw its Tender after it has been submitted, provided that written notice of the modification, including substitution or withdrawal of the Tender, is received by the Procuring Entity prior to the deadline prescribed for submission of Tenders prescribed under ITT sub-Clause 22.1.

24.2 The Tenderer's modification or substitution or withdrawal notice shall be prepared, sealed, marked, and dispatched in accordance with the provisions of ITT Clauses 20 and 21 with the outer and inner envelopes additionally marked "**MODIFICATION**" or **SUBSTITUTION** or "**WITHDRAWAL**" as appropriate. The notice may also be sent by electronic mail and facsimile, but followed by a signed confirmation copy, postmarked not later than the deadline for submission of Tenders.

24.3 No Tender may be withdrawn, replaced or modified 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 shall result in the Tenderer's forfeiture of its Tender Security or execution of Tender Securing Declaration, pursuant to the ITT sub-Clause 19.9.

24.4 Withdrawal of a Tender between the deadline for submission of Tenders and the expiration of the period of Tender validity specified in the **Tender Data Sheet** or as extended pursuant to sub-Clause 22.2 shall result in the forfeiture of the Tender Security and execution of Tender Securing Declaration pursuant to ITT sub-Clause 19.9.

24.5 Tenderers may only offer discounts to, or otherwise modify the prices of their Tenders by submitting Tender modifications in accordance with this Clause, or included in the original Tender submission.

E. Opening and Evaluation of Tenders

25. Opening of Tenders

- 25.1** The Procuring Entity will open all Tenders including modifications, substitution or withdraw notices made pursuant to ITT Clause 24, in public, in the presence of Tenderers or their representatives who choose to attend and other parties with legitimate interest and Tender proceedings, at the place on the date and at time specified in the **Tender Data Sheet**. The Tenderers' representatives who are present shall sign a register as proof of their attendance.
- 25.2** Envelopes marked "**WITHDRAWAL**" shall be opened and read out first. Tenders for which an acceptable notice of withdrawal has been submitted pursuant to ITT Clause 24 shall not be opened but returned to the Tenderer. If the withdrawal envelope does not contain a copy of the "Power of Attorney" confirming the signature as a person duly authorized to sign on behalf of the Tenderer, the corresponding Tender will be opened. Subsequently, all envelopes marked "**MODIFICATION**" shall be opened and the submissions therein read out in appropriate detail. Thereafter all envelopes marked or "**SUBSTITUTION**" opened and the submissions therein read out in appropriate detail.
- 25.3** All other envelopes shall be opened one at a time. The Tenderers' names, the Tender prices, the total amount of each Tender and of any alternative Tender (if alternatives have been requested or permitted), any discounts, the presence or absence of Tender security, and such other details as the appropriate tender opening committee may consider appropriate, will be announced by the Secretary of the Tender Opening Committee at the opening.
- 25.4** Tenders or modifications that are not opened and not read out at Tender opening shall not be considered further for evaluation, irrespective of the circumstances. In particular, any discount offered by a Tenderer which is not read out at Tender opening shall not be considered further.
- 25.5** Tenderers are advised to send in a representative with the knowledge of the content of the Tender who shall verify the information read out from the submitted documents. Failure to send a representative or to point out any un-read information by the sent Tenderer's representative shall indemnify the Procuring Entity against any claim or failure to read out the correct information contained in the Tenderer's Tender.

- 25.6** No Tender will be rejected at Tender opening except for late Tenders which will be returned unopened to the Tenderer, pursuant to ITT Clause 23.
- 25.7** The Secretary of the appropriate tender opening committee shall prepare minutes of the Tender opening. The record of the Tender opening shall include, as a minimum: the name of the Tenderers and whether or not there is a withdrawal, substitution or modification, the Tender price per Lot if applicable, including any discounts and alternative offers and the presence or absence of a Tender Security or Tender Securing Declaration.
- 25.8** The Tenderers' representatives who are present shall be requested to sign the record. The omission of a Tenderer's signature on the record shall not invalidate the contents and affect the record.
- 25.9** A copy of the minutes of the Tender opening shall be furnished to individual Tenderers upon request.

26. Confidentiality

- 26.1** Information relating to the examination, clarification, evaluation, and comparison of Tenders and recommendations for the award of a Contract shall not be disclosed to Tenderers or any other persons not officially concerned with such process until the award to the successful Tenderer has been announced.
- 26.2** Any effort by a Tenderer to influence the Procuring Entity's processing of Tenders or award decisions may result in the rejection of his Tender.
- 26.3** Notwithstanding sub-Clause 26.2, from the time of Tender opening to the time of Contract award, if any Tenderer wishes to contact the Procuring Entity on any matter related to the Tendering process, it should do so in writing.

27. Clarification of Tenders

- 27.1** To assist in the examination, evaluation, comparison of Tenders and post-qualification of the Tenderer, the Procuring Entity may, at its discretion, ask a Tenderer for clarification of its Tender including breakdown of prices. Any clarification submitted by a Tenderer that is not in response to a request by the Procuring Entity shall not be considered.
- 27.2** The request for clarification and the response shall be in writing. No change in the prices or substance of the Tender shall be sought, offered, or permitted except to confirm the correction of arithmetic errors discovered by the Procuring

Entity in the evaluation of Tenders in accordance with ITT Clause 29.

- 27.3** From the time of Tender opening to the time of Contract award if any Tenderer wishes to contact the Procuring Entity on any matter related to the Tender it should do so in writing.

28. Preliminary Examination of Tenders

- 28.1** Prior to the detailed evaluation of Tenders, the Procuring Entity will determine whether:
- a) The Tender has been submitted in the required format;
 - b) Any Tender Security submitted is in the required form, amount and validity period;
 - c) The Tender has been signed by the person lawfully authorized to do so;
 - d) The required number of copies of the Tender have been submitted;
 - e) The Tender is valid for the period required;
 - f) All required documents and information have been submitted; and
 - g) Any required samples have been submitted.
- 28.2** The Procuring Entity will confirm that the documents and information specified under ITT Clause 12 and ITT Clause 13 have been provided in the Tender. If any of these documents or information is missing, or is not provided in accordance with the Instructions to Tenderers, the Tender shall be rejected.
- 28.3** The Procuring Entity may waive any minor informality, 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
- 28.4** A substantially responsive Tender is one which conforms to all the terms, conditions, and specifications of the Tendering documents, without material deviation or reservation. A material deviation or reservation is one that:
- a) Affects in any substantial way the scope, quality, or execution of the Works;
 - b) Limits in any substantial way, inconsistent with the

Tendering documents, the Procuring Entity's rights or the Tenderer's obligations under the Contract; or

- c) If rectified, would affect unfairly the competitive position of other Tenderers presenting substantially responsive Tenders.

28.5 If a Tender is not substantially responsive, it will be rejected by the Procuring Entity, and may not subsequently be made responsive by correction or withdrawal of the non-conforming deviation or reservation.

29. Correction of Errors

29.1 Tenders determined to be substantially responsive will be checked by the Procuring Entity for any arithmetic errors. Errors will be corrected by the Procuring Entity as follows:

- a) If there is a discrepancy between unit prices 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, unless in the opinion of the Procuring Entity there is an obvious misplacement of the decimal point in the unit price, in which the total price as quoted shall govern and the unit price shall be corrected;
- b) If there is an error in a total corresponding to the addition or subtraction of subtotals, the subtotals shall prevail and the total shall be corrected; and
- c) Where there is a discrepancy between the amounts in figures and in words, the amount in words will govern.

29.2 The amount stated in the Tender will, be adjusted by the Procuring Entity in accordance with the above procedure for the correction of errors and, with, the concurrence of the Tenderer, shall be considered as binding upon the Tenderer. If the Tenderer does not accept the corrected amount, its Tender will then be rejected, and the Tender Security may be forfeited and the Tender Securing Declaration may be executed in accordance with sub-Clause 19.9.

30. Conversion to Single Currency

30.1 To facilitate the evaluation and comparison, the Procuring Entity will convert all Tender prices expressed in the amounts in various currencies in which the Tender prices are payable to Kenya Shillings at the selling exchange rate established for similar transactions by the Central Bank of Kenya ruling on the date specified in the **Tender Data Sheet**.

31. Comparison of Tenders

- 31.1** The Procuring Entity shall evaluate and compare only the Tenders determined to be substantially responsive in accordance with ITT Clause 28.
- 31.2** In evaluating the Tenders, the Procuring Entity will determine for each Tender the evaluated Tender price by adjusting the Tender price as follows:
Making any correction for errors pursuant to ITT Clause 29;
Excluding provisional sums and the provision, if any for contingencies in the Bill of Quantities, but including Day work , where priced competitively ; and
Making appropriate adjustments to reflect discounts or other price modifications offered in accordance with sub-Clause 24.5.
- 31.3** The Procuring Entity may waive any minor informality or non-conformity, which does not constitute a material deviation, provided such waiver does not prejudice or affect the relative standing of any Tenderer. Variations, deviations, and alternative offers and other factors, which are in excess of the requirements of the Tendering documents or otherwise result in unsolicited benefits for the Procuring Entity will not be taken into account in Tender evaluation.

32. National Preference

- 32.1** In the evaluation of Tenders the Procuring Entity shall apply exclusive preference to citizens of Kenya where:
- a) The funding is 100% from the Government of Kenya or a Kenyan body;
 - b) The amounts are below the prescribed threshold of KShs.200 million;
- 32.2** To qualify for the preference the candidate shall provide evidence of eligibility by:
- a) Proving Kenyan citizenship by production of a Kenyan Identity Card; or
 - b) Providing proof of being a “citizen contractor” in terms of section 3(1) of the Act, i.e. being a natural person or an incorporated company wholly owned and controlled by persons who are citizens of Kenya.
- 32.3** The Minister of Finance may prescribe additional preference and/or reservation schemes, for example for procurements above these thresholds. If such additional preference schemes apply, details will be given in the

Tender Data Sheet.

33. Determination of the Lowest Evaluated Tender

33.1 The Tender with the lowest evaluated price from among those which are eligible, compliant and substantially responsive shall be the lowest evaluated Tender.

34. Post-qualification of Tenderer

34.1 If specified in the **Tender Data Sheet**, post-qualification shall be undertaken.

34.2 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, in accordance with the criteria listed in sub-Clause 13.3.

34.3 The determination will take into account the Tenderer's financial, technical, and production capabilities. It will be based upon an examination of the documentary evidence of the Tenderer's qualifications submitted by the Tenderer, pursuant to sub-Clause 13.3, as well as such other information as the Procuring Entity deems necessary and appropriate. Factors not included in these Tendering documents shall not be used in the evaluation of the Tenderer's qualifications.

34.4 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.

F. Award of Contract

35. Criteria of Award

35.1 Subject to ITT Clause 35 and 36, the Procuring Entity will award the Contract to the Tenderer whose Tender has been determined to be substantially responsive to the Tendering documents and who has offered the lowest Evaluated Tender Price, provided that such Tenderer has been determined to be:

- a) Eligible in accordance with the provisions of ITT Clause 3;
- b) Is determined to be qualified to perform the Contract satisfactorily;

c) Successful negotiations have been concluded.

35.2 If, pursuant to sub-Clause 14.1, this Contract is being awarded on a “lot and package” basis, the lowest evaluated Tender price will be determined when evaluating this Contract in conjunction with other Contracts to be awarded concurrently, taking into account any discounts offered by the Tenderer for award of more than one Contract.

36. Clarifications

36.1 Clarifications may be undertaken with the lowest evaluated Tenderer relating to the following areas:

- a) A minor alteration to the technical details of the statement of requirements;
- b) Reduction of quantities for budgetary reasons, where the reduction is in excess of any provided for in the Tendering documents;
- c) A minor amendment to the Contract Data Sheet;
- d) Finalizing payment arrangements;
- e) Mobilization arrangements;
- f) Agreeing final delivery or work schedule to accommodate any changes required by the Procuring Entity;
- g) The methodology or staffing; or
- h) Clarifying details that were not apparent or could not be finalized at the time of Tendering.

36.2 Clarifications shall not change the substance of the tender.

37. Procuring Entity’s Right to Accept any Tender and to Reject any or all Tenders

37.1 Notwithstanding ITT Clause 35, the Procuring Entity reserves the right to accept or reject any Tender, and to cancel the Tendering process and reject all Tenders, at any time prior to the award of Contract, without thereby incurring any liability to the affected Tenderer or Tenderers.

37.2 Notice of the rejection of all Tenders shall be given promptly within 14 days to all Contractors that have submitted Tenders.

37.3 The Procuring Entity shall upon request communicate to any Tenderer the grounds for its rejection of its Tenders, but is not required to justify those grounds.

38. Procuring Entities Right to Vary Quantities at the Time of Award

38.1 The Procuring Entity reserves the right at the time of contract award to increase or decrease the quantity of goods or related services originally specified in these Tendering documents (schedule of requirements) provided this does not exceed by the percentage indicated in the **Tender Data Sheet**, without any change in unit price or other terms and conditions of the Tender and Tendering documents.

39. Notification of Award

39.1 The Tenderer whose Tender has been accepted will be notified of the award by the Procuring Entity prior to expiration of the Tender validity period by e-mail or facsimile confirmed by registered letter. This letter (hereinafter and in the Conditions of Contract called the "Letter of Acceptance") will state the sum that the Procuring Entity will pay the Contractor in consideration of the provision and maintenance of the Work(s) as prescribed by the Contract (hereinafter and in the Contract called the "Contract Price").

39.2 The notification of award will constitute the formation of the Contract, subject to the Tenderer furnishing the Performance Security in accordance with ITT Clause 41 and signing the Contract in accordance with sub-Clause 40.2

39.3 At the same time as the person submitting the successful Tender is notified, the Procuring Entity will notify each unsuccessful Tenderer, the name of the successful Tenderer and the Contract amount and will discharge the Tender Security and Tender Securing Declaration of the Tenderer pursuant to ITT sub Clause 19.7.

39.4 If, after notification of award, a Tenderer wishes to ascertain the grounds on which its Tender or application for pre-qualification was unsuccessful, it should address its request to the secretary of the Tender Committee that authorized the award of contract. The secretary of the Tender Committee shall, within fourteen days after a request, provide written reasons as to why the Tender, proposal or application to be pre-qualified was unsuccessful.

However, failure to take this opportunity to clarify the grounds for rejection does not affect the Tenderer's right to seek immediate review by the Public Procurement Administrative Review Board under Clause 45.

40. Signing of Contract

- 40.1** Promptly, and in no case later than 14 days, after notification, Procuring Entity shall send the successful Tenderer the Agreement and Contract Data Sheet, incorporating all agreements between the parties obtained as a result of Contract negotiations.
- 40.2** Within the period specified in the notification or Tender Data Sheet but not earlier than fourteen (14) days since notification of award of contract, the successful Tenderer shall sign and date the contract and return it to the Procuring Entity.

41. Performance Security

- 41.1** Within thirty (30) days but after 14 days after receipt of the Letter of Acceptance, the successful Tenderer shall deliver to the Procuring Entity a Performance Security in the amount and in the form stipulated in the Tender Data Sheet and the Contract Data Sheet, denominated in the type and proportions of currencies in the Letter of Acceptance and in accordance with the Conditions of Contract.
- 41.2** If the Performance Security is provided by the successful Tenderer in the form of a Bank Guarantee or Insurance Bond, it shall be issued either:
- a) At the Tenderer's option, by a bank or insurance firm located in Kenya, or a foreign bank or insurance firm through a correspondent bank or insurance firm located in Kenya;
 - b) With the consent of the Procuring entity, directly by a foreign bank acceptable to the Procuring entity.
- 41.3** Failure of the successful Tenderer to comply with the requirement of sub-Clause 41.1 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 Tenderer or call for new Tenders.

42. Advance Payment

42.1 The Procuring Entity will provide an Advance Payment as stipulated in the Conditions of Contract, subject to a maximum amount, as stated in the Tender Data Sheet.

42.2 The Advance Payment request shall be accompanied by an Advance Payment Security (Guarantee) in the form provided in Section X. For the purpose of receiving the Advance Payment, the Tenderer shall make an estimate of, and include in its Tender, the expenses that will be incurred in order to commence work. These expenses will relate to the purchase of equipment, machinery, materials, and on the engagement of labour during the first month beginning with the date of the Procuring Entity's "Notice to Commence" as specified in the Contract Data Sheet.

43. Adjudicator

43.1 The Procuring Entity proposes the person named in the Tender Data Sheet to be appointed as Adjudicator under the Contract, at an hourly fee specified in the Tender Data Sheet, plus reimbursable expenses. If the Tenderer disagrees with this proposal, the Tenderer should so state in the Tender. If, in the Letter of Acceptance, the Procuring Entity has not agreed on the appointment of the Adjudicator, the Adjudicator shall be appointed by the Appointing Authority designated in the Contract Data Sheet at the request of either party.

G. Review of Procurement Decisions

44. Right to Review

44.1 A Tenderer who claims to have suffered or risk suffering, loss or damage or injury as a result of breach of a duty imposed on a Procuring Entity or an Approving Authority by the Public Procurement and Disposal Act, 2005 and the Public Procurement and Disposal Regulations 2006, the procurement proceedings or processes, may seek administrative review as prescribed by the Act. The following matters, however, shall not be subject to the administrative review:

- a) The choice of procurement method;
- b) a decision by the Procuring Entity to reject all Tenders, proposals or quotations;

c) Where a contract is signed in accordance to Section 68 of the Public Procurement and Disposal Act,2005;

d) Where an appeal is frivolous.

45. Time Limit on Review

45.1 The Tenderer shall submit an application for review in the number of copies and pay fees as prescribed by the Public Procurement and Disposal Regulations 2006 within fourteen (14) days of the time the Tenderer became or should have become aware of the circumstances giving rise to the complaint or dispute.

46. Submission of Applications for Review by the Public Procurement Administrative Review Board

46.1 Any application for administrative review shall be submitted in writing to the Secretary, Public Procurement Administrative Review Board on Form RB 1 at the address shown in the Tender Data Sheet. The secretary to the review board shall immediately after filing of the request, serve a copy thereof on the Procuring Entity or Director-General as the case may be.

46.2 The application for administrative review shall be in accordance with the requirements of Regulation 73 of the Public Procurement and Disposals Regulations,2006, including:

a) Reasons for the complaint ,including any alleged breach of the Act or Regulations;

b) An explanation of how the provisions of the Act and or Regulation has been breached or omitted, including the dates and name of the responsible public officer, where known;

c) Statements or other evidence supporting the complaint where available as the applicant considers necessary in support of its request;

d) Remedies sought;

e) Any other information relevant to the complaint.

47. Decision by the Public Procurement Administrative Review Board

47.1 The Administrative Review Board shall within thirty days after receipt of an application for administrative review deliver a written decision which shall indicate:

a) Annulling anything the Procuring Entity has done in the procurement proceedings, including annulling the procurement proceedings in their entirety;

- b) Giving directions to the Procuring Entity with respect to anything to be done or redone in the procurement proceedings;
- c) Substituting the decision of the Review Board for any decision of the Procuring Entity in the procurement proceedings;
- d) Order the payment of costs as between parties to the review.

47.2 The decision made by the Review Board shall, be final and binding on the parties unless judicial review thereof commences within fourteen (14) days from the date of the Review Board's decision.

**48. Appeal on the
decision of the Review
Board**

48.1 Any party to the review aggrieved by the decision of the Review Board may appeal to the High Court and the decision of the High Court shall be final.

SECTION III: TENDER DATA SHEET

Tender Data Sheet (TDS)

Instructions to Tenderers Clause Reference

TDS Reference Number	ITT Clause Number	Amendments of, and Supplements to, Clauses in the Instruction to Tenderers
1.	1.1	The Procuring Entity is Athi Water Works Development Agency
2.	1.1	Name of Project is; REHABILITATION AND EXPANSION OF DANDORA ESTATE WASTE WATER TREATMENT PLANT
3.	1.2	The expected completion date of the works: is Eighteen (18) months from the commencement date
4.	1.3	The Objectives of the Project is: <i>Rehabilitate and expand the treatment capacity of Dandora Estate Waste Water Treatment Plant (DESWWP)</i>
5.	2.1	Name of financing institution is: Government of Kenya Name of the Procuring Entity is Athi Water Works Development Agency Financial Year: FY 2020/2021 Describe works under the contracts: <ul style="list-style-type: none"> a) Rehabilitation of DESTP, inlet channels and waste water stabilization ponds b) Construction a 20,000m³/day waste water treatment system complete with Anaerobic ponds, facultative and maturation ponds c) Construction of a wetland d) Sewerage treatment auxiliary works
6.	2.2	The loan/ credit number is: N/A
7.	5.1	Alternative Tenders are <i>“not allowed”</i> in this Tender.
8.	5.2	Alternative time for completion <i>not applicable</i>
9.	3.1	Only Tenderers registered as water works contractor with the Ministry of Water Supply and Sewerage contractor in Category B, and Water Works Contractor NCA 2. This Tender is: National Competitive Bidding [<i>exclusively reserved for Citizen contractors</i>].
B. Tendering Documents		
12.	8.2	The number of copies to be completed and returned with the Tender is One Original and

		Three Copies and a soft editable copy																																							
13.	8.1	<p>Address for clarification of Tendering Document is; Attention: Chief Executive Officer Street Address: Africa Re-Centre, Hospital Rd. P.O. Box 45283 Floor/Room number: 3rd Floor City: Nairobi ZIP Code: 00100 Country: Kenya Telephone: +254-020-2724292/3</p>																																							
14.	8.2	<p>Period to Respond to request for clarification by the Procuring Entity <i>Seven Days (7 days)</i> Period Prior to deadline for submission of Tenders Period for Tenderers to request clarification <i>Fourteen Days (14 days)</i> Prior to deadline for submission of Tenders</p>																																							
C. Preparation of Tenders																																									
15.	11.1	Language of Tender and all correspondence shall be <i>English</i>																																							
16.	13.3	<p>Other information or materials required to be completed and submitted by Tenderers :</p> <ol style="list-style-type: none"> Copies of original documents defining the constitution or legal status, place of registration, and principal, place of business; written power of attorney authorizing the signatory of the Tender to commit the tender. The essential equipment to be made available for the Contract by the successful Tenderer (proposals for timely acquisition or own, lease, hire, etc.) shall be: <table border="1"> <thead> <tr> <th>No.</th><th>Equipment Type and Characteristics</th><th>Minimum Number required</th></tr> </thead> <tbody> <tr><td>(1)</td><td>1.5m³ or 30 ton Excavators</td><td>4</td></tr> <tr><td>(2)</td><td>Backhoe loader</td><td>5</td></tr> <tr><td>(3)</td><td>7-10 ton lorries</td><td>4</td></tr> <tr><td>(4)</td><td>15 ton tippers</td><td>2</td></tr> <tr><td>(5)</td><td>Motor Graders (3.6m blade)</td><td>2</td></tr> <tr><td>(6)</td><td>Concrete Mixers (> 5m³/hr)</td><td>3</td></tr> <tr><td>(7)</td><td>Concrete dumpers(> 0.75m³)</td><td>4</td></tr> <tr><td>(8)</td><td>Concrete Poker vibrators (35-40mm)</td><td>4</td></tr> <tr><td>(9)</td><td>Air compressor (with > 8 Jack hammers)</td><td>3</td></tr> <tr><td>(10)</td><td>Mobile rubber tyred Crane (5 ton)</td><td>3</td></tr> <tr><td>(11)</td><td>Storm water drainage pumps (> 3m³/min.)</td><td>3</td></tr> <tr><td>(12)</td><td>Generators - >15kVA;</td><td>3</td></tr> </tbody> </table> 	No.	Equipment Type and Characteristics	Minimum Number required	(1)	1.5m ³ or 30 ton Excavators	4	(2)	Backhoe loader	5	(3)	7-10 ton lorries	4	(4)	15 ton tippers	2	(5)	Motor Graders (3.6m blade)	2	(6)	Concrete Mixers (> 5m ³ /hr)	3	(7)	Concrete dumpers(> 0.75m ³)	4	(8)	Concrete Poker vibrators (35-40mm)	4	(9)	Air compressor (with > 8 Jack hammers)	3	(10)	Mobile rubber tyred Crane (5 ton)	3	(11)	Storm water drainage pumps (> 3m ³ /min.)	3	(12)	Generators - >15kVA;	3
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		<p>3. Required personnel shall have the following experience in works of an equivalent nature and volume.</p> <table><tr><th>No.</th><th>Position</th><th>Total Work Similar Experience (years)</th><th>In Similar Works Experience (years)</th></tr><tr><td>1.</td><td>One (1) Site Agent (Registered Civil Engineer or equivalent)</td><td>15</td><td>7</td></tr><tr><td>2.</td><td>One (1) Deputy Site Agent (Registered Civil Engineer or equivalent)</td><td>10</td><td>5</td></tr><tr><td>3.</td><td>Two (2) Site Engineers (Civil Engineers)</td><td>8</td><td>5</td></tr><tr><td>4.</td><td>Two (2) Site Engineering surveyors (registered or equivalent)</td><td>5</td><td>5</td></tr><tr><td>5.</td><td>One (1) Environmentalist (University Graduate in Environmental Science or equivalent) – Registered with NEMA</td><td>5</td><td>4</td></tr><tr><td>6.</td><td>Three (3) Site Works Inspectors/ Foremen (Diploma or equivalent in Civil Engineering)</td><td>10</td><td>5</td></tr><tr><td>7.</td><td>One (1) Health and Safety Officer (Degree in Environmental or Health Sciences/ + training and certification in Occupational Health and Safety Course</td><td>7</td><td>3</td></tr></table> <p>8. Evidence of adequate working capital for this contract.</p> <p>9. Information regarding litigation, current</p>	No.	Position	Total Work Similar Experience (years)	In Similar Works Experience (years)	1.	One (1) Site Agent (Registered Civil Engineer or equivalent)	15	7	2.	One (1) Deputy Site Agent (Registered Civil Engineer or equivalent)	10	5	3.	Two (2) Site Engineers (Civil Engineers)	8	5	4.	Two (2) Site Engineering surveyors (registered or equivalent)	5	5	5.	One (1) Environmentalist (University Graduate in Environmental Science or equivalent) – Registered with NEMA	5	4	6.	Three (3) Site Works Inspectors/ Foremen (Diploma or equivalent in Civil Engineering)	10	5	7.	One (1) Health and Safety Officer (Degree in Environmental or Health Sciences/ + training and certification in Occupational Health and Safety Course	7	3
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6.	Three (3) Site Works Inspectors/ Foremen (Diploma or equivalent in Civil Engineering)	10	5																															
7.	One (1) Health and Safety Officer (Degree in Environmental or Health Sciences/ + training and certification in Occupational Health and Safety Course	7	3																															
17.	13.4	<p>In the case of joint venture each partner shall submit information required under Clause ITT Clause 13.4. In addition, the Tenderer shall furnish the following,</p> <p>(i) The lead partner shall meet not less than 75% of all the qualifying criteria in above.</p> <p>(ii) The other partners shall meet individually not less than <u>25%</u> of all the qualifying criteria given in above</p> <p>(iii) The joint venture must satisfy collectively the criteria of section 4, for which propose the relevant figures for each of the partners shall be added together to arrive at the joint ventures total capacity. Individual members must each satisfy the requirements of above.</p>																																
18.	16.4	<p>The price shall be <i>Fixed</i></p> <p>Information to be submitted with the Tender are: (state if any). N/A</p>																																
19.	17.1	<p>The currency in which the prices shall be quoted shall be: <i>Kenyan Shilling</i></p>																																
20.	17.2	<p>The authority for establishing the rates of exchange shall be Central Bank of Kenya.</p>																																
	30.2	<p>The applicable date for exchange rates for tendering and evaluation purposes is date of tender submission.</p>																																

21.	18.1	The Tender validity period shall be 120 days after date of tender opening.
22.	19.1	The amount of Tender Security shall be an Unconditional Bank Guarantee or from an insurance company registered by IRA and approved by PPRA, of KShs. 2,000,000.00 (Kenya Shillings Two Million Only)
23.	20.1	In addition to the original of the Tender, the Tenderer should submit Three copies of the Tender
24.	20.2	Written confirmation of authorization is Power of Attorney

D. Submission of Tenders

25.	21.2 a)	Tenders shall be submitted to: Attention: Chief Executive Officer, Athi Water Works Development Agency, 3rd Floor, Africa Re Centre, Hospital Road, Upper Hill, P.O. Box 45283-00100, Nairobi, Kenya. Fax: 254-20-2724295 ; Email : info@awwda.go.ke
26.	21.2 b)	Project name: Rehabilitation and Expansion of Dandora Estate Sewerage Treatment Plant NCB NO. AWWDA/GOK/DESTP/W-04/2020-2021 Time and date for submission 12.00pm East African Time on 4th September, 2020
27.	22.1	The deadline for Tender submission is a) Day Friday b) Date 4th September, 2020 c) Time 12:00 pm East African Time
28.	22.3	The extension of the deadline for submission of Tenders shall be made not later than <i>seven days</i> before the expiry of the original deadline.
29	24.4	Expiry of Tender validity is 120 days after the Date of Tender Opening.

E. Opening and Evaluation of Tenders

29.	25.1	The Tender opening shall take place at: Chief Executive officer Street Address: Africa Re-Centre, Hospital Rd. P.O. Box 45283 Floor/Room number: 3rd Floor City: Nairobi ZIP Code: 00100 Country: Kenya Telephone: +254-020-2724292/3
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		Date 4th September, 2020 Time 12.05 pm East African Time
30.	32.3	Additional Preference <i>None</i>
31.	34.1	Post- qualification will “ <i>be undertaken</i> ”
32.	38.1	Percentage for quantities increase or decrease is: <i>N/A</i>
F. Award of Contract		
33.	41.1	The amount of Performance Security shall be 10% of the contract price (Unconditional Bank Guarantee)
34.	42.1	The Advance Payment shall be 10% of the Contract Price upon receipt of an Unconditional Bank Guarantee of similar amounts.
35.	43.1	<p>The proposed adjudicator for the project is: From name recommended by the Kenya Chapter of the Chartered Institute of Arbitrators, P.O Box 50163-00200, Nairobi.</p> <p>The hourly fee for this proposed Adjudicator shall be Kshs 20,000 (Kenya Shillings Twenty Thousand).</p>
G. Review of Procurement Decisions		
37.	46.1	<p>The address for submitting appeals to Administrative Review Board: The Secretary, Public Procurement Administrative Review Board, The Public Procurement Oversight Authority, 10th Floor, National Bank House, P.O. Box 58583-00200, NAIROBI, Kenya. Tel : +254 (0) 20 3244000 Email: info@ppoa.go.ke Website: www.ppoa.go.ke</p>

APPENDIX TO INSTRUCTIONS TO TENDERERS

CLAUSE

13.3 Eligibility and Qualification requirements (Evaluation Criteria)

1. PRELIMINARY EVALUATION (All Are Mandatory)

Bidders are required to meet the following requirements:

- i. Offer Eligibility statement on bidders' letterhead indicating that the bidder is eligible for the assignment and has not been debarred for any procurement within the last five years
- ii. Attach Copy of Current Valid Tax Compliance Certificate, Business Permit
- iii. Certificate of Incorporation with CR12 demonstrating at least 51% ownership by Kenyan citizens.
- iv. Form of Tender duly completed, signed, stamped and witnessed. Appendix to Form of Tender shall also be duly completed.
- v. BOQ duly completed (Bidders are required to fill on the provided BOQ as a Mandatory requirement for Uniformity during Evaluation)
- vi. All Financial alterations if Any must be countersigned by the bidder
- vii. Confidential Business Questionnaire duly filled
- viii. Audited financial accounts for the Last 3 years.
- ix. Submit a written Power of Attorney on bidder's letter head (or duly fill the form provided in the Bid document)
- x. Bidders MUST Stamp and serialize EVERY Page of their document with Official rubber Stamp for Ownership.
- xi. Details of any past or current litigation or arbitration proceedings in which the Bidder is/was involved as one of the parties on bidder's letter head (or duly filled the declaration form provided in the Bid document).
- xii. All required information shall be attached to the Original Tender document and neatly bound.
- xiii. Submit proof of registration as a water and sewerage contractor with the Ministry of Water and Sanitation under Category B, and Water Works Contractor, NCA 2

N/B: A firm lacking in any of the above details **shall be considered NOT qualified** at this stage and shall not be progressed to the Technical Evaluation stage.

2. TECHNICAL EVALUATION:

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1. Financial Situation and Performance							
Requirement			Single Entity	Joint Venture, Consortium or Association			Documentation Required
				All partners combined	Each partner	At least one partner	
1.1	Financial Capabilities	(i) The Tenderer shall demonstrate that it has access to, or has available, liquid assets, unencumbered real assets, lines of credit, and other financial means (independent of any contractual advance payment) sufficient to meet the construction cash flow requirements estimated as Kshs. 200,000,000 (or equivalence amount in freely convertible currency) for the subject contract(s) net of the Bidders other commitments.	Must meet requirement	Must meet Requirement	N/A	N/A	Financial Accounts Bank line of credit
		(ii) The Tenderers shall also demonstrate, to the satisfaction of the Employer, that it has adequate sources of finance to meet the cash flow requirements on works currently in progress and for future contract commitments.	Must meet requirement	Must meet requirement	N/A	N/A	
		(iii) The audited balance sheets or, if not required by the laws of the Bidder’s country, other financial statements acceptable to the Employer, for the last <u>Three (3) years</u> shall be submitted and must demonstrate the current soundness of the Bidder’s financial position and indicate its prospective long-term profitability.	Must meet requirement	Must meet requirement	N/A	N/A	
1.2	Average Annual Construction Turnover	Minimum average annual construction turnover of Kshs. 750 Million , calculated as total certified payments received for contracts in progress and/or completed within the last <u>Five</u> years	Must meet requirement	Must meet requirement	Must meet 25% , <i>(twenty five percent)</i> of the requirement	Must meet 40% , <i>(forty percentage)</i> of the requirement	Turnover Financial Accounts

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2. Experience							
Requirement			Single Entity	Joint Venture, Consortium or Association			Documentation Required
				All partners combined	Each partner	At least one partner	
2.1 (a)	General Construction Experience	Experience under construction contracts in the role of prime contractor, JV member, sub-contractor, or management contractor for at least the last Five (5) years, starting 1 st January, 2016, and with activity in at least nine (9) months in each year.	Must meet requirement	N/A	Must meet requirement	N/A	Proof of works undertaken
2.2 (a)	Specific Construction & Contract Management Experience	(i) A minimum number of similar ¹ contracts specified below that have been satisfactorily and substantially ² completed as a prime contractor, joint venture member ³ , management contractor or sub-contractor ³ between 1 st January, 2016 and application submission deadline: (i) at least 1 (One) water/waste water Engineering project of minimum value Kshs 400 million ; For the above and any other contracts completed and under implementation as prime contractor, joint venture member, management contractor or sub-contractor on or after the first day of the calendar year during the period stipulated in 2.2 (a) above, a minimum construction experience in the following key activities successfully completed:	Must meet requirement	Must meet requirement ⁴	N/A	N/A	Proof of works undertaken

¹ The similarity shall be based on the physical size, complexity, methods/technology and/or other characteristics described in Section VII, Work's Requirements. Summation of number of small value contracts (less than the value specified under requirement) to meet the overall requirement will not be accepted.

² Substantial completion shall be based on 80% or more works completed under the contract.

³ For contracts under which the Bidder participated as a joint venture member or sub-contractor, only the Bidder's share, by value, shall be considered to meet this requirement.

⁴ In the case of JV, the value of contracts completed by its members shall not be aggregated to determine whether the requirement of the minimum value of a single contract has been met. Instead, each contract performed by each member shall satisfy the minimum value of a single contract as required for single entity. In determining whether the JV meets the requirement of total number of contracts, only the number of contracts completed by all members each of value equal or more than the minimum value required shall be aggregated.

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		1.Concrete production of 150m ³ per month 2.Earthworks of 100,000m ³ per month					
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3. Personnel

The Bidder must demonstrate that it will have the personnel for the key positions that meet the following requirements:

No.	Position	Total Work Similar Experience (years)	In Similar Works Experience (years)
1.	One (1) Site Agent (Registered Civil Engineer or equivalent)	15	7
2.	One (1) Deputy Site Agent (Registered Civil Engineer or equivalent)	10	5
3.	Two (2) Site Engineers (Civil Engineers)	8	5
4.	Two (2) Site Engineering surveyors (registered or equivalent)	5	5
5.	One (1) Environmentalist (University Graduate in Environmental Science or equivalent) – Registered with NEMA	5	4
6.	Three (3) Site Works Inspectors/Foremen (Diploma or equivalent in Civil Engineering)	10	5
7.	One (1) Health and Safety Officer (Degree in Environmental or Health Sciences/ + training and certification in Occupational Health and Safety Course	7	3

The Tenderer shall provide details of the proposed personnel and their experience records in the relevant Forms included in Section VIII,

4. Equipment

The Tender must demonstrate that it will have access to the key Contractor's equipment listed hereafter:

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No.	Equipment Type and Characteristics	Minimum Number required
(1)	1.5m ³ or 30 ton Excavators	4
(2)	Backhoe loader	5
(3)	7-10 ton lorries	4
(4)	15 ton tippers	2
(5)	Motor Graders (3.6m blade)	2
(6)	Concrete Mixers (> 5m ³ /hr)	3
(7)	Concrete dumpers(> 0.75m ³)	4
(8)	Concrete Poker vibrators (35-40mm)	4
(9)	Air compressor (with > 8 Jack hammers)	3
(10)	Mobile rubber tyred Crane (5 ton)	3
(11)	Storm water drainage pumps (> 3m ³ /min.)	3
(12)	Generators - >15kVA;	3

The Bidder shall provide further details of proposed items of equipment using the relevant Form in Section VIII.

N/B: A firm lacking in any of the above details **shall be dropped** at this stage and shall not be progressed to the Financial Evaluation stage.

3. FINANCIAL EVALUATION:

The lowest responsive evaluated tender shall be awarded the contract.

N/B: The tender sum as submitted and read out during the tender opening shall be absolute and final and shall not be subject of correction, adjustment of amendment in any way as per the provisions of the PPADA ACT Section 82.

SECTION IV: GENERAL CONDITIONS OF CONTRACT

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A.General

1. Definitions

1.1 Boldface type is used to identify defined terms.

The **Adjudicator** is the person appointed jointly by the Procuring Entity and the Contractor to resolve disputes in the first instance, as provided for in Clauses 27 and 28 hereunder.

Bill of Quantities means the priced and completed Bill of Quantities forming part of the Tender.

Compensation Events are those defined in Clause 47 hereunder.

The **Completion Date** is the date of completion of the Works as certified by the Project Manager, in accordance with Sub-Clause 58.1.

The **Contract** is the Contract between the Procuring Entity and the Contractor to execute, complete, and maintain the Works. It consists of the documents listed in Clause 2.3 below.

The **Contractor** is a person or corporate body whose Tender to carry out the Works has been accepted by the Procuring Entity.

The **Contractor's Tender** is the completed Tendering document submitted by the Contractor to the Procuring Entity.

The **Contract Price** is the price stated in the Letter of Acceptance and thereafter as adjusted in accordance with the provisions of the Contract.

Days are calendar days; months are calendar months.

Dayworks are varied work inputs subject to payment on a time basis for the Contractor's employees and Equipment, in addition to payments for associated Materials and Plant.

A **Defect** is any part of the Works not completed in accordance with the Contract.

The **Defects Liability Certificate** is the certificate issued by the Project Manager upon correction of defects by the Contractor.

The **Defects Liability Period** is the period named in the **Contract Data Sheet** and calculated from the Completion Date.

Drawings include calculations and other information provided or approved by the Project Manager for the execution of the Contract.

The **Procuring Entity** is the party who employs the

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Contractor to carry out the Works.

Equipment is the Contractor's machinery and vehicles brought temporarily to the Site to construct the Works.

The **Initial Contract Price** is the Contract Price listed in the Procuring Entity's Letter of Acceptance.

The **Intended Completion Date** is the date on which it is intended that the Contractor shall complete the Works. The Intended Completion Date is specified in the **Contract Data Sheet**. The Intended Completion Date may be revised only by the Project Manager by issuing an extension of time or an acceleration order.

Materials are all supplies, including consumables, used by the Contractor for incorporation in the Works.

Plant is any integral part of the Works that shall have a mechanical, electrical, chemical, or biological function.

The **Project Manager** is the person named in the **Contract Data Sheet** (or any other competent person appointed by the Procuring Entity and notified to the Contractor, to act in replacement of the Project Manager) who is responsible for supervising the execution of the Works and administering the Contract and shall be an "Architect" or a "Quantity Surveyor" registered under the Architects and Quantity Surveyors Act Cap 525 or an "Engineer" registered under Engineers Registration Act Cap 530.

The **Site** is the area defined as such in the **Contract Data Sheet**.

Site Investigation Reports are those that were included in the Tendering documents and are factual and interpretative reports about the surface and subsurface conditions at the Site.

Specification means the Specification of the Works included in the Contract and any modification or addition made or approved by the Project Manager.

The **Start Date** is given in the **Contract Data Sheet**. It is the latest date when the Contractor shall commence execution of the Works. It does not necessarily coincide with any of the Site Possession Dates.

A **Subcontractor** is a person or corporate body who has a Contract with the Contractor to carry out a part of the work in the Contract, which includes work on the Site.

Temporary Works are works designed, constructed, installed, and removed by the Contractor that are needed for construction or installation of the Works.

A **Variation** is an instruction given by the Project Manager that varies the Works.

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The **Works** are what the Contract requires the Contractor to construct, install, and turn over to the Procuring Entity, as defined in the **Contract Data Sheet**.

“**Force Majeure**” means an event which is beyond the reasonable control of a Party and which makes a Party’s performance of its obligations under the Contract impossible or so impractical as to be considered impossible under the circumstances.

- 2. Interpretation**
- 2.1 In interpreting these Conditions of Contract, singular also means plural, male also means female or neuter, and the other way round. Headings have no significance. Words have their normal meaning under the language of the Contract unless specifically defined. The Project Manager will provide instructions clarifying queries about these Conditions of Contract.
- 2.2 If sectional completion is specified in the **Contract Data Sheet**, references in the Conditions of Contract to the Works, the Completion Date, and the Intended Completion Date apply to any Section of the Works (other than references to the Completion Date and Intended Completion Date for the whole of the Works).
- 2.3 The documents forming the Contract shall be interpreted in the order of priority given in the **Contract Data Sheet**:
- (1) Agreement;
 - (2) Letter of Acceptance;
 - (3) Contract Data Sheet;
 - (4) Conditions of Contract;
 - (5) Technical Specifications;
 - (6) Contractor’s Tender;
 - (7) Drawings;
 - (8) Bill of Quantities; and
 - (9) Any other document listed in the **Contract Data Sheet** as forming part of the Contract.
- 3. Language, Law, Fraud and Corruption**
- 3.1 The language of the Contract and the law governing the Contract are stated in the **Contract Data Sheet**.
- 3.2 The Government requires that Procuring Entities (including beneficiaries of Government funded projects) as well as Tenderers/Suppliers/Contractors under Government financed contracts, observe the highest standard of ethics during the procurement and execution of such contracts. It is the responsibility of the Procuring Entity to ensure that Tenderers, suppliers, and contractors

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and their subcontractors observe the highest standard of ethics during the procurement and execution of such contracts. In pursuance of this policy:

For the purpose of this provision, the following definitions are provided:

- (i). **“Corruption”** has the meaning assigned to it in the Anti-Corruption and Economic Crime Act 2003 and includes the offering, giving, receiving or soliciting of anything of value to influence the action of a public official in the procurement or disposal process or in contract execution;
- (ii). **“Fraudulent Practice”** includes a misrepresentation of fact in order to influence a procurement or disposal process or the execution of a contract to the detriment of the Procuring Entity and includes collusive practices amongst Tenderers prior to or after Tender submission designed to establish Tender prices at artificial noncompetitive levels and deprive the Procuring Entity of the benefits of free and open competition;
- (iii). **“Collusive Practice”** means an arrangement between two or more suppliers, contractors and subcontractors designed to achieve an improper purpose, including to influence improperly the actions of the Procuring Entity prior to or after Tender submission, designed to establish Tender prices at artificial non competitive levels and to deprive the Procuring Entity of the benefit of free and open competition;
- (iv). **“Coercive Practice”** means impairing or harming, or threatening to impair or harm, directly or indirectly a supplier, contractor or subcontractor or the property of any of them to influence improperly the actions of a Procuring Entity;
- (v). **“Obstructive Practice”** means deliberately destroying, falsifying, altering or concealing of evidence material to the investigation or making false statements to investigators in order to materially impede an investigation into allegations of a corrupt, fraudulent, coercive or collusive practice; and /or threatening, harassing or intimidating any party to prevent it from disclosing its knowledge of matters relevant to the investigation or from pursuing the investigation.

A Procuring Entity has the right to require that Tenderers,

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suppliers, and contractors and their subcontractors permit persons duly appointed by KACC/PPOA/KNAO to inspect their accounts and records and other documents relating to the Tender submission and contract performance;

The Procuring Entity will reject a proposal for award if it determines that the Tenderer recommended for award has engaged in corrupt, fraudulent practices or others stated under Clause 44.1.a in competing for the contract;

In pursuit of the policy defined in sub-Clause 44.1 the Procuring Entity will cancel the portion of the funds allocated to a contract for goods, works, or services if it at any time determines that corrupt or fraudulent practices were engaged in by representatives of the Procuring Entity or Approving Authority or of a beneficiary of the funds during the procurement or the execution of that contract;

In the event that the Procuring Entity or Approving Authority does not take timely and appropriate action satisfactory to the Government of Kenya to remedy the situation, then the Director-General may order an investigation of procurement proceedings for the purpose of determining whether there has been a breach of the Public Procurement and Disposal Act, 2005.

3.3 The Director-General may, on the advice of the Advisory Board, debar a person from participating in procurement proceedings on the ground that the person has committed an offence under the Public Procurement and Disposal Act, 2005. A debarment shall be for a period of time of not less than five years. Before a person is so debarred, he/she will be given an opportunity to make representations to the Director-General and may request the Review Board to review the debarment.

3.4 Any communication between the Tenderers and the Procuring Entity related to matters of alleged fraud or corruption must be made in writing.

4. Confidentiality 4.1 The Service Providers, their Subcontractors, and the Personnel of either of them shall not disclose any proprietary or confidential information relating to the Project, the Services, this Contract, or the Procuring Entity's business or operations without the prior written consent of the Procuring Entity.

5. Project Manager's Decisions 5.1 Except where otherwise specifically stated, the Project Manager will decide contractual matters between the Procuring Entity and the Contractor in the role

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representing the Procuring Entity.

- | | |
|--|--|
| 6. Delegation | 6.1 The Project Manager may delegate any of his duties and responsibilities to other people except to the Adjudicator, after notifying the Contractor, and may cancel any delegation after notifying the Contractor. |
| 7. Communications | 7.1 Communications between parties that are referred to in the Conditions shall be effective only when in writing. A notice shall be effective only when it is delivered. |
| 8. Subcontracting | 8.1 The Contractor may subcontract with the approval of the Project Manager, but may not assign the Contract without the approval of the Procuring Entity in writing. Subcontracting shall not alter the Contractor's obligations. |
| 9. Other Contractors | 9.1 The Contractor shall cooperate and share the Site with other contractors, public authorities, utilities, and the Procuring Entity between the dates given in the Schedule of Other Contractors, as referred to in the Contract Data Sheet . The Contractor shall also provide facilities and services for them as described in the Schedule. The Procuring Entity may modify the Schedule of Other Contractors, and shall notify the Contractor of any such modification |
| 10. Personnel | <p>10.1 The Contractor shall employ the key personnel named in the Schedule of Key Personnel, as referred to in the Contract Data Sheet, who shall be appropriately qualified and registered with the appropriate bodies to carry out the functions stated in the Schedule or other personnel approved by the Project Manager. The Project Manager will approve any proposed replacement of key personnel only if their relevant qualifications and abilities are substantially equal to or better than those of the personnel listed in the Schedule.</p> <p>10.2 If the Project Manager asks the Contractor to remove a person who is a member of the Contractor's staff or work force, stating the reasons, the Contractor shall ensure that the person leaves the Site within seven days and has no further connection with the work in the Contract.</p> |
| 11. Procuring Entity's and Contractor's Risks | 11.1 The Procuring Entity carries the risks which this Contract states are Procuring Entity's risks, and the Contractor carries the risks which this Contract states are Contractor's risks. |
| 12. Procuring Entity's Risks | <p>12.1 From the Start Date until the Defects Correction Certificate has been issued, the following are Procuring Entity's risks:</p> <p>a) The risk of personal injury, death, or loss of or damage to property (excluding the Works, Plant, Materials, and</p> |

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Equipment), which are due to:

- (i) Use or occupation of the Site by the Works or for the purpose of the Works, which is the unavoidable result of the Works; or
 - (ii) Negligence, breach of statutory duty, or interference with any legal right by the Procuring Entity or by any person employed by or contracted to him except the Contractor.
- b) The risk of damage to the Works, Plant, Materials, and Equipment to the extent that it is due to a fault of the Procuring Entity or in the Procuring Entity's design, or due to war or radioactive contamination directly affecting the country where the Works are to be executed.

12.2 From the Completion Date until the Defects Correction Certificate has been issued, the risk of loss of or damage to the Works, Plant, and Materials is an Procuring Entity's risk except loss or damage due to:

- (a) A Defect which existed on the Completion Date;
- (b) An event occurring before the Completion Date, which was not itself an Procuring Entity's risk; or
- (c) The activities of the Contractor on the Site after the Completion Date.

13. Contractor's Risks

13.1 From the Starting Date until the Defects Correction Certificate has been issued, the risks of personal injury, death, and loss of or damage to property (including, without limitation, the Works, Plant, Materials, and Equipment) which are not Procuring Entity's risks are Contractor's risks.

14. Insurance

14.1 The Contractor shall provide, in the joint names of the Procuring Entity and the Contractor, insurance cover from the Start Date to the end of the Defects Liability Period, in the amounts and deductibles stated in the **Contract Data Sheet** for the following events which are due to the Contractor's risks:

- (a) Loss of or damage to the Works, Plant, and Materials;
- (b) Loss of or damage to Equipment;
- (c) Loss of or damage to property (except the Works, Plant, Materials, and Equipment) in connection with the Contract; and
- (d) Personal injury or death.

14.2 Policies and certificates for insurance shall be delivered by

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the Contractor to the Project Manager for the Project Manager's approval before the Start Date. All such insurance shall provide for compensation to be payable in the types and proportions of currencies required to rectify the loss or damage incurred.

14.3 If the Contractor does not provide any of the policies and certificates required, the Procuring Entity may effect the insurance which the Contractor should have provided and recover the premiums the Procuring Entity has paid from payments otherwise due to the Contractor or, if no payment is due, the payment of the premiums shall be a debt due.

14.4 Alterations to the terms of insurance shall not be made without the approval of the Project Manager.

14.5 Both parties shall comply with any conditions of the insurance policies.

15. Site Investigation Reports

15.1 The Contractor, in preparing the Tender, shall rely on any Site Investigation Reports referred to in the **Contract Data Sheet**, supplemented by any information available to the Tenderers.

16. Queries about the Contract Data Sheet

16.1 The Project Manager will clarify queries on the **Contract Data Sheet**.

17. Contractor to Construct the Works

17.1 The Contractor shall construct and install the Works in accordance with the Specifications and Drawings.

18. Commencement and Completion

18.1 The Contractor may commence execution of the Works on the Start Date and shall carry out the Works in accordance with the Programme submitted by the Contractor, as updated with the approval of the Project Manager, and complete them by the Intended Completion Date.

19. Approval by the Project Manager

19.1 The Contractor shall submit Specifications and Drawings showing the proposed Temporary Works to the Project Manager, who is to approve them if they comply with the Specifications and Drawings.

19.2 The Contractor shall be responsible for the design of Temporary Works.

19.3 The Project Manager's approval shall not alter the Contractor's responsibility for design of the Temporary Works.

19.4 The Contractor shall obtain approval of third parties to the design of the Temporary Works, where required.

19.5 All Drawings prepared by the Contractor for the execution of the temporary or permanent Works, are subject to prior

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approval by the Project Manager before their use.

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| 20. Protection of the Environment | 20.1 The Contractors shall take all reasonable steps to protect the environment and to limit damage and nuisance to people and property resulting from pollution, noise and other results of his operations. |
| | 20.2 The Contractors shall ensure that emissions, surface discharges and effluent from his activities shall not exceed prescribed values in the environmental laws. |
| 21. Labour Laws | 21.2 The Contractor shall comply with all the relevant labour laws applicable in the Country, including laws relating to workers employment, working hours, health, safety, welfare, and immigration, and shall allow them all their legal rights. |
| | 21.2 The Contractor shall require his employees to obey all applicable laws, including those concerning safety at work. |
| 22. Health and Safety | 22.1 The Contractor shall at all times take all reasonable precautions to maintain the health and safety of his personnel. |
| | 22.2 The Contractor shall ensure that first aid facilities are available at all times at the site and that suitable arrangements are made for all necessary welfare and hygiene requirements and for the prevention of epidemics. |
| | 22.3 The Contractor shall notify the Procuring Entity details of any accident as soon as practicable after its occurrence. The Contractor shall maintain records and make reports concerning health, safety, and welfare of persons, and damage to the property, as the Procuring Entity may reasonably require. |
| | 22.4 The Contractor shall conduct an HIV-Aids awareness programme, and shall take other such measures as specified in the Contract Data Sheet to reduce the risk of transfer of HIV virus between and among Contractor personnel, the Procuring Entity's Staff and the surrounding community. |
| 23. Discoveries | 23.1 Anything of historical or other interest or of significant value unexpectedly discovered on the Site shall be the property of the Procuring Entity. The Contractor shall notify the Project Manager of such discoveries and carry out the Project Manager's instructions for dealing with them. |
| 24. Possession of the Site | 24.1 The Procuring Entity shall give possession of all parts of the Site to the Contractor. If possession of a part is not given by the date stated in the Contract Data Sheet , the |

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Procuring Entity will be deemed to have delayed the start of the relevant activities, and this will be a Compensation Event.

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| 25. Access to the Site | 25.1 The Contractor shall allow the Project Manager and any person authorized by the Project Manager access to the Site and to any place where work in connection with the Contract is being carried out or is intended to be carried out. |
| 26. Instructions, Inspections and Audits | <p>26.1 The Contractor shall carry out all instructions of the Project Manager which comply with the applicable laws where the Site is located.</p> <p>26.2 The Contractor shall permit the Kenya Government to inspect the Contractor's accounts and records relating to the performance of the Contractor and to have them audited by auditors appointed by the Kenya Government, if so required by the Kenya Government</p> |
| 27. Disputes | 27.1 If the Contractor believes that a decision taken by the Project Manager was either outside the authority given to the Project Manager by the Contract or that the decision was wrongly taken, the decision shall be referred to the Adjudicator within 14 days of the notification of the Project Manager's decision. |
| 28. Procedure for Disputes | <p>28.1 The Adjudicator shall give a decision in writing within 28 days of receipt of a notification of a dispute.</p> <p>28.2 The Adjudicator shall be paid by the hour at the rate specified in the Tender Data Sheet and Contract Data Sheet, together with reimbursable expenses of the types specified in the Contract Data Sheet, and the cost shall be divided equally between the Procuring Entity and the Contractor, whatever decision is reached by the Adjudicator. Either party may refer a decision of the Adjudicator to an Arbitrator within 28 days of the Adjudicator's written decision. If neither party refers the dispute to arbitration within the above 28 days, the Adjudicator's decision will be final and binding.</p> <p>28.3 The arbitration shall be conducted in accordance with the arbitration procedure published by the institution named and in the place shown in the Contract Data Sheet.</p> |
| 29. Replacement of Adjudicator | 29.1 Should the Adjudicator resign or die, or should the Procuring Entity and the Contractor agree that the Adjudicator is not functioning in accordance with the provisions of the Contract, a new Adjudicator will be jointly appointed by the Procuring Entity and the Contractor. In case of disagreement between the Procuring Entity and the Contractor, within 30 days, the |

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Adjudicator shall be designated by the Appointing Authority designated in the **Contract Data Sheet** at the request of either party, within 14 days of receipt of such request.

B. Time Control

30. Programme

- 30.1 Within the time stated in the **Contract Data Sheet**, the Contractor shall submit to the Project Manager for approval a Programme showing the general methods, arrangements, order, and timing for all the activities in the Works.
- 30.2 An update of the Programme shall be a programme showing the actual progress achieved on each activity and the effect of the progress achieved on the timing of the remaining work, including any changes to the sequence of the activities.
- 30.3 The Contractor shall submit to the Project Manager for approval an updated Programme at intervals no longer than the period stated in the **Contract Data Sheet**. If the Contractor does not submit an updated Programme within this period, the Project Manager may withhold the amount stated in the **Contract Data Sheet** from the next payment certificate and continue to withhold this amount until the next payment after the date on which the overdue Programme has been submitted.
- 30.4 The Project Manager's approval of the Programme shall not alter the Contractor's obligations. The Contractor may revise the Programme and submit it to the Project Manager again at any time. A revised Programme shall show the effect of Variations and Compensation Events

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- 31. Extension of the Intended Completion Date**
- 31.1 The Project Manager shall extend the Intended Completion Date if a Compensation Event occurs or a Variation is issued which makes it impossible for Completion to be achieved by the Intended Completion Date without the Contractor taking steps to accelerate the remaining work, which would cause the Contractor to incur additional cost.
- 31.2 The Project Manager shall decide whether and by how much to extend the Intended Completion Date within 21 days of the Contractor asking the Project Manager for a decision upon the effect of a Compensation Event or Variation and submitting full supporting information. If the Contractor has failed to give early warning of a delay or has failed to cooperate in dealing with a delay, the delay by this failure shall not be considered in assessing the new Intended Completion Date.
- 32. Acceleration**
- 32.1 When the Procuring Entity wants the Contractor to finish before the Intended Completion Date, the Project Manager will obtain priced proposals for achieving the necessary acceleration from the Contractor. If the Procuring Entity accepts these proposals, the Intended Completion Date will be adjusted accordingly and confirmed by both the Procuring Entity and the Contractor.
- 32.2 If the Contractor's priced proposals for acceleration are accepted by the Procuring Entity, they shall be incorporated in the Contract Price and treated as a Variation.
- 33. Delays Ordered by the Project Manager**
- 33.1 The Project Manager may instruct the Contractor to delay the start or progress of any activity within the Works.
- 34. Management Meetings**
- 34.1 Either the Project Manager or the Contractor may require the other to attend a management meeting. The business of a management meeting shall be to review the plans for remaining work and to deal with matters raised in accordance with the early warning procedure.
- 34.2 The Project Manager shall record the business of management meetings and provide copies of the record to those attending the meeting and to the Procuring Entity. The responsibility of the parties for actions to be taken shall be decided by the Project Manager either at the management meeting or after the management meeting and stated in writing to all who attended the meeting.
- 35. Early Warning**
- 35.1 The Contractor shall warn the Project Manager at the earliest opportunity of specific likely future events or circumstances that may adversely affect the quality of the work, increase the Contract Price or delay the execution of the Works. The Project Manager may require the

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Contractor to provide an estimate of the expected effect of the future event or circumstance on the Contract Price and Completion Date. The estimate shall be provided by the Contractor as soon as reasonably possible.

- 35.2 The Contractor shall cooperate with the Project Manager in making and considering proposals for how the effect of such an event or circumstance can be avoided or reduced by anyone involved in the work and in carrying out any resulting instruction of the Project Manager.

C. Quality Control

36. Identifying Defects

- 36.1 The Project Manager shall check the Contractor's work and notify the Contractor of any Defects that are found. Such checking shall not affect the Contractor's responsibilities. The Project Manager may instruct the Contractor to search for a Defect and to uncover and test any work that the Project Manager considers may have a Defect.

37. Tests

- 37.1 If the Project Manager instructs the Contractor to carry out a test not specified in the Specification to check whether any work has a Defect and the test shows that it does, the Contractor shall pay for the test and any samples. If there is no Defect, the test shall be a Compensation Event.

38. Correction of Defects

- 38.1 The Project Manager shall give notice to the Contractor of any Defects before the end of the Defects Liability Period, which begins at Completion, and is defined in the **Contract Data Sheet**. The Defects Liability Period shall be extended for as long as Defects remain to be corrected.
- 38.2 Every time notice of a Defect is given, the Contractor shall correct the notified Defect within the length of time specified by the Project Manager's notice.
- 38.3 If the Contractor has not corrected a defect within the time specified in the Procuring Entity's notice, a penalty for lack of performance will be paid by the Contractor. The amount to be paid will be calculated as a percentage of the cost of having the defect correct, assessed as described in Clause 39.

39. Uncorrected Defects

- 39.1 If the Contractor has not corrected a Defect within the time specified in the Project Manager's notice, the Project Manager will assess the cost of having the Defect corrected, and the Contractor will pay this amount.

D. Cost Control

40. Bill of

- 40.1 The Bill of Quantities shall contain items for the

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- Quantities** construction, installation, testing, and commissioning work to be done by the Contractor.
- 40.2 The Bill of Quantities is used to calculate the Contract Price. The Contractor shall be paid for the quantity of the work done at the rate in the Bill of Quantities for each item.
- 41. Changes in the Quantities**
- 41.1 If the final quantity of the work done differs from the quantity in the Bill of Quantities for the particular item by more than 25 percent, provided the change exceeds 1 percent of the Initial Contract Price, the Project Manager shall adjust the rate to allow for the change.
- 41.2 The Project Manager shall not adjust rates from changes in quantities if thereby the Initial Contract Price is exceeded by more than 15 percent, except with the prior approval of the Procuring Entity.
- 41.3 If requested by the Project Manager, the Contractor shall provide the Project Manager with a detailed cost breakdown of any rate in the Bill of Quantities.
- 42. Variations**
- 42.1 All Variations shall be included in the updated Programmes produced by the Contractor.
- 43. Payments for Variations**
- 43.1 The Contractor shall provide the Project Manager with a quotation for carrying out the Variation when requested to do so by the Project Manager. The Project Manager shall assess the quotation, which shall be given within seven days of the request or within any longer period stated by the Project Manager and before the Variation is ordered.
- 43.2 If the work in the Variation corresponds with an item description in the Bill of Quantities and if, in the opinion of the Project Manager, the quantity of work is above the limit stated in Sub-Clause 41.1 or the timing of its execution do not cause the cost per unit of quantity to change, the rate in the Bill of Quantities shall be used to calculate the value of the Variation. If the cost per unit of quantity changes, or if the nature or timing of the work in the Variation does not correspond with items in the Bill of Quantities, the quotation by the Contractor shall be in the form of new rates for the relevant items of work.
- 43.3 If the Contractor's quotation is unreasonable, the Project Manager may order the Variation and make a change to the Contract Price, which shall be based on the Project Manager's own forecast of the effects of the Variation on the Contractor's costs.
- 43.4 If the Project Manager decides that the urgency of varying the work would prevent a quotation being given and considered without delaying the work, no quotation shall

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be given and the Variation shall be treated as a Compensation Event.

43.5 The Contractor shall not be entitled to additional payment for costs that could have been avoided by giving early warning.

44. Cash Flow Forecasts

44.1 When the Programme is updated, the Contractor shall provide the Project Manager with an updated cash flow forecast. The cash flow forecast shall include different currencies, as defined in the Contract, converted as necessary using the Contract exchange rates.

45. Payment Certificates

45.1 The Contractor shall submit to the Project Manager monthly statements of the estimated value of the work executed less the cumulative amount certified previously.

45.2 The Project Manager shall check the Contractor's monthly statement and certify the amount to be paid to the Contractor within twenty eight 28 days of receipt of the certificate from the contractor.

45.3 The value of work executed shall be determined by the Project Manager.

45.4 The value of work executed shall comprise the value of the quantities of the items in the Bill of Quantities completed.

45.5 The value of work executed shall include the valuation of Variations and Compensation Events.

45.6 The Project Manager may exclude any item certified in a previous certificate or reduce the proportion of any item previously certified in any certificate in the light of later information.

45.7 The Project Manager shall not be bound to certify any payment, if the net amount, after all retentions and deductions would be less than minimum amount of Interim Payment Certificate stated in the **Contract Data Sheet**.

46. Payments

46.1 Payments shall be adjusted for deductions for advance payments and retention. The Procuring Entity shall pay the Contractor the amounts certified by the Project Manager within 28 days of the date of each certificate. If the Procuring Entity makes a late payment, the Contractor shall be paid interest on the late payment in the next payment Interest shall be calculated from the date by which the payment should have been made up to the date when the late payment is made at the prevailing rate of interest for commercial borrowing for each of the currencies in which payments are made as indicated in the **Contract Data Sheet**.

46.2 If an amount certified is increased in a later certificate or

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as a result of an award by the Adjudicator or an Arbitrator, the Contractor shall be paid interest upon the delayed payment as set out in this clause. Interest shall be calculated from the date upon which the increased amount would have been certified in the absence of dispute.

46.3 Unless otherwise stated, all payments and deductions will be paid or charged in the proportions of currencies comprising the Contract Price.

46.4 Items of the Works for which no rate or price has been entered in will not be paid for by the Procuring Entity and shall be deemed covered by other rates and prices in the Contract.

47. Compensation Events

47.1 The following shall be Compensation Events:

- (a) The Procuring Entity does not give access to a part of the Site by the Site Possession Date stated in the **Contract Data Sheet**.
- (b) The Procuring Entity modifies the Schedule of Other Contractors in a way that affects the work of the Contractor under the Contract.
- (c) The Project Manager orders a delay or does not issue Drawings, Specifications, or instructions required for execution of the Works on time.
- (d) The Project Manager instructs the Contractor to uncover or to carry out additional tests upon work, which is then found to have no Defects.
- (e) The Project Manager unreasonably does not approve a subcontract to be let.
- (f) Ground conditions are substantially more adverse than could reasonably have been assumed before issuance of the Letter of Acceptance from the information issued to Tenderers (including the Site Investigation Reports), from information available publicly and from a visual inspection of the Site.
- (g) The Project Manager gives an instruction for dealing with an unforeseen condition, caused by the Procuring Entity, or additional work required for safety or other reasons.
- (h) Other contractors, public authorities, utilities, or the Procuring Entity does not work within the dates and other constraints stated in the Contract, and they cause delay or extra cost to the Contractor.
- (i) The advance payment is delayed.

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- (j) The effects on the Contractor of any of the Procuring Entity's Risks.
- (k) The Project Manager unreasonably delays issuing a Certificate of Completion.
- (l) Other Compensation Events described in the Contract or determined by the Project Manager shall apply.

47.2 If a Compensation Event would cause additional cost or would prevent the work being completed before the Intended Completion Date, the Contract Price shall be increased and/or the Intended Completion Date shall be extended. The Project Manager shall decide whether and by how much the Contract Price shall be increased and whether and by how much the Intended Completion Date shall be extended.

47.3 As soon as information demonstrating the effect of each Compensation Event upon the Contractor's forecast cost has been provided by the Contractor, it shall be assessed by the Project Manager, and the Contract Price shall be adjusted accordingly. If the Contractor's forecast is deemed unreasonable, the Project Manager shall adjust the Contract Price based on the Project Manager's own forecast. The Project Manager will assume that the Contractor will react competently and promptly to the event.

47.4 The Contractor shall not be entitled to compensation to the extent that the Procuring Entity's interests are adversely affected by the Contractor's not having given early warning or not having cooperated with the Project Manager.

48. Taxes

48.1 The Project Manager shall adjust the Contract Price if taxes, duties, and other levies are changed between the date 28 days before the submission of Tenders for the Contract and the date of the last Completion certificate. The adjustment shall be the change in the amount of tax payable by the Contractor, provided such changes are not already reflected in the Contract Price or are a result of Clause 50.

49. Currencies

49.1 Where payments are made in currencies other than the Kenya Shillings, the exchange rates used for calculating the amounts to be paid shall be the exchange rates stated in the Contractor's Tender.

50. Price Adjustment

50.1 The amounts payable to the Contractor, in various currencies pursuant to Sub-Clause 45.1, shall be adjusted in respect of the rise or fall in the cost of labour, Contractor's Equipment, Plant, materials, and other inputs

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to the Works, by applying to such amounts the formulae prescribed in this clause based on the prevailing consumer price index obtained from the Central Bureau of Statistics or the monthly inflation rate issued by the Central Bank of Kenya.

50.2 To the extent that full compensation for any rise or fall in costs to the Contractor is not covered by the provisions of this or other clauses in the Contract, the unit rates and prices included in the Contract shall be deemed to include amounts to cover the contingency of such other rise or fall of costs.

50.3 The adjustment to be applied to amount payable to the Contractor as certified in Payment Certificates shall be determined formulae for each of the currencies in which the Contract Price is payable. No adjustment is to be applied to work valued on the basis of Cost or current prices. The formulae shall be as follows;

$$P_n = a + b \frac{L_n - L_o}{L_o} + c \frac{M_n - M_o}{M_o} + d \frac{E_n - E_o}{E_o} + \text{etc.}$$

where;

P_n is a price adjustment factor to be applied to the amount in each specific currency for the payment of the work carried out in the subject month, where such variations and daywork are not otherwise subject to adjustment;

a is a constant, specified in the **Appendix to Tender**, representing the nonadjustable portion in contractual payments;

b, c, d, etc., are weightings or coefficients representing the estimated proportion of each cost element (labour, materials, equipment usage, etc.) in the Works or sections thereof, net of Provisional Sums, as specified in the **Appendix to Tender**; the sum of a, b, c, d, etc., shall be one;

L_n, M_n, E_n, etc., are the current cost indices or reference prices of the cost elements in the specific currency of origin for month “**n**,” determined pursuant to Sub-Clause 50.5, applicable to each cost element; and

L_o, M_o, E_o, etc., are the base cost indices or reference prices corresponding to the above cost elements at the date specified in Sub-Clause 50.5

The value of net work done, certified by the Project Manager, in any monthly Interim or Final Certificate as payable by the Procuring Entity to the Contractor before deduction of any retention money shall be increased or decreased by an amount of

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‘F’.

$$F = P_n \times P_c$$

where;

The effective value **P_c** of work done which is to be subjected to increase or decrease shall be the difference between:

- (i) the amount which, in the opinion of the Project Manager, is due to the Contractor under Clause 45 (before deduction of retention money and before deducting sums previously paid on account) less:
 - any amount for payment or repayment of any advance payment;
 - any amount for materials on site (if any);
 - any amounts for nominated sub-contractors (if any)
 - any amounts for any other items based on actual cost or current prices; or
 - any sums for increase or decreases in the Contract Price paid under this Sub-Clause
- and
- (ii) the amount calculated in accordance with (i) above of this Sub-clause and included in the last preceding statement.

50.4 The sources of indices shall be those listed in the **Appendix to Tender**, as approved by the Engineer. Indices shall be appropriate for their purpose and shall relate to the Contractor's proposed source of supply of inputs on the basis of which his Contract Price and expected foreign currency requirements shall have been computed. As the proposed basis for price adjustment, the Contractor shall have submitted with his Tender the tabulation of Weightings and Source of Indices in the **Appendix to Tender**, which shall be subject to approval by the Engineer.

50.5 The base cost indices or prices shall be those prevailing on the day 28 days prior to the latest date for submission of Tenders. Current indices or prices shall be those prevailing on the day 28 days prior to the last day of the period to which a particular Interim Payment Certificate is related. If at any time the current indices are not available, provisional indices as determined by the Engineer will be used, subject to subsequent correction of the amounts paid to the Contractor when the current indices become available.

50.6 If the Contractor fails to complete the Works within the time for completion prescribed under Clause 58 adjustment of prices thereafter until the date of completion of the Works shall be made using either the

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indices or prices relating to the prescribed time for completion, or the current indices or prices, whichever is more favourable to the Procuring Entity, provided that if an extension of time is granted pursuant to Clause 28, the above provision shall apply only to adjustments made after the expiry of such extension of time.

- 50.7 The weightings for each of the factors of cost given in the **Appendix to Tender** shall be adjusted if, in the opinion of the Engineer, they have been rendered unreasonable, unbalanced, or inapplicable as a result of varied or additional work already executed or instructed under Clause 43 or for any other reason.

51. Retention

- 51.1 The Procuring Entity shall retain from each payment due to the Contractor the proportion stated in the **Contract Data Sheet** until Completion of the whole of the Works.
- 51.2 On completion of the whole of the Works, half the total amount retained shall be repaid to the Contractor and the other half when the Defects Liability Period has passed and the Project Manager has certified that all Defects notified by the Project Manager to the Contractor before the end of this period have been corrected.
- 51.3 On completion of the whole Works, the Contractor may substitute retention money with an “on demand” Bank guarantee.

52. Liquidated Damages

- 52.1 The Contractor shall pay liquidated damages to the Procuring Entity at the rate per day stated in the **Contract Data Sheet** for each day that the Completion Date is later than the Intended Completion Date. The total amount of liquidated damages shall not exceed the amount defined in the **Contract Data Sheet**. The Procuring Entity may deduct liquidated damages from payments due to the Contractor. Payment of liquidated damages shall not affect the Contractor’s liabilities.
- 52.2 If the Intended Completion Date is extended after liquidated damages have been paid, the Project Manager shall correct any overpayment of liquidated damages by the Contractor by adjusting the next payment certificate. The Contractor shall be paid interest on the overpayment, calculated from the date of payment to the date of repayment, at the rates specified in Sub-Clause 46.1.
- 52.3 If the Contractor has not corrected a defects within the time specified in the Procuring Entity’s notice, the Procuring Entity will assess the cost of having the defect corrected, the Contractor will pay this amount, and a penalty for lack of performance calculated as described in

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Clause 38.

53. Bonus

- 53.1 The Contractor shall be paid a Bonus calculated at the rate per calendar day stated in the **Contract Data Sheet** for each day (less any days for which the Contractor is paid for acceleration) that the Completion is earlier than the Intended Completion Date. The Project Manager shall certify that the Works are complete, although they may not be due to be complete.

54. Advance Payment

- 54.1 The Procuring Entity shall make advance payment to the Contractor of the amounts stated in the **Contract Data Sheet** by the date stated in the **Contract Data Sheet**, against provision by the Contractor of an Unconditional Bank Guarantee in a form and by a bank acceptable to the Procuring Entity in amounts and currencies equal to the advance payment. The Guarantee shall remain effective until the advance payment has been repaid, but the amount of the Guarantee shall be progressively reduced by the amounts repaid by the Contractor. Interest will not be charged on the advance payment.
- 54.2 The Contractor is to use the advance payment only to pay for Equipment, Plant, Materials, and mobilization expenses required specifically for execution of the Contract. The Contractor shall demonstrate that advance payment has been used in this way by supplying copies of invoices or other documents to the Project Manager.
- 54.3 The advance payment shall be repaid by deducting proportionate amounts from payments otherwise due to the Contractor, following the schedule of completed percentages of the Works on a payment basis. No account shall be taken of the advance payment or its repayment in assessing valuations of work done, Variations, price adjustments, Compensation Events, Bonuses, or Liquidated Damages.

55. Performance Securities

- 55.1 The Performance Security shall be provided to the Procuring Entity no later than the date specified in the Letter of Acceptance and shall be issued in an amount and form and by a bank or surety acceptable to the Procuring Entity, and denominated in the types and proportions of the currencies in which the Contract Price is payable. The Performance Security shall be valid until a date 28 days from the date of issue of the Certificate of Completion in the case of a Bank Guarantee, and until one year from the date of issue of the Completion Certificate in the case of a Performance Bond.

56. Dayworks

- 56.1 If applicable, the Dayworks rates in the Contractor's Tender shall be used for small additional amounts of work only when the Project Manager has given written

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instructions in advance for additional work to be paid for in that way.

56.2 All work to be paid for as Dayworks shall be recorded by the Contractor on forms approved by the Project Manager. Each completed form shall be verified and signed by the Project Manager within two days of the work being done.

56.3 The Contractor shall be paid for Dayworks subject to obtaining signed Dayworks forms.

57. Cost of Repairs

57.1 Loss or damage to the Works or Materials to be incorporated in the Works between the Start Date and the end of the Defects Correction periods shall be remedied by the Contractor at the Contractor's cost if the loss or damage arises from the Contractor's acts or omissions.

E. Finishing the Contract

58. Completion Certificate

58.1 The Contractor shall request the Project Manager to issue a certificate of Completion of the Works, and the Project Manager will do so upon deciding that the work is completed.

59. Taking Over

59.1 The Procuring Entity shall take over the Site and the Works within seven days of the Project Manager's issuing a certificate of Completion.

60. Final Account

60.1 The Contractor shall supply the Project Manager with a detailed account of the total amount that the Contractor considers payable under the Contract before the end of the Defects Liability Period. The Project Manager shall issue a Defects Liability Certificate and certify any final payment that is due to the Contractor within 56 days of receiving the Contractor's account if it is correct and complete. If it is not, the Project Manager shall issue within 56 days a schedule that states the scope of the corrections or additions that are necessary. If the Final Account is still unsatisfactory after it has been resubmitted, the Project Manager shall decide on the amount payable to the Contractor and issue a payment certificate.

61. Operating and Maintenance Manuals

61.1 If "as built" Drawings and/or operating and maintenance manuals are required, the Contractor shall supply them by the dates stated in the **Contract Data Sheet**.

61.2 If the Contractor does not supply the Drawings and/or manuals by the dates stated in the **Contract Data Sheet**, or they do not receive the Project Manager's approval, the Project Manager shall withhold the amount stated in the

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Contract Data Sheet from payments due to the Contractor.

62. Termination

- 62.1 The Procuring Entity or the Contractor may terminate the Contract if the other party causes a fundamental breach of the Contract.
- 62.2 Fundamental breaches of Contract shall include, but shall not be limited to, the following:
- (a) The Contractor stops work for 28 days when no stoppage of work is shown on the current Programme and the stoppage has not been authorized by the Project Manager;
 - (b) The Project Manager instructs the Contractor to delay the progress of the Works, and the instruction is not withdrawn within 28 days;
 - (c) The Procuring Entity or the Contractor is made bankrupt or goes into liquidation other than for a reconstruction or amalgamation;
 - (d) A payment certified by the Project Manager is not paid by the Procuring Entity to the Contractor within 84 days of the date of the Project Manager's certificate;
 - (e) The Project Manager gives Notice that failure to correct a particular Defect is a fundamental breach of Contract and the Contractor fails to correct it within a reasonable period of time determined by the Project Manager;
 - (f) The Contractor does not maintain a Security, which is required; and
 - (g) The Contractor has delayed the completion of the Works by the number of days for which the maximum amount of liquidated damages can be paid, as defined in the **Contract Data Sheet**.
 - (h) If the Contractor, in the judgment of the Procuring Entity has engaged in corrupt or fraudulent practices in competing for or in executing the Contract.

For the purpose of this paragraph:

“corrupt practice” means the offering, giving, receiving or soliciting of anything of value to influence the action of a public official in the procurement process or in contract execution and includes inter alia, bribery and extortion or coercion which involves threats of injury to person ,property or reputation, and.

“fraudulent practice” means a misrepresentation of facts in order to influence a procurement process or

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the execution of a contract to the detriment of the Procuring Entity, and includes collusive practice among Tenderers (prior to or after Tender submission) designed to establish Tender prices at artificial non-competitive levels and to deprive the Procuring Entity of the benefits of free and open competition.

62.3 When either party to the Contract gives notice of a breach of Contract to the Project Manager for a cause other than those listed under Sub-Clause 62.2 above, the Project Manager shall decide whether the breach is fundamental or not.

62.4 Notwithstanding the above, the Procuring Entity may terminate the Contract for convenience.

62.5 If the Contract is terminated, the Contractor shall stop work immediately, make the Site safe and secure, and leave the Site as soon as reasonably possible.

63. Payment upon Termination

63.1 If the Contract is terminated because of a fundamental breach of Contract by the Contractor, the Project Manager shall issue a certificate for the value of the work done and Materials ordered less advance payments received up to the date of the issue of the certificate and less the percentage to apply to the value of the work not completed, as indicated in the **Contract Data Sheet**. Additional Liquidated Damages shall not apply. If the total amount due to the Procuring Entity exceeds any payment due to the Contractor, the difference shall be a debt payable to the Procuring Entity.

63.2 If the Contract is terminated for the Procuring Entity's convenience or because of a fundamental breach of Contract by the Procuring Entity, the Project Manager shall issue a certificate for the value of the work done, Materials ordered, the reasonable cost of removal of Equipment, repatriation of the Contractor's personnel employed solely on the Works, and the Contractor's costs of protecting and securing the Works, and less advance payments received up to the date of the certificate.

64. Property

64.1 All Materials on the Site, Plant, Equipment, Temporary Works, and Works shall be deemed to be the property of the Procuring Entity if the Contract is terminated because of the Contractor's default.

65. Release from Performance

65.1 If the Contract is frustrated by the outbreak of war or by any other event entirely outside the control of either the Procuring Entity or the Contractor, the Project Manager shall certify that the Contract has been frustrated. The Contractor shall make the Site safe and stop work as quickly as possible after receiving this certificate and shall be paid for all work carried out before receiving it and for

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any work carried out afterwards to which a commitment was made.

66. Suspension of Financing

66.1 In the event that the source of financing is suspended to the Procuring Entity, from which part of the payments to the Contractor are being made:

- (a) The Procuring Entity is obligated to notify the Contractor of such suspension within 7 days of having received the financing agency's suspension notice.
- (b) If the Contractor has not received sums due it within the 28 days for payment provided for in Sub-Clause 46.1, the Contractor may immediately issue a 14-day termination notice.

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Contract Data Sheet

Instructions for completing the Contract Data Sheet

CDS Clause	GCC Clause	Description
1	1.1	<p>a) General</p> <p>The Procuring Entity is; The Chief Executive Officer, Athi Water Works Development Agency 3rd Floor, Africa Re Centre, Hospital Road, Upper Hill P.O. Box 45283-00100 Nairobi, Kenya</p> <p>The Adjudicator is as recommended by the Kenya Chapter of the Chartered Institute of Arbitrators, P.O Box 50163-00200, Nairobi</p> <p>The Defects Liability Period is <i>12 months (365 days)</i></p> <p>The Project Manager is; Chief Manager – Water/ Sanitation Services Athi Water Works Development Agency P.O. Box 45283-00100 Nairobi</p> <p>The name and identification number of the Contract is AWWDA/GOK/DESTP/W-04/2020-2021</p> <p>The Works consist of :</p> <ul style="list-style-type: none"> a) Rehabilitation of DESTP, inlet channels and waste water stabilization ponds b) Construction a 20,000m³/day waste water treatment system complete with Anaerobic ponds, facultative and maturation ponds c) Construction of a wetland d) Sewerage treatment auxiliary works <p>The objectives of the contract are <i>to increase the efficiency and capacity Dandora Estate Sewerage treatment plant</i></p> <p>The Start Date shall be 28 days after date of issuance of the Project Managers order to commence works</p> <p>The Intended Completion Date for the whole of the Works shall be <i>Eighteen (18) months from Commencement date</i></p> <p>The following documents also form part of the Contract:</p> <ul style="list-style-type: none"> (a) Contract Agreement (b) Letter of Acceptance (c) The minutes of negotiation

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		<p>(d) <i>The Letter of Tender</i></p> <p>(e) <i>The Particular Conditions of Contract including Contract Data (Appendix to Tender)</i></p> <p>(f) <i>The General Conditions of Contract</i></p> <p>(g) <i>Specifications</i></p> <p>(h) <i>Drawings</i></p> <p>(i) <i>Bills of Quantities, Price Adjustment Schedule</i></p> <p>(j) <i>The Contractor's Submission</i></p> <p>The Site is located in Nairobi County</p>
2.	2.2	Indicate whether there is sectional completion: Not Applicable
3.	2.3(9)	List other documents that form part of the contract if any: N/A
4.	3.1	<p>The language of the Contract documents is <i>English</i></p> <p>The law that applies to the Contract is the Kenyan Law.</p>
5.	9.1	Include the Schedule of Other Contractors, if any. N/A
6.	10.1	<p>Include the Schedule of Key Personnel.</p> <p><i>As indicated in the ITTs</i></p>
7.	14.1	<p>The minimum insurance covers shall be:</p> <ul style="list-style-type: none"> (a) loss of or damage to the Works, Plant, and Materials [Kshs 2,000,000]; (b) loss of or damage to Equipment [Kshs 2,000,000]; (c) loss of or damage to property (except the Works, Plant, Materials, and Equipment) in connection with the Contract [Kshs 2,000,000]; and (d) Personal injury or death [Kshs 3,000,000];
8.	15.1	<p>Site Investigation Reports available to the Tenderers are:</p> <p>N/A</p>
9.	22.4	<p>The other measures include:</p> <ul style="list-style-type: none"> <i>a. Minimising the number of migrant workers employed on the project and household in the site camp</i> <i>b. Providing access to voluntary counselling and testing (VCT)</i> <i>c. Providing psychological support and health care including prevention and treatment of opportunistic infections for workers infected and affected, as well as their families</i> <i>d. Providing condoms (male and female) to workers</i>
10.	24.1 & 47.1	The Site Possession Date shall be 28 days' after date of contract signature

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11.	28.2	Hourly rate of Fees payable to the Adjudicator is: KES 20,000 Types of reimbursable expenses to be paid to the Adjudicator include: a) Transport b) Communication c) Accommodation
12.	28.3	Arbitration will take place at <i>Nairobi Kenya</i> in accordance with rules and regulations published by Chartered Institute of Arbitrators
13.	29.1	Appointing Authority for the Adjudicator: Chartered Institute of Arbitrators
A. Time Control		
14.	30.1	The Contractor shall Submit a Programme for the Works within 28 days of delivery of the Letter of Acceptance.
15.	30.3	The period between Programme updates is <i>30</i> days.
16.	30.3	The amount to be withheld by the Project Manager in the case the contractor does not submit an updated programme is: KES 300,000
B. Quality Control		
17.	38.1	The Defects Liability Period is <i>365 days after satisfactory completion of works</i>
C. Cost Control		
18.	45.7	Minimum Amount of Interim Payment Certificate will be <i>N/A</i>
19.	46.1	The interest rate shall be N/A above prevailing interest rate for commercial borrowing from the contractors' bank
20.	47.1(a)	The Site Possession Date shall be 28 days' after date of contract signature
21.	50	The contract <i>is not</i> subject to price adjustment in accordance with Clause 50 of the General Conditions of Contract.
22.	51.1	The amount of retention is 10% of the value of works of Interim Payment Certificate'.
		Limit of retention will be <i>Not Applicable</i>
23.	52.1	The rate of liquidated damages is <i>0.15 percent of contract price per day</i>
	52.1 62.2 (g)	The maximum amount of liquidated damages is 10% of Contract Price
24.	53.1	The bonus for early completion is <i>N/A</i>

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25.	54.1	The amount of advance payment shall be 10 per cent of the contract sum payable after submission of <i>Unconditional Bank Guarantee of equivalent amount</i>
		Monthly Recovery of Advance Payment: 10 percent of amount of Interim Payment Certificate.
26.	55.1	The Performance Security shall be 10 percent of the contract price (Unconditional Bank Guarantee)
		D. Finishing the Contract
27.	61.1	As built drawings shall be supplied by the contractor by 30days upon completion Operating manual shall be supplied by the contractor by 30 days upon completion
28.	61.2	The amount to be withheld by the Project Manager in the case the contractor does not submit as built drawings is: KES 500,000 The amount to be withheld by the Project Manager in the case the contractor does not submit operating manual is: KES 500,000
29.	63.1	The percentage to apply to the value of the work not completed, representing the Procuring Entity's additional cost for completing the Works, is 10%.

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SECTION VI: TECHNICAL SPECIFICATIONS

Specifications

SECTION 1	GENERAL REQUIREMENTS
SECTION 2	EARTHWORKS, BACKFILLING AND RESTORATION
SECTION 3	CONCRETE WORKS - GENERAL
SECTION 4	PIPELINES, PIPEWORK
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SECTION 6	ROADS AND SURFACING
SECTION 7	SAFETY, HEALTH AND ENVIRONMENT
SECTION 8	GENERAL SPECIFICATION - ENVIRONMENTAL IMPACT MITIGATION

General Specifications

SECTION 1. GENERAL REQUIREMENTS

1.1 Introduction

These specifications cover the construction of the works as shown on the drawings and listed in the Bills of Quantities and shall be read in conjunction with the Contract Documents as listed in Volume I, Instructions to Tenderers.

All references given are intended solely for the convenience of those using the above documents and shall be in no way exclude the application of the other clauses in the documents which may, in the opinion of the Engineer have any bearing on the point in question.

1.1.1 Location

The project is located in Nairobi County, and will be implemented within the jurisdictions of Nairobi Water Service Provider

1.2 Scope of Works

The following works are to be carried.

- a) Rehabilitation of DESTP, inlet channels and waste water stabilization ponds
- b) Construction a 20,000m³/day waste water treatment system complete with Anaerobic ponds, facultative and maturation ponds
- c) Construction of a wetland
- d) Sewerage treatment auxiliary works

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101 Quality and Approvals

The materials and workmanship shall be the best of their respective kinds and to the approval of the Project Manager. The words “to the approval of the Project Manager” shall be deemed to be included in the description of all items relating to design, construction, installation and materials and workmanship for the due execution of the Works.

The Contractor shall submit all data, details and samples as necessary and as reasonably requested by the Project Manager of all materials that the Contractor proposes to use in the Works. Method statements which adequately demonstrate the Contractor’s proposed method of working, methods of maintaining safety and compliance with the programme shall be submitted for the Project Manager’s approval prior to the commencement of work on any area of the Site.

Where the Contractor is responsible for the preparation of Construction Documents to describe the permanent works such Construction Documents shall be approved prior to the procurement of any materials or commencement of any work to which the documents relate.

No materials, Plant or equipment shall be procured for the Contract and no work, permanent or temporary, shall commence without first obtaining the Project Manager’s approval.

All materials, Plant and equipment supplied shall be designed for operation under the above described

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conditions.

102 Construction Documents

Drawings and Documents which are to be submitted by the Contractor to describe the Permanent Works shall become Construction Documents upon their approval.

All drawings, technical specifications, bill of quantities, schedules, cost estimates; programme and other information to be submitted by the contractor shall be in English and shall be submitted for approval in triplicate. Following approval, the contractor shall supply a further five copies to the Project Manager. Construction Documents shall not be departed from without the approval of the Project Manager.

All drawings and documents submitted by the Contractor shall have been checked, signed and be ready for issue and shall bear:

- Title of the drawing or document;
- Scale;
- Date;
- Work item reference number complying with an approved numbering system;
- Name and references of the Contractor;
- Names of the employer and the Project Manager;
- Date of approval by the Contractor and the signature of the person responsible for approval.

Drawings and documents submitted for approval shall be delivered to the Project Manager's office as designated by the Project Manager.

Unless otherwise specified the Contractor shall allow a minimum of 21 days, after the date of receipt by the Project Manager for approval of drawings and documents by the Project Manager.

103 Operation and Maintenance Manuals

The Contractor shall submit to the Project Manager for approval six copies of the Operation and Maintenance (O&M) Manuals as described in Clause 58 of the Contract Data.

The Contractor shall supply the final version of the O&M Manuals prior to the issue of the Taking- Over Certificate for either the whole of the Works or the respective Section or part of the Works. Each set shall be bound together in a stout plastic or other approved cover.

O&M Manuals shall be supplied written in English language, all parts and equipment listings shall be in English.

104 Level Datum

Before the commencement of constructional work the Contractor shall establish, in a position to the approval of the Project Manager, steel datum pegs which shall be securely concreted in. The level of these pegs shall be established and agreed with the Project Manager and all levels used in the construction of the Works shall be referred to these established datum points. The correctness of this datum shall be checked at regular intervals during the construction period as agreed with the Project Manager.

Where possible construction drawings and all levels used for construction shall be referred to the national height datum as defined by the Survey of Kenya. The Contractor shall be responsible for obtaining the location and values of the permanent bench marks. In cases where such bench marks do not exist, the site datum shall be agreed with the Project Manager.

105 Setting Out of the Works

The site layout drawings show indicative site layouts. Prior to commencing construction, the Project Manager will agree with the Contractor the basic information supplementary to that shown on the Drawings such as the position of manholes, chambers, centre-lines and base-lines sufficient for the Contractor to locate the Works.

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Project Manager in triplicate for approval. Any modifications to the setting out drawings or data sheets required by the Project Manager shall be made by the Contractor and resubmitted for final approval. Should it be necessary during setting out or during construction for the approved setting out details to be amended, the Contractor shall amend the drawings or data sheets or make new ones for approval as required by the Project Manager.

For pipelines, the Contractor shall in the presence of the Project Manager set-out the pipeline alignments in accordance with the indicative alignments shown on the drawings taking into account physical features on the ground, any existing services, any requirements of relevant Authorities and any changes deemed necessary by the Project Manager, confirming the locations of all valves, air valves, washouts, hydrants and bends.

The Contractor shall prepare and submit to the Project Manager, at an approved scale, plans of the pipeline route and profiles of ground levels after any initial clearing of the wayleave or easement showing the proposed pipe invert levels and precise chainages for all valves and fittings for approval. Following approval the Contractor shall submit to the Project Manager two copies of the agreed alignment and profiles.

106 Boundaries of Works

The Employer shall provide the Site upon which the Permanent Works are to be constructed. Where a drain or pipeline is to be within an existing road or track reservation or is otherwise located in land designated Public Domain the Site width will be restricted to the limit of the public land. The existing

boundary fences and walls shall not be disturbed without prior approval of the Project Manager and, unless road diversions and closure notices are approved and posted, carriageways shall be left available for the safe passage of traffic.

The Contractor shall not enter upon or occupy with men, tools, equipment or materials any land other than the site without the written consent of the owner of such land.

On occupation of the Site or other land the Contractor shall provide such fencing, as required.

107 Work through Private Land

In order that the necessary parts of the Site which are on private land may be obtained the Contractor shall supply the Project Manager with full information of his programme sufficiently in advance of the dates upon which the Contractor proposes to enter upon each areas of the Site. The Contractor shall where required, in consultation with the Project Manager, programme the Works to designate the areas of the Site to which the Contractor is to be given possession and the sequence of taking possession.

The Contractor shall obtain written approval before entering upon any private land or cutting through ditch, bank, hedge, wall, fence or any other form of boundary marking and he shall carry out all reasonable requirements as approved by the Project Manager in the matter of reinstatement.

108 Public Utility Mains and Services

Where the Contract indicates the positions of existing services or apparatus the positions shown are believed to be correct but no warranty is given as to the accuracy or completeness of the information.

It shall be the responsibility of the Contractor to obtain all information available from the Public Utility Authorities regarding the position of existing mains and services and he shall copy this information to the Project Manager as soon as he obtains it.

The Contractor shall carry out excavation works in a manner which safeguards any existing services, including hand excavation as necessary and shall be responsible for the cost of any repair work necessitated by damage caused by him to any main or service and for any costs arising from the disruption.

The Contractor shall obtain all information and assistance from the Public Utility Authorities for the locating of the mains and services and shall agree with the Project Manager any trial excavation which may be necessary to confirm or establish these locations.

The Contractor shall be responsible for locating all existing services, whether known to the Public Utility Authorities or not, and shall conduct his own survey as necessary to accurately locate all services. All efforts to identify these existing services shall be carried out in advance of conducting excavation for the permanent works.

Any temporary or permanent diversion of mains and services shall be agreed with the appropriate Authority.

109 Safeguards to Existing Pipes, Cables, Structures

It shall be the Contractor's responsibility to safeguard by means of temporary or permanent supports or otherwise all existing sewers, pipes, cables, structures or other things which would be liable to suffer damage if such precautionary measures were not taken.

Safeguards shall be to the approval of the Project Manager and of the undertaker or owner concerned.

110 Record Drawings

At all sites and any locations where the Contractor executes work under the Contract, including locations where the Contractor undertakes repair or rehabilitation work, the Contractor shall record the location and nature of all water supply and wastewater works including their ancillaries and any associated services.

Where instructed by the Project Manager for the purpose of producing Record Drawings, the Contractor shall undertake such surveys and investigations to determine the location of existing services. Such surveys and investigations shall be additional to those surveys and investigations undertaken by the Contractor for the purpose of determining the location of services prior to excavation.

The Contractor shall where necessary utilize appropriate equipment and where instructed by the Project Manager excavate trial pits to confirm the location and determine the size and nature of the buried services.

For sites where the Contractor undertakes permanent works Record Drawings shall be submitted to the Project Manager, for approval, in the form of As Built Drawings. In the case of repairs and rehabilitation the Record Drawings shall be submitted for approval within a period of 21 days following execution of the work.

Record Drawings shall be prepared to an approved format, and scale in line with the construction drawing.

111 Connections to Existing Pipes, Cables and Equipment

The Contractor shall be responsible for joining up and making connections between pipes and cables laid by him and existing pipes and cables. The Contractor shall submit to the Project Manager a drawing showing the details of the connection, and shall state the date on which the particular connection is required, and the work shall not proceed until the Project Manager's approval has been given.

The Contractor shall be responsible for ensuring the compatibility of new pipes and cables with existing pipework, cables, tubing and equipment.

112 Lighting, Watching and Traffic Control

Where necessary for safety of the public or where required by the Project Manager, the Works shall be properly fenced and signed. In addition, the Works shall be lighted from half an hour before sunset until half-an-hour after sunrise and at other times when visibility is poor. The position and number of the lamps shall be such that the extent and position of the Works are clearly defined. Each Site shall be provided with watchmen as required.

113 Contractor's Offices

The Contractor shall provide and maintain offices for the use of his representative and staff to which written instructions by the Project Manager can be delivered. Any instructions delivered to such offices shall be deemed to have been delivered to the Contractor.

Offices shall be located to give convenient access to the Works and shall be subject to the approval of the Project Manager. The Contractor shall be responsible for obtaining the land on which to establish any temporary site offices.

114 Resident Engineer's Office

A Rented Office will be established for Supervision of the Works at a location within the Project Area. The Contractor to provide the rented office from the date of Commencement of Work. The Office and its location will be to the Resident Engineer's approval.

The Office will be of a design and construction approved by the Resident Engineer and will be constructed of strong, durable and weatherproof materials with walls, ceilings and floors adequately insulated against heat and cold.

The Office will have a floor area of at least 200 square metres and will be provided with equipment and furniture detailed under the following clauses. The Offices shall have burglar proofing to all windows and external doors.

In addition to the above, provision will be made for shaded parking (carports) for at least two vehicles.

Provision will be made by the Contractor for all necessary gas, electricity, kerosene, water, light, attendance and stationery required in connection with execution of the Contract.

Security Guards hired from a reputable Security Firm approved by the Resident Engineer will be provided for

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day and night security at the Office. The Office, furniture and equipment shall be insured against fire, theft and natural calamity.

a) Furniture and Equipment for the Resident Engineer's Office

The office shall be suitably furnished with the following as minimum requirements. The actual list of Furniture and Equipment and specifications will be determined and issued to the Contractor by the Resident Engineer before procurement. All items shall revert to the Client at the end of Project.

<u>Furniture & Equipment</u>	<u>Quantity</u>
Writing Desk with 3 lockable drawers	4 Nr
Writing Desk without Locks	1 Nr
High Back Chairs with arm rests	5 Nr
Wooden Conference Table, 3.0m x 1.2m	1 Nr
Wooden Table, 2.4m x 1.2m	1 Nr
Office chairs without arm rests	12 Nr
Visitors Chairs without arm rests	5Nr
Lockable Steel Cupboard (Size 1m x 1.8m x 0.5m deep)	1 Nr
Office paper punch	2 Nr
Pin board 2.4m x 1.2m	4Nr
Whiteboard, 1.2m x 1.2m	1 Nr
Office Tray (3 tier)	4 Nr
Office Stapling Machines	3 Nr
Heavy Duty Stapler	1 Nr
Wooden Filing Cabinets with sliding doors	4 Nr
‘Casio’ or similar small portable scientific electronic calculator	2 Nr
‘Casio’ or similar small portable electronic calculator	2 Nr
First Aid kit (for 10 persons) in Metal Box	2 Nr
Potable Fire Extinguisher (5 litres)	2 Nr
Small office scissors	2 Nr
Wastepaper baskets	4 Nr
Electric kettle (capacity 1.8 litres)	1 Nr
Coffee/Tea making facility including crockery for all supervisory staff 10 Nr. and 12 additional guests	1 Nr
Pedastal electric fan, size 400mm	1 Nr
‘Sanyo’ or equivalent approved Refrigerator (0.3 cu.m. capacity)	1 Nr
Wooden book shelves with lockable glass frontage 2.0m x 1.5m	3 Nr
Desktop – “DELL” OptiPlex – specifications to be issued prior to ordering	4Nr
Laptop – “DELL” Latitude – specifications to be issued prior to ordering	3 Nr
Microsoft Surface Pro 3 Tablet, Intel Core i7, 3.3 GHz, Windows 8.1 Professional, Microsoft Office Pro, with USB port, cover, 3 Years Next Business Day Warranty	1Nr
Stand-alone ACAD 3D (latest version) Civil software including annual maintenance and service fee	3Nr
Printer / Photocopier / Scanning Machine – Nashuatec Model MPC 205/AO 20 Pages per minute, B/W and Colour, A3/A4 Size Paper or approved equivalent	1 Nr
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<u>Furniture & Equipment</u>	<u>Quantity</u>
Stand-alone A4 Laser Printer HP or approved equivalent	1Nr
Petty Cash Box with security lock	1 Nr
Wall Clock	2 Nr
Ibico' or approved equivalent binding machine suitable to bind upto 40mm spirals	1 Nr
Flashlights (battery powered)	2 Nr
Digital Camera	3 Nr
Smart Phones – Apple (latest model) or approved equivalent	3Nr

b) Provisions and Consumables for the Resident Engineer's Office

Stationery required **per month** as below. The list given below is indicative, for pricing purposes. The Actual list of Stationery will be issued every month by the Resident Engineer before ordering.

<u>Stationery</u>	<u>Quantity</u>
Photocopy paper A4	4 Reams
A3 paper	2 Ream
Biro pens blue/black	½ Doz.
Clutch Pencils	½ Doz.
Box files	6 Nr
Spring Files	6 Nr
Document Wallets	6 Nr
Spirals (various sizes of Reports)	2 Doz.
Embossed (hardback cover)	2 Doz.
Perspex covers	2 Doz.
Cellotape (medium)	1 Nr
Masking tape (medium)	1 Nr
Staples	2 Pac.
Paper clips (various sizes)	2 Pac.
Pencil leads (0.5/0.7)	2 Sets
C-DR (Pack of 12)	1 Pac.
CD-RW (Pack of 12)	1 Pac.
Highlighters (set of all colours)	2 Sets
A6 hardcover notebooks	2 Nr
Soft Pencil Erasers (Staedtler or equivalent)	3 Nr
Envelopes (all sizes)	3 Doz.
Batteries for flashlights	3 Sets
Black ink cartridge/ toner for the A4/A3 printer	1 Set
Colour cartridges/toner for the A4/A3 printer	1 Set

In addition, the Contractor to supply consumables including soap, lavatory paper, disinfectant and cleaning materials, coffee/tea, milk, sugar, drinking water, etc. every month throughout the Contract Period adequate for 10Nr Supervision Staff and 12Nr additional guests.

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The Contractor will also be responsible for the following services for the Office:

- i) Payment for all services including water, electricity, sewerage, Telephone and Internet
- ii) Guarding of the premises (24 hour security services);
- iii) Maintaining insurance against theft of equipment and other materials from the offices;
- iv) Service, maintain / repair office equipment and appliances;

The cost of all the above services shall be included by the Contractor under the relevant item in Bill No. 1 – Preliminaries and General for for Maintenance and Attendance for the Resident Engineer's Office. Apart from the consumables, the rest of equipment will revert to the Employer at the end of the Contract.

c) Survey Equipment for the Resident Engineer's Office

Listed below are the principal items of survey equipment to be made available for the exclusive use of the Resident Engineer during the whole duration of Project Implementation. All equipment shall be as new and with all necessary carrying containers, manuals, insurances, etc. The Equipment to revert to Contractor at completion of all Works.

Equipment	Quantity
Total Station including tripods, complete with reflectors, poles, brackets and carrying case (Wild or similar)	2 Nr
Automatic Level (Wild or Similar) with legs and metric staff, complete with carrying case	2 Nr
Metric extending levelling staffs with vertical bubble	2 Nr
30m (enamelled or otherwise protected) steel bands	2 Nr
3 metre ranging rods	30 Nr
Survey umbrellas with stand	6 Nr
Work boots	8 sets
Rain Gear (trousers and jacket type, complete with rain hat)	8 sets
Hard hats	12 sets
5 metre retractable pocket steel tapes	8 Nr
30 metre metal tapes	4Nr
100 metre metal tapes	3Nr
Builders spirit levels 1000mm long	4 Nr
Hammers 3 kg each	4 Nr

The Contractor shall also supply pegs, crayons, spray paint, nails and all other items required for setting out and measuring the work.

The Contractor shall be responsible for maintaining the survey and field equipment throughout the Contract Period, including replacement of items damaged during the normal course of the Works.

The Contractor shall provide all such labour and assistance as may be required by the Engineer for checking the Contractor's setting out and/or survey.

The Contractor shall make available such labour, materials, equipment and consumables as the Engineer may require from time to time, for inspections and tests in connection with the Works.

d) Staff for the Resident Engineer's Office

Contractor will provide the following Staff for the Resident Engineer's Office. The Staff are to be employed and paid by the Contractor (including all overtime, PAYE, NSSF, NHIF, etc) but will report directly to the Resident Engineer for day to day instructions. The Resident Engineer will interview, test and approve the Staff prior to their deployment on the Works.

i) Secretary:

The Contractor shall provide a Secretary for the exclusive use of the Resident Engineer for the duration of the Contract. The secretary shall be English speaking, with a minimum 5 years experience in secretarial / office administration work. The secretary shall be conversant with standard office computer hardware and software (MS-Word, Excel, PowerPoint, etc).

ii) Office Assistant:

An Office Assistant (messenger / tea boy / office cleaner) shall also be provided by the Contractor exclusively for the Resident Engineer's Office.

iii) Survey Assistants / Chainmen:

The Contractor shall provide the services of two Survey Assistants / Chainmen for the sole use of the Resident Engineer for the whole period of the Contract.

iv) Drivers:

The Contractor shall provide licensed Drivers for the exclusive use of the Resident Engineer. The drivers shall be available at all times during normal working hours and when specifically required by the Resident Engineer or his authorized representative, outside these hours. The drivers shall have a minimum 10 years of clean driving record and a Certificate of Good Conduct from the Kenya Police.

Each driver shall be provided with uniform as follows, as a minimum, to be replenished/replaced as and when necessary as directed by the Resident Engineer. The cost of uniform is deemed to be covered by the Contractor's monthly rate for the drivers.

- | | | |
|------------------------------|---|-----------|
| • 2 Nr good quality Trousers | - | Navy Blue |
| • 3 Nr Shirts | - | Sky Blue |
| • 2 Nr woollen Sweaters | - | Navy Blue |
| • 1 Nr pair Hard Toe Shoes | - | Black |
| • 3 Nr Pairs of Socks | - | Black |

115 Vehicles for the Project Manager

The Contractor shall provide and maintain for the duration of the Contract vehicles for the use of the Project Manager. At the conclusion of the Contract the vehicles will be handed over to the Employer in a fully serviced and roadworthy condition, free from defects. Selection of vehicles shall be agreed with the Project Manager at the commencement of the contract and at minimum will be:

4WD, Twin Cab Pick-up and Station Wagon Vehicles, or approved equivalent, including road licenses, number plates, insurances, etc. The vehicle to revert to Employer after completion of Contract. Minimum specifications include but not limited to the following:

- Engine - 2.8 litres Turbo Diesel
- Rear Differential Gear Lock
- Braking System to include ABS (Anti-Lock Brake System)
- Gear Lock
- Power Steering with adjustable Steering Column
- Electronic Fuel Injection System.
- Automatic Transmission
- Power Windows
- Immobiliser and Alarm System
- Fuel tank capacity between 80 litres and 100 litres
- Front Bull Bar

116 Contractor's Yards, Stores and Accommodation for Workmen

The Contractor shall be responsible for obtaining the land and for the provision of all temporary yards, stores, workshops, offices, mess rooms, shelters and for all services in connection therewith. The location of all such facilities shall be agreed beforehand with the Project Manager and shall be such as to avoid obstruction and nuisance to the public.

The Contractor shall construct secure storage compounds and storage building where he shall store at his own risk all equipment and Plant awaiting erection. The Contractor shall also provide secure covered storage for all samples submitted to the Project Manager for approval. Storage building shall be weatherproof and shall be of sufficient size to accommodate all items requiring covered storage.

The Contractor shall provide and maintain suitable and sufficient shelters and mess rooms for his workmen and supervisory staff as are customary and necessary. The Contractor shall provide sufficient closets or latrines to the satisfaction of the relevant authority. They shall be properly screened and maintained in a clean and sanitary state at all times. The Contractor shall be responsible for making all arrangements for the proper disposal of waste.

117 Water and Electricity Supplies

The Contractor shall make all arrangements for and provide adequate supply of potable water to each site as necessary for the execution and testing of the Works and for use by his workmen.

The Contractor shall make arrangements for and provide any electricity supply required for the execution of the Works, including the Tests on Completion.

118 Contractor's Staff and Workmen

The Contractor shall agree to employ Kenyan workers to the maximum extent possible. The Contractor shall provide a competent Site Agent to the approval of the Project Manager to be in charge of the work who shall not be changed except with the consent of the Project Manager.

The Contractor agrees that his workmen and employees shall be considered for all purposes in his direct pay and employ and under his supervision and control. He shall be directly and personally responsible for discharging all obligations, financial or other, which may be or becoming owing to any such workman or employee or to his successors, assignees or personal representatives. There shall be no contractual or legal relations of any kind whatsoever between the Employer and any such workman, employee or any person employed in the performance of the Contractor's obligations under this Contract.

The Project Manager may request and the Contractor agrees to accept the request for the immediate

removal from the site of any employee or worker of the Contractor adjudged by the Project Manager to be incompetent, disorderly, and unreliable or of bad character. Such employee shall not again be employed on the Works.

119 Training of Employers Workmen

The Contractor shall make provision for the on-site training of up to 3 of the Employer's staff. The cost of this will be covered in the Contractor's rates.

120 Project Management

121.1 Project Control

The Contractor shall provide within his site organization a project management capability to advise and be directly responsible to the Site Agent. (Contractor's chief site representative). The duties of the section shall include the following:

- a) Planning and programme preparation particularly in relation to the requirements of the Employer and the public authorities, and the requirements to maintain water supply and waste water disposal services where careful detailed arrangements have to be made and adhered to.
- b) Planning the execution of the Works in a manner which minimizes disruption to the water supply system and will permit the efficient and effective commissioning of the water supply system and their respective components.
- c) Ensuring adequate potable water supplies and wastewater disposal services are maintained to all consumers.
- d) Continuous surveillance of progress and anticipation of factors likely to affect the timely performance of the Contract.
- e) Making proposal for modification to forward planning and to the programme at an early stage in the light of factors resulting from (d) above.
- f) Continuous appraisal of the Contractor's methods and routines particularly as to their effect on the community and property.
- g) Forward planning for resource requirements taking due account of possible shortages and delays in the arrival on site of materials, equipment, plant and personnel and their mobilization for effective usage.
- h) Acquisition and process of up-to-date information for progress meetings with the Project Manager. The preparation of monthly progress reports including an update of the detailed programme and cash flow forecast which shall include progress photographs as directed by the Project Manager.

The Contractor's project management staff shall be of adequate ability and experience. Programmes shall be based upon Critical Path Management (CPM) networks in precedence format and shall be prepared using a suitable PC-based project management software package approved by the Project Manager.

Reporting shall be in a manner compatible with the Employers project management procedures and shall use the Earned Value (EV) Technique and shall monitor the actual gross value of work completed against the predicted value.

121.2 Monthly Statements and Certificates

Monthly statements and certificates shall be submitted in an approved manner and format. In addition to the statements submitted in hard copy the Contractor shall submit a computer copy using data base software as prescribed by the Project Manager. The statements and certificates shall detail the measured value of the work completed on each item of the Works in such detail that the

Project Manager can identify location and measurement of each item. A location shall constitute a single structure such as a reservoir, pump station or section of a pipeline or a component of a system such as a pipeline valve complex.

Each item shall be uniquely identified in accordance with the numbering system as instructed by the Project Manager.

121.3 Progress Meetings

The Contractor shall provide a suitable venue, near the vicinity of the Site, and arrange progress review meetings to be chaired by the Project Manager at monthly intervals to coincide with submission of monthly progress submissions. The Contractor shall allow for attendance by the Project Manager and up to 4 representatives of the Project Manager's or Employer. The meetings shall be attended by the Contractor's senior representatives, Site Agent and other members of his senior staff as may be deemed necessary.

122 Equipment for the Employer

The Contractor shall hand over to the Employer on completion of the Works a complete set of tools and equipment together with spare parts and fittings to facilitate the maintenance and operation of the installed works.

123 Facilities for Survey and Inspection by the Project Manager

The Contractor shall make available technicians and such labour, materials and safety equipment as the Project Manager may require for inspections and survey work in connection with the Works. The Contractor shall provide all necessary tackle, test equipment, access, labour, staff and any other thing the Project Manager may reasonably require in order that he may safely, conveniently and quickly carry out such inspections as he deems necessary at any time during the execution of the Works and during the Defects Liability Period. The Project Manager, his representative and assistants, shall not inspect any area of the Works where they deem the safety provision to be inadequate and the Contractor shall undertake any work required by the Project Manager in order to make it safe.

124 Inspections by the Project Manager during Defects Liability Period

The Project Manager will give the Contractor due notice of his intention to carry out any inspections during the Defects Liability Period and the Contractor shall thereupon arrange for a responsible representative to be present at the times and dates named by the Project Manager. This representative shall render all necessary assistance and shall record all matters and things to which his attention is directed by the Project Manager.

125 Protective Clothing and Safety Equipment

The Contractor shall provide for the Project Manager, his Representative and assistants any additional protective clothing and safety equipment necessary for the proper discharge of their duties on the Site.

The Contractor shall provide any necessary protective clothing and safety equipment for the use of authorized visitors to the site including the Employer and his staff and representatives and those of any relevant authority who have reason to visit the Site.

126 Notice Boards

The Contractor shall provide and erect sign boards at the Sites where works are being executed, giving information to the public on the Project and the Employer and further details as will be prescribed by the Employer. The location of the sign boards at the sites will be indicated by the Project Manager. The Contractor shall maintain, alter, move or adapt the sign boards from time to time as may be instructed by the Project Manager. The display of any named Sub-contractors or any other information associated with the Works shall be to the approval of the Project Manager.

127 Language of Correspondence and Records

All communications from the Contractor to the Project Manager shall be in the English language. All

books, timesheets, records, notes, drawings, documents, specifications and manufacturers' literature shall be in

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the English language. If any of the aforementioned is in another language a certified translation in English shall be submitted to the Project Manager.

128 Standards and Regulations

Each and every part of the Works shall be designed, constructed, manufactured, tested and installed in accordance with an internationally recognized standard, Code of Practice, or Regulation applicable to that part of the Works.

Such standards and codes shall include:

- a) British Standard Specification last published.
- b) International Electromechanical Commission, where available (IEC).
- c) International Organization for Standardization (ISO).

The Contractor shall provide and keep permanently on site copies of such standards as may be directed by the Project Manager and shall make them available to the Project Manager as required.

129 Equivalency of Standards and Codes

Wherever reference is made in the Contract, including Specifications, Drawings and Bill of Quantities, to specific standards and codes to be met by the goods and materials to be furnished, and work performed or tested, the provisions of the latest current edition or revision of the relevant standards and codes in effect shall apply, unless otherwise stated in the Contract. Where such standards and codes are national, or relate to a particular country or region, other authoritative standards that ensure a substantially equal or higher quality than the standards and codes specified will be accepted subject to the Project Manager's prior review and written consent. In the event the Project Manager determines that such proposed deviations do not ensure substantially equal or higher quality, the Contractor shall comply with the standards specified in the Contract.

130 Quality Control

The Contractor shall be responsible for his own quality control and shall provide sufficient competent personnel for supervising the Works, taking and preparing samples and for carrying out all necessary tests.

131 Units

The International System of (metric) Units as set out in ASTM E380 shall be used throughout the Contract except where otherwise provided.

132 Inspection and Testing during Manufacture

The performance of each item of Plant or Pipe shall be tested in accordance with the Specification to the requirements of the Project Manager.

Test certificates in triplicate shall be submitted by the Contractor to the Project Manager within 2 weeks of the date of the tests. Type tests are not acceptable. Test certificates shall be supplied for tests carried out on the actual Plant being supplied.

Plant shall not be dispatched from the manufacturer's works until it has passed the specified tests and approval been given by the Project Manager.

The Project Manager shall at his discretion witness tests of individual items of Plant at the manufacturer's works. The Project Manager shall be given three weeks' notice in writing before such tests are to take place.

The acceptance by the Project Manager of any item of Plant or equipment after testing at the manufacturer's works shall in no way relieve the Contractor of his responsibility for the correct performance.

Section 2 Earthworks, Backfilling and Restoration

201 Conditions of Site

Before carrying out work on any Site, the Site shall be inspected by the Contractor in conjunction with the Project Manager to establish its general condition which shall be agreed and recorded in writing and by means of digital photography.

Details recorded shall include the location of all boundary and survey beacons, the condition of buildings, surface, terracing (if any), ditches, watercourses, roads, tracks, fences and other information relating to the Site and elsewhere which may be affected by the works.

In the case of way leaves for pipelines the boundaries of the way leave will be defined by the Employer and the contractor shall where directed provide erect and maintain in position, from commencement to the final completion of the Works, in every section substantial timber stakes or similar approved markers not less than 1.5 m high indicating the position of the boundary at 100m or other such intervals as the Project Manager may direct. In the event of any boundary or survey mark established for the purpose of land title being disturbed or displaced the Contractor shall forthwith replace the beacon. Where necessary the Contractor shall employ the services of an approved licensed surveyor for the purpose of setting out boundaries.

202 Site Clearance and Topsoil Removal

Site clearance shall be carried out over the areas to be occupied by the Permanent Works before beginning excavation or filling or other work, and shall include the clearance of all trees, stumps, bushes and other vegetation and the removal of all boulders between 0.01 and 0.2m³ volumes. Boulders located within 1m of any pipe centreline shall be removed where directed by the Project Manager.

Before beginning clearance in any area the Contractor shall give seven days written notice of his intention to the Project Manager who will determine the extent and limits of such clearance.

Topsoil shall mean the surface layer of soil which by its humus content supports vegetation and is unsuitable, as a formation to roads and concrete structures or as a backfill or bedding material. The extent and depth of topsoil that needs removal shall be agreed with the Project Manager. Topsoil shall be set aside for re-use or disposal as directed by the Project Manager.

Trees to be removed shall be uprooted or cut down as near to the ground level as possible. Bushes, undergrowth, small trees stumps and tree roots shall, where directed by the Project Manager, be grubbed out. All holes left by the stumps or roots shall be backfilled with suitable material in a manner approved by the Project Manager.

The Project Manager may require that individual trees, shrubs and hedges are preserved; the Contractor shall take all necessary precautions to prevent their damage.

In the case of wayleaves for pipelines and the like, the Contractor shall preserve as far as practicable all grass and other vegetation outside the limits of trenches and permanent works and shall not necessarily destroy crops or any vegetation whose removal would not be essential to his operations.

203 Erosion

The Contractor shall take care at all times to prevent erosion on every site and elsewhere on land which may be affected by his operations and the Project Manager may impose such reasonable limitations and restrictions upon the method of clearance and upon the timing and season of the year when clearance is carried out as the circumstances warrant.

204 Ground Levels

Before commencement of any earthworks or demolition the sites shall be surveyed, as necessary, in conjunction with the Project Manager to establish existing ground levels. These agreed ground levels shall form the basis for the calculation of any subsequent excavation and

filling.

205 Trial Holes

The Contractor shall excavate refill and restore in advance of his programme such trial holes as he may require for determining the nature of the subsoil and the location of existing underground services and obstructions.

206 Excavation Generally

Excavations shall be made in open cutting unless tunnelling or heading is specified or approved by the Project Manager and shall be taken out as nearly as possible to exact dimensions and levels so that minimum of infilling will afterwards be necessary. The Contractor shall ensure the stability and safety of excavations and shall take all measures necessary to ensure that no collapse or subsidence occurs.

Except where described in the Contract or permitted under the Contract excavation shall not be battered. The sides of all excavations shall be kept true and shall where necessary be adequately supported by means of timber, steel or other type struts, walling, poling boards, sheeting, bracing and the like.

Excavations shall be kept free from water and it shall be the Contractor's responsibility to construct and maintain temporary diversion and drainage works and to carry out pumping and to take all measures necessary to comply with this requirement.

In the event of soft or otherwise unsuitable ground being encountered at formation level or if the formation is damaged or allowed to deteriorate the Contractor shall forthwith inform the Project Manager, shall excavate to such extra depth and refill with compacted granular or other approved fill or C15 concrete (minimum compressor strength 15N/mm²) as the Project Manager may require. With respect to the side face of any excavation against which concrete or other work will be in contact the Project Manager may require that the net dimensions of the work be increased.

The Contractor shall be responsible for the disposal of Surplus excavated material off site, which shall be to a location approved by the Project Manager. No excavated material suitable for re-use shall be removed without the approval of the Project Manager.

The Contractor shall not deposit excavated materials on public or private land except where directed by the Project Manager or with the consent in writing of the relevant authority or of the owner or responsible representative of the owner of such land and only then in those places and under such conditions as the relevant authority, owner or responsible representative may prescribe.

207 Excavation in Excess

If any part of any excavation is in error excavated deeper and/or wider than is required the extra depth and/or width shall be filled with Grade C15P concrete or compacted granular or other approved fill to the original formation level and/or dimensions as the Project Manager directs.

In pipe trenches where the pipe is not bedded on or surrounded with concrete, excess excavation shall be filled with compacted granular material. Excess excavation in rock trenches shall be filled with concrete (15N/mm² compressive strength) up to 150mm below the pipe invert.

208 Mechanical Excavation

Mechanical excavation shall be employed only if the subsoil is suitable and only in such manner which will allow adequate support of the excavations. The Contractor shall ensure that there are no pipes, cables, mains or other services or property which may be disturbed or damaged by its use.

209 Excavation for Pipelaying

The width of trench excavation shall be the minimum required for efficient working after allowance has been made for any timbering and strutting, and shall not exceed the widths described in the Contract. At any one spread the maximum length of open trench shall not,

without the prior approval of the Project Manager, exceed 100 metres.

Trenches in rock for pipes up to 100mm bore shall be excavated to provide a minimum clearance of 100 mm around the outside of the pipe and joints. For pipes exceeding 100mm bore the minimum clearance shall be increased to 150mm.

Where the trench is in rock or rocky ground the Contractor shall excavate the pipe trench to a depth of 150mm below the invert of the pipe and refill with compacted granular fill.

The materials for re-use excavated from trenches shall be stockpiled at the sides of the trench except where this would obstruct any road or footpath and prevent the passage of traffic or pedestrians. In such cases the Contractor shall excavate the trench in such lengths and stockpile the excavated materials at such places as the Project Manager may require.

Where excavation for pipe laying is carried out behind thrust blocks on existing pipelines the Contractor shall provide adequate support arrangements to transfer thrusts to the surrounding ground.

210 Headings

Excavation for pipes in heading shall be carried out to the approval of the Project Manager and to dimensions which will permit a proper inspection to be made. The heading shall be properly and securely timbered. The pipe shall be laid on a minimum thickness of 150mm of concrete. After the pipe has been laid, jointed and tested the heading shall be filled in short lengths not exceeding 1 metre with Grade C15P concrete or as directed. The heading shall be completely filled with concrete and hard filling shall then be rammed into the concrete at the crown of the heading.

Special precautions shall be taken to prevent a slump in the concrete and to ensure that no slips or falls of the heading or in the ground above or in the shafts can take place.

211 Excavation for Foundations of Structures

The Contractor shall give sufficient notice to the Project Manager to enable him to inspect and approve foundations in advance of placement of the permanent works. The Project Manager may withdraw his approval if work is not commenced within 48 hours or the formation is subsequently allowed to deteriorate.

If the Project Manager directs a bottom layer of excavation of not less than 75mm thickness shall be left undisturbed and subsequently taken out by hand immediately before concrete or other work is placed.

Formations which are to receive concrete blinding or a drainage layer shall be covered with such blinding or layer immediately the excavation has been completed, inspected and approved by the Project Manager.

Surfaces against which permanent works are to be placed shall be kept free of oil, water, mud or any material.

No concrete or other materials shall be placed until formations have been approved. Adequate notice shall be given to the Project Manager to enable him to examine the formation.

212 Rock Surfaces under Concrete Structures

212.1 Concrete Placed Directly on Rock

Rock under concrete structures shall be prepared by picking, barring and wedging or other methods which will leave the rock in as sound a condition as may reasonably be expected according to the rock quality.

Rock surfaces shall be thoroughly cleaned by compressed air and water jet or such means as

the Project Manager my direct before concrete is placed.

212.2 Concrete Placed on Capping Layer

Where instructed the rock excavation shall be taken down to a depth of 1.0m below the underside of the structure and the excavation backfilled with capping materials to the required formation level. Capping material shall be granular material. The material shall be compacted in 150mm layers to achieve a density of not less than 95% maximum dry density at optimum moisture content + 5% to 2% as determined by the BS heavy compaction tests to BS 1377.

213 Explosives

The Contractor shall at all times take every possible precaution and comply with the Explosives Laws of Kenya and regulations relating to the handling, transportation, storage and use of explosives and shall at all times when engaged in blasting operations post sufficient warning flagmen to the full satisfaction of the Project Manager's Representative.

The Contractor shall also provide a special proper store for explosives in accordance with local regulations and shall provide experienced men with valid blasting licences, for handling explosives to the satisfaction of the Project Manager and the authorities concerned.

The Contractor shall at all times make full liaison with and inform well in advance and obtain such supervision and permission as is required from the Police and all Government Authorities, public bodies and private parties whosoever concerned or affected by blasting operations.

Blasting shall only be carried out on those sections of the Works for which permission in writing shall have been given by the Project Manager and the relevant authorities and shall be restricted to such hours and conditions as may be prescribed. Blasting within 10 metres of existing water mains will not be permitted.

Blasting shall be carried out so as not to weaken existing structures or the foundations or ground adjacent to the existing and proposed works. The Contractor shall take all necessary precautions to prevent loss, injury or accident to persons or property and shall be entirely liable for any accident or damage that may result from the use of explosives.

The Contractor shall submit to the Project Manager for his approval a method statement including details of the intended drilling patterns, depths of holes, the amounts of explosives at each location and the method or sequence of setting off that he proposes to use.

214 Excavated Materials Suitable for Re-use

In so far as they are suitable and comply with the Specification, materials arising from excavations shall be re-used in the Works.

During excavation, the Contractor shall ensure that all material suitable for re-use are kept separate and set aside and protected as necessary to prevent loss or deterioration.

The materials forming the surface and foundations of roads, road verges, tracks and footways shall when excavated, and if required for further use, be carefully separated. All hard materials shall be kept free from soil or other excavated materials.

During excavation of pipe trenches the Contractor shall ensure that all granular or other approved material suitable for filling around and over pipes shall be kept separate and re-used for this purpose.

Paving slabs, bricks and similar surfaces shall be carefully removed and stacked. Prior to the commencement of excavation the number of badly broken and unsuitable paving slabs, bricks etc. on the line of the excavations shall be agreed with the Project Manager.

In verges and other grass surfaces the grass and top soil shall be stripped and separately stacked.

215 Backfilling of Excavations

Backfilling shall be thoroughly compacted in layers not exceeding 150mm compacted thickness and by means which will not damage the Works.

Backfilling of reinforced concrete structures shall be with suitable material approved by the Project Manager.

“Granular material” as backfill is defined as unconsolidated quarry dust, gravel, sand or similar in which the clay or silt content is not predominant. The use of angular crushed stone shall not be permitted.

216 Pipe Beddings

Unless otherwise specified granular material for beddings shall consist of aggregate to BS EN 12620 and shall conform to the following grading.

Pipe Nominal Diameter (mm)	Max Size (mm)	Grading (mm)
<50	sand	N/A
50	10	10 single-size
80	10	10 single-size
100	10	10 single-size
150	15	10 or 14 single-size or 14 to 5 graded
200 to 500	20	10, 14 or 20 single-sized or 14 to 5 graded or 20 to 5 graded
>500	40	10, 14 20 or single-size crushed rock or 14 to 5 graded or 20 to 5 graded or 40 to 5 graded

Granular bedding material where specified shall have a Compaction Fraction not greater than 0.3 as ascertained by the test method described below.

Aggregates for flexible pipes shall consist of sub-rounded or rounded material which will not cause damage to or penetrate the pipe material.

Sand bedding material shall consist of approved local sand which material shall have a Compaction Fraction ascertained by the test method described below of not greater than 0.3.

Class A bedding shall consist of Grade C15P concrete bed and surround.

Class A1 bedding shall comprise a 120 degrees cradle of Grade C15P insitu un-reinforced concrete under the pipe with selected backfill material to a depth of 300mm above the crown of the pipe.

Class B bedding shall comprise a 180 degrees bed of single-size granular material in

accordance with the above table, with selected backfill material to a depth of 300mm above the crown of the pipe.

Class S bedding shall comprise a complete surround of granular material in accordance with the above table to a depth of 150mm above the crown of the pipe.

Class D bedding shall comprise a hand-trimmed natural bottom to the trench with selected backfill material placed around and over the pipe to a depth of 300mm above the crown of the pipe.

Granular bedding and selected backfill material, placed around and to a thickness of 300mm above the crown of the pipes shall be placed simultaneously on both sides of the pipe in layers not exceeding 150mm thickness and compacted by the use of hand rammers taking particular care to compact the material under barrel of the pipe and around joints.

In trenches where there is a continuous accumulation of groundwater, the trench shall after obtaining the approval of the Project Manager, be over-excavated by 150mm and shall be backfilled using compacted granular material in accordance with the above table.

If the quantity of suitable material which can be obtained from the excavations is insufficient, the Contractor shall either screen the excavated material or transport suitable material from other excavated or borrow pits on the Site. In cases where insufficient material exists on the Site, the Contractor shall import suitable material after obtaining the written approval of the Project Manager.

217 Compaction Fraction Test

217.1 Apparatus required:

- 1) Open-ended cylinder 250 mm long and 150mm \pm 5mm internal diameter (150mm diameter pipe is suitable);
- 2) Metal hammer with striking face 38 mm diameter and weighing 1 kg.
- 3) Rule.

i) 217.2 Method

Obtain a representative sample, more than sufficient to fill the cylinder (viz. about 10kg). It is important that the moisture content of the sample should not differ from that of the main body of material at the time of its use in the trench.

Place the cylinder on a firm flat surface and gently pour the sample material into it, loosely and without tamping. Strike off the top surface level with the top of the cylinder and remove all surplus material. Lift the cylinder up clear of its contents and place on a fresh area of flat surface. Place about one quarter of the material back in the cylinder and tamp vigorously until no further compaction can be obtained. Repeat with the second quarter, tamping as before, and so on for the third and fourth quarters, tamping the final surface as level as possible.

Measure down from the top of the cylinder to the surface of the compacted material. This distance in millimetres divided by the height of the cylinder (250mm) is the Compaction Fraction of the material under test.

To obtain a representative sample about 50kg of the proposed material should be heaped on a clear surface and divided with the spade down the middle into two halves. One of these should then be similarly divided, and so on until the required weight sample is left.

218 Selected Backfill Material

Backfill in contact with the pipes shall be selected material and shall not contain large stones, rocks, tree roots or similar objects which through impact or by concentrating imposed loads might damage the pipes. The material shall be capable of being compacted without the use of heavy rammers and should be free of clay lumps or other material larger than 75mm or stones

larger than the maximum particle size specified for pipe bedding.

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219 Backfilling of Pipe Trenches

The trench above pipe bedding level (300mm above the crown of the pipe) shall be filled with the approved back fill material obtained from the trench excavations, free from clay lumps, boulders and rock fragments larger than 150mm.

If the quantity of material which can be obtained from the pipe trench excavation is insufficient, the Contractor shall either screen the excavated material or transport suitable material from other excavations or borrow pits on the Site. In cases where insufficient material exists on the Site, the Contractor shall import suitable material after obtaining the written approval of the Project Manager.

The material shall be placed in layers not exceeding 150mm thickness and compacted by the use of rammers to achieve a density of not less than 95% maximum density at optimum moisture content +5% to -2% as determined by the BS Heavy Compaction Test to BS 1377.

For trenches in fields and open areas where agreed by the Project Manager the trench backfill shall be compacted to obtain a density of not less than 85% maximum dry density at optimum moisture content +5% to -2% as determined by the BS Heavy Compaction Test to BS 1377.

The density of the compacted fill shall be determined by the Contractor using the "sand replacement" method as directed by the Project Manager.

Before backfilling trenches the Contractor shall obtain approval from the Project Manager of the methods he proposes to use and shall demonstrate by means of tests that the specified compaction can be achieved. The method of compaction shall at all times be to the approval of the Project Manager.

Where ground water conditions are such that the bedding material would be likely to act as a carrier for ground water from higher or lower ground, the Project Manager may instruct flow barriers of suitable selected earth or concrete to be inserted in lieu of bedding material. Such barriers to be erected at reasonable intervals close to flexible joints in the pipe.

220 Making Good Subsidence after Backfilling

Backfilling, whether in foundations or in pipe trenches, shall be thoroughly compacted by ramming and any subsidence due to consolidation shall be made up with extra compacted material.

Should subsidence occur after any surface reinstatement has been completed the surface reinstatement shall first be removed, the hollows made up, and then the surface reinstatement re-laid.

Any subsidence that occurs adjacent to the Site of the Works which is attributable to the Contractor's activities shall be reinstated to the full satisfaction of the Project Manager.

221 Removal of Timbering from Excavations

Timbering shall be removed from the excavations before or during the process of backfilling except in so far as this removal of timber would be likely to cause damage to adjacent property, structures or structure foundations in which event the Contractor shall leave in the excavation such timbering as he considers necessary or as may be ordered by the Project Manager.

222 Reinstatement of Surfaces

All surfaces whether public or private that are affected by the Works shall be reinstated temporarily in the first instance and when the ground has consolidated fully the Contractor shall reinstate the surfaces permanently.

Temporary reinstatement and permanent reinstatement of all surfaces, affected by the operations of the Contractor shall be carried out and maintained to the satisfaction of the Project Manager and the responsible authority or owner.

Temporary reinstatement shall be carried out immediately the trenches are backfilled. Permanent reinstatement shall not be carried out until the ground has consolidated completely. The Contractor shall inform the Project Manager before carrying out this work. In the event of further settlement occurring after completion of the permanent reinstatement the Contractor shall forthwith make good the reinstatement to the approval of the Project Manager or responsible authority.

For the purpose of temporary and permanent reinstatement in bitumen and surfaced roads the surface

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width of trenches shall be increased by 150mm on each side of the trench for a depth of 75mm to provide a solid abutment for the surfacing material.

Reinstatement of surfaced roads shall be carried out to the approval of the relevant authority. The responsible authority shall have the right to carry out permanent reinstatement at the Contractor's expense.

Trenches in open ground shall be reinstated to the condition in which the ground was before excavation was commenced. The final surface of the trench shall be flush with the surrounding ground.

In verges and other grass surfaces and after the backfilling had been thoroughly consolidated the topsoil shall be re-laid rolled and planted with grass or other vegetation as directed by the Project Manager as may be necessary and watered until the grass has become well established. Should the planting fail it shall be replanted as required until satisfactory growth is obtained. If at any time any reinstatement deteriorates the Contractor shall restore it to a proper condition immediately.

Should the Contractor not remedy the defect to the Project Manager's satisfaction forthwith any remedial work considered necessary may be undertaken by the Employer and/or the responsible authority at the Contractor's expense.

All trees, shrubs and plants shall be carefully transplanted and shall be returned to their original location after the refilling of the excavations. Return of old or mature trees may be waived in cases where the age of the tree makes return impracticable, and approved tree seedlings shall be planted in their place. Topsoil shall be carefully set aside and replaced at the surface of the backfilling.

The trenches shall be refilled and rammed solid as specified in the Contract and shall not be topped up above the original surface level to allow settlement.

If any trench becomes dangerous the Project Manager may call upon the Contractor for its reinstatement at three hours' notice and failing this to have the work done by others at the Contractor's expense.

In the case of footpaths the trench shall be refilled and rammed as specified to within 125mm of the surface. A foundation layer of 100mm compacted thickness of approved crushed limestone shall then be laid and compacted. The surface shall be cleaned and primed and the footpath surfacing shall be temporarily reinstated with 25mm compacted thickness of 14 mm nominal size dense wearing course macadam laid and compacted so as to achieve a dense, smooth and even course surface using a roller of 750 to 3000kg mass. Any kerbs shall be reinstated to their original condition.

The trench surface shall be thus maintained until the end of the Period of Maintenance or permanent reinstatement is ordered by the Project Manager. Where permanent reinstatement is ordered by the Project Manager the temporary surface and part of the foundation shall be removed to 50mm depth to permit the construction of a tiled or paved surface to match the original surface. An approved tiled or paved surface shall then be laid and bedded on sand or mortar to an even finish.

223 Safety of Excavations in Roads

Where the surface of the road (other than that which lies immediately above the trench) is damaged either by the concentration of traffic caused by an open trench, by subsidence or other causes arising from the operations of the Contractor, he shall permanently reinstate the whole of the surface so damaged to its original condition.

The Contractor shall ensure that trenches and reinstatement are maintained in a safe condition and shall take immediate action to remedy any deterioration which renders the works unsafe. If in the opinion of the Project Manager any excavation or reinstatement is in a dangerous condition the Contractor shall immediately remedy the defect. Should the Contractor fail to carry out the reinstatement promptly the work any be carried out by others at the Contractor's expense.

224 Temporary Reinstatement of Asphalted Roads

In all asphalted or bitumen sprayed roads the trenches shall be refilled and compacted to the underside of the original road surface. A sub-base layer shall then be laid consisting of approved free drainage granular material conforming to the following grading limits:

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100% by weight passing 50mm sieve 75-
95 by weight passing 25.4mm sieve 40-75
by weight passing 9.51mm sieve 30-60 by
weight passing 4.75mm sieve 20-45 by
weight passing 2.0mm sieve 15-30 by
weight passing 425mm sieve 5-15 by
weight passing 72mm sieve.

A base layer shall then be laid consisting of approved crushed limestone material conforming to the following grading limits.

100%	by weight	passing 50mm sieve
60% - 80%	by weight	passing 20mm sieve
25% - 40%	by weight	passing 5mm sieve

The materials shall have a plasticity index of not exceeding 6%. The materials forming the sub- base and foundation shall be laid in layers, brought to optimum moisture content and compacted to 95% of the maximum dry density as determined by Part 4 Clauses 3.3/3.4 BS 1377:1990.

Prior to application of the temporary reinstatement the surface of the road foundation shall be cleared of all dust, debris and other deleterious matter and shall then be primed with one application of prime coat MC-70 or similar approved. All joints with adjacent road surfacing shall be cut straight and vertical and primed.

The road surfacing shall be temporarily reinstated with 25mm finished thickness of asphaltic concrete. The asphaltic concrete shall be laid and compacted so as to achieve a dense smooth and even surface using a roller of not less than 12 tonne mass.

The surface shall be maintained until the end of the period of Maintenance or until instructions are given for the permanent reinstatement to be carried out. The surface shall not be topped up above the original surface level to allow for settlement.

225 Temporary Reinstatement of Unmade Roads

In all unmade roads the trenches shall be refilled and compacted as specified in the Contract to within 150mm of the surface.

The trench shall be surfaced with 150mm compacted thickness of base layer material as

specified above.

The surface shall be maintained until the end of the Period of Maintenance and shall not be topped up above the level of the original surface to allow for settlement.

226 Permanent Reinstatement of Asphaltic Roads

Where instructions are given that permanent reinstatement is to be carried out then the temporary asphaltic concrete surface and part of the foundation layer shall be removed to a minimum depth of 200mm and the surface of the foundation shall be rolled, all dust and debris removed, joints cut straight and vertical.

The permanent reinstatement shall comprise crushed limestone material to a total compacted thickness of 150mm and the wearing course 50mm compacted thickness of 14 mm nominal size dense wearing course asphaltic concrete. The laying and finishing of the coated macadam shall be carried out so as to achieve a dense, smooth and even surface using a roller of not less than 12 tonnes mass.

227 Forming Banks and Filled Areas

The filling to be used in the embankments and filled areas shall be material selected from that arising from surplus excavation (unless otherwise defined in the Particular Specification), the material being placed according to its nature as shall be directed by the Project Manager. The fill shall be placed in layers not exceeding 150mm thick, each layer being thoroughly compacted by an approved roller to the satisfaction of the Project Manager.

228 Restoration of Borrow Areas, Spoil Tips and Quarries

Any spoil tips, quarries or other borrow area developed by the Contractor for the purpose of the Works shall be finished to safe and fair slopes to the approval of the Project Manager.

229 Top soiling and Grassing

Where required surfaces shall be soiled with fine sifted soil or silt not less than 100 mm compacted thickness which shall be raked and brought to a fine tilth.

Surfaces required to be grassed shall be planted with approved local grass at a spacing of 200mm x 200mm. The grassed area shall be replanted if the first or subsequent operation is unfruitful or if for any reason the grass is destroyed. Grassed areas shall be watered and attended until the grass has become well established.

The soiling and planting of the grass in slopes shall be carried out immediately the slope is formed and the grass shall be kept weeded and cut until the work is accepted at the time of the Certificate of Completion.

The Contractor shall supply attendance during the Defects Liability Period to ensure that all planted grass is kept weeded and cut, and if necessary watered.

230 Free Draining Fill

Free draining fill for use as backing to wall shall consist of sound hard stone or broken rock or concrete derived from demolition of structures. The particles shall be roughly cubiform and shall be between 75mm and 25mm in size. All smaller particles, Dust, rubbish and organic matter shall be excluded.

231 Hardcore

Hardcore shall consist of sound hard stone or broken rock or concrete derived from excavations or demolition of structures and shall be graded from 150mm to 50mm in size, except that sufficient but not excessive blinding materials of smaller sizes may be permitted at the discretion of the Project Manager.

Section 3. Concrete Works – General

301. Scope

The standard of materials and of workmanship shall not be inferior to the recommendations of the current:

- (a) British Standard Code of Practice BS 8110)
The Structural Use of Concrete
)
Or
)
Whichever is applicable to the particular structures
- (b) British Standard Code of Practice BS 8007 Design of
concrete structures for Retaining
Aqueous Liquids
)
)
- (c) Appropriate British Standards
- (d) Approved Kenyan Standards
Or
- (e) Other equivalent and approved international standards

The requirements outlined in the above documents must be read with those of this Section of the Specification and where any conflict exists between the recommendations of the above and of this Specification, the requirements of the Specification shall prevail. As and when required by the Project Manager the Contractor shall prepare and submit, before commencing the work, a time chart (additional to the general programme) detailing the various operations for concrete work.

No material shall be used in the Works until prior approval for its use has been given by the Project Manager; neither shall any change in the nature, quality, kind, type, source of supply or manufacture be made without the Project Manager's permission.

Names of manufacturers and test certificates for materials not supplied by the Employer shall be supplied as soon as possible to the Project Manager.

The cost of providing samples and the cost of carrying out tests required by Clause 306 (except as otherwise provided in the Conditions of Contract) together with the cost of supplying equipment for sampling and site testing indicated in columns 3 and 4 of Table 3.8 of this Section of the Specification shall be borne by the Contractor.

During the progress of the Works, consignment notes for materials not supplied by the Employer shall be supplied to the Project Manager giving details of each consignment.

The Contractor shall provide all samples required by the Project Manager as soon as possible after contract award. No deliveries in bulk shall be made until the samples are approved by the Project Manager. All condemned material shall be removed from the site within 24 hours.

A competent person approved by the Project Manager shall be employed by the Contractor whose duty will be to supervise all stages in the preparation and placing of the concrete. All cubes shall be made and site tests carried out under his direct supervision, in consultation with the Project Manager.

All materials which have been damaged, contaminated or have deteriorated or do not comply in any way with the requirements of these Preambles shall be rejected and shall be removed immediately from the site at the Contractor's expense. No materials shall be stored or stacked on suspended floors without the Project Manager's prior approval.

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The use of the word "approved" in this Specification refers to the approval of the Project Manager or his delegates.

Cross-references between certain clauses of this Specification have been shown in brackets following the particular item.

302 Concrete

ii) 302.1 Requirements

The mix proportions shall be selected to ensure that the workability of the fresh concrete is suitable for the conditions of handling and placing, having regard to the structural element being constructed, the disposition of reinforcement, and taking full account of the environment to which it will be subjected.

The minimum cement contents and maximum water/cement ratios of designed mixes shall be as given in Table 3.1.

The maximum cement content in any mix shall not exceed 425 kg/m³ for normal structures and 500 kg/m³ for liquid retaining structures.

In all cases of mix proportioning, the added water shall be included with due allowance for the moisture contained in the aggregates and shall be the minimum consistent with the workability requirements.

Table 3.1 Minimum Cement Contents

Normal Conditions

Type of Structural Element	Exposure Conditions (BS 8110)	Minimum Cement Content (kg/m ³)	Maximum Aggregate Size	Maximum Water/Cement Ratio

Additional Requirements when Exposed to Sulphate Conditions (All Structural Concrete)

Concentration of Sulphates (expressed as SO ₃)		Minimum Cement Content (kg/m ³) Maximum Aggregate Size				Maximum Water/Cement Ratio
In soil (Total SO ₃)	In ground water Parts per 100,000	Type of Cement	40 mm	20 mm	10 mm	
≤ 0.2	≤ 30	No Special Precautions				-
0.2 - 0.5	30 - 120	OPC or CEM1,II or IV per KS1725	300	330	370	0.50
		SRPC	250	280	320	0.55
0.5 - 1.0	120 - 250	OPC or CEMI, II or IV per KS1725	Not permitted			-
		SRPC	300	330	370	0.50

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1.0 - 2.0	250 - 500	OPC or CEMI, II or IV per KS1725	Not permitted			-
		SRPC	340	370	410	0.45
□□2.0	□□500	SRPC	Ditto but with protective coating			0.45

OPC - Ordinary Portland Cement
 SRPC - Sulphate Resisting Portland Cement

302.2 Strength

The characteristic strength of concrete means that value of the 28-day cube strength below which 5% of all possible test results would be expected to fall.

The relationship between grade of the concrete and its characteristic strength shall be as given in BS 5328. The grade of concrete to be used in particular locations shall be as given in Table 3.2 unless noted otherwise on the drawings.

iii) Table 3.2 Concrete Strength Requirements

Location	Maximum Coarse Aggregate Size (mm)	Grade of Concrete (BS 5328)
Blinding Concrete - General Structures - Liquid Retaining Structures	20 or 40 20	C15P
Blinding Concrete - Sulphate Condition	20	C20P
Substructure thickness less than 400 mm	20	C25D
Substructures, walls and slabs more than 400 mm	20 or 40	C25D
Superstructures, Normal Concrete	20	C25D
Liquid Retaining Structures	20	C30D
Fine Concrete	10	C25D
Precast Concrete	10 or 20	C30D

In the above table suffix P means a prescribed mix, D means a designed mix and A means a design mix complying with the requirements of BS 8007.

302.3 Mixes

(a) Designed Mixes

Proportions shall be determined in accordance with the "Design of Normal Concrete Mixes" published by the United Kingdom Department of The Environment and obtainable from:-

Building Research Establishment and Bookshop Garston
Watford
WD2 7JR
ENGLAND

Tel: +44 1923 894040

Fax: +44 1923 664010

Or other approved methods, for the requirements set out in this Specification.

For the purpose of determining the design mean strength of the concrete a margin shall be added to the characteristic strength for the particular grade of concrete. This design margin shall be assessed on the degree of control reasonably to be expected in the manufacture of the concrete and shall neither be less than 5.0 N/mm² nor less than 1.64 times the standard deviation. Until such time as the standard deviation has been assessed the margin shall be not less than 7.5 N/mm².

Details of the designed mixes shall be forwarded immediately to the Project Manager for his approval.

(b) Prescribed Mixes

Proportions for the several grades of concrete shall conform to the requirements of Tables 3.3 and 3.4.

(d) Chloride Content

The total chloride content of the concrete mix shall comply with the requirements of BS 8500: Part 2: Section 5

302.4 Quality Control

The principal basis of control shall be by comparison of the results of the compression cube tests at 28 days, except for small quantities of concrete whose strength can be otherwise derived and which is permitted for use by the Project Manager. 40 sample cubes shall be made initially in eight samples each day for five days of concreting and thereafter one sample per 25 m³ of concrete but not less than one sample for each day's concreting.

Where materials are of an unfamiliar grading or type, compression cube tests shall be carried out at 7 days and adjustments made in advance of the main control methods outlined above.

Cube test results will be examined individually in 10 consecutive sets of four and the standard deviation and mean strength of each set calculated. The concrete mix proportions will only be acceptable if all of the following requirements are complied with: -

- (i) Not more than two results in 40 are less than the characteristic crushing strength.
- (ii) No value of the average for any set of four results is less than the characteristic strength plus one-half of the design margin (Clause 302).
- (iii) When 40 results have been obtained and the mean strength and standard deviation are calculated, the mean strength minus 1.64 times the standard deviation shall be greater than the characteristic strength.

Where the results do not conform to the above requirements the following action shall be taken:-

- Adjustments to the mix shall be made to obtain the strength required.
- In the case where any result is less than 80% of the characteristic strength the structural implications shall be considered and action taken as ordered by the Project Manager (as provided for in Clause 305).

For those Prescribed Mixes required to be tested, requirements (i) and (ii) only will be applicable.

302.5 Production

Aggregates and cement shall be proportioned by weigh-batching, and water shall be proportioned by volume. Subject to the prior approval of the Project Manager volume-batching of aggregates may be used for small sections of works, but volume batching of cement will in no case be accepted. The Contractor may, however, so proportion the mix that each batch shall use a whole bag or bags of cement, the weight of which is known precisely. Where permission has been given for volume batching of aggregates, all gauge boxes shall be accurate and due allowance shall be made for the bulking of the aggregates in assessing the correct volume to be used.

The aggregates and the cement shall be thoroughly mixed in a clean mechanical mixer for a period of time agreed with the Project Manager and the water added on the basis of the

approved design.

The amount of water added shall conform to the requirements of Clause 302.

Batching mixing machines shall comply with the requirements of BS 1305. They shall be provided in such numbers and of such capacity as to ensure a continuous supply of freshly mixed concrete at all times during construction.

Target strength for trial mix = 1.3 x Characteristic Strength

Target strength for works = 1.2 x Characteristic Strength

Continuous mixing machines shall be used only with the written permission of the Project Manager.

Not less than 30 days prior to the installation of the Contractor's plant and equipment for processing, handling, transportation, storing and proportioning ingredients, and for mixing, transporting and placing concrete, the Contractor shall submit drawings for approval by the Project Manager, showing proposed general plant arrangements, together with a general description of the equipment proposed for use.

After completion of installation, the operation of the plant and equipment shall be subject to the approval of the Project Manager.

Where these Preambles, the Bills of Quantities or the Drawings require specific procedures to be followed, such requirements are not to be construed as prohibiting use by the Contractor of alternative procedures if it is approved by the Project Manager, prior to use of such alternatives.

Approval of plant and equipment or their operation, or of any construction procedure, shall not operate to waive or modify any provision or requirements contained in the Preambles governing the quality of the materials of the finished work.

APPENDIX TO INSTRUCTIONS TO TENDERERS

iv) **Table 3.3 Prescribed Mixes - Mass of Dry Aggregate to be Used With 100 kg of Cement**

Grade of concrete	Nominal maximum size of aggregate (mm)	40		20		14		10	
	Workability	Medium	High	Medium	High	Medium	High	Medium	High
	Range for standard sample (mm)	50-100	80-170	25-75	65-135	5-55	50-100	0-45	15-65
	Total aggregate	kg	kg	kg	kg	kg	kg	kg	kg
C7.5P		1080	920	900	780	N/A	N/A	N/A	N/A
C10P		900	800	770	690	N/A	N/A	N/A	N/A
C15P		790	690	680	580	N/A	N/A	N/A	N/A
C20P		660	600	600	530	560	470	510	420
C25P		560	510	510	460	490	410	450	370
C30P		510	460	460	400	410	360	380	320

N/A not applicable

v) **Table 3.4 Prescribed Mixes - Percentage by Mass of Fine Aggregate to Total Aggregate**

Grade of concrete	Nominal maximum size of aggregate (mm)	40		20		14		10	
	Workability	Medium	High	Medium	High	Medium	High	Medium	High
C7.5P } C10P } C15P }		30-45		35-50		N/A		N/A	
C20P } C25P } C30P }	Grading Zone 1	35	40	40	45	45	50	50	55
	2	30	35	35	40	40	45	45	50
	3	30	30	30	35	35	40	40	45
	4	25	25	25	30	30	35	35	40

N/A implies 'Not Applicable'

Notes on the use of Tables 3.3 and 3.4

NOTE 1. The proportions given in the tables will normally provide concrete of the strength in N/mm² indicated by the grade except where poor control is allied with the use of poor materials.

NOTE 2. For grades C7.5P, C10P and C15P a range of fine-aggregate percentages is given; the lower percentage is applicable to finer materials such as zone 4 sand and the higher percentage to coarser materials such as zone 1 sand.

NOTE 3. For all grades, small adjustments in the percentage of fine aggregate may be required depending on the properties of the particular aggregates being used.

NOTE 4. For grades C20P, C25P and C30P, and where high workability is required, it is advisable to check that the percentage of fine aggregate stated will produce satisfactory concrete if the grading of the fine aggregate approaches the coarser limits of zone 1 or the finer limits of zone 4.

302.6 Cement

Cement shall, as a minimum, meet the requirements of CEMI-32.5, CEMII-32.5 or CEMIV-32.5 in accordance with Kenya Standard KS 1725 Part 1 (Composition, Specifications and conformity criteria for common cements) and Part 2 (conformity Evaluation). Concrete for power floated floors shall as a minimum meet the requirements of CEMI-42.5, CEMII-42.5 or CEMIV-42.5.

Approval to the use of cement manufactured to the above standards or any other approved standards shall be subject to the Contractor demonstrating that the resulting concrete shall meet the strength requirements as given in the drawings and the relevant sections of the Concrete Specifications.

Pulverised-fuel ash shall have a maximum colour index of 6 (Colour comparator disc reference No. 296570) when measured using the Lovibond Colour Comparator system as recommended in BS 3892: Part 1 Appendix H, Clause H8.

Cement shall be fresh when delivered to Site and the consignments shall be used in the order of their delivery. The Contractor shall mark the date of delivery on each consignment and each consignment shall be stored separately and in such manner as to be easily accessible and identifiable.

No cement in bags or other containers shall be used unless these and the manufacturer's seals are

intact at the time of mixing.

If the cement is delivered in bags it shall be stored in a waterproof shed or building at a temperature of not less than 8°C and the bags shall be placed on dry boards above the floor to prevent deterioration or contamination from any cause.

Bulk cement may be used provided it is stored in an approved container.

The Contractor shall not use cement which has hardened into lumps, but subject to removal of the lumps by screening, the Project Manager may allow such cement to be used in non-structural concrete mixes.

Cement of different types shall be kept separate in storage and shall not be mixed together in the production of concrete.

302.7 Aggregates

The Contractor shall investigate the proposed aggregate sources in detail and shall submit a comprehensive report with technical information and data which shall include the following:

- (a) Location. Only Sources equipped with facilities adequate for the production of the materials as specified and in such quantities as shall be required for the prompt execution of the Contract shall be approved.
- (b) Petrology of sources and possible or likely variability during the Contract period.
- (c) Method of production
- (d) Schedule of available and proposed processed aggregates by size, including details of actual screen sizes to produce each aggregate.
- (e) Test data as applicable for each aggregate type and size based upon representative samples and tested in accordance with the appropriate British Standards.
- (f) A detailed statement of the aggregate proposed for use in each grade of concrete.

Samples of all aggregate, including fine aggregates and sand shall be submitted to the Project Manager for his approval. All samples shall be taken in accordance with BS 812 and shall weigh not less than the minimum weight indicated on Table 1 of that Standard.

The Contractor shall produce with each consignment or at intervals directed by the Project Manager a certificate signed by the Supplier, or other approved analyst, giving fully detailed chemical and physical properties of all aggregates together with a sieve analysis carried out in accordance with the appropriate British Standard.

Any changes in the particulars of the aggregates which occur during the course of the Contract must be notified to the Project Manager without delay.

The aggregates shall be stored on Site in separate stockpiles so arranged as to prevent the intermingling of the various aggregate sizes. The stockpiles shall be suitably protected to prevent contamination of the aggregates from the ground, rubbish or by leaves, dust or other windblown materials.

Aggregates shall conform to the requirements of "Acceptable Standards" of Table 3.8.

Building sand for mortar and similar uses and aggregates for concrete shall comply to BS 882 and shall be perfectly clean and free from all foreign matter and shall not consist of, nor contain argillaceous limestone or shells.

Where the nominal size specified exceeds 37.5 mm the grading shall be subject to the Project Manager's approval or in accordance with his directions.

Unless otherwise agreed with the Project Manager, single-sized aggregates shall be used in batching and mixing concrete.

The following impurities in both fine and coarse aggregates shall not exceed the limits stated in the following clauses.

The total chloride content of the concrete mix arising from the aggregate together with that from any admixtures and any other source, expressed as a percentage of chloride ion shall not in any circumstances exceed 0.1%.

Note: Marine aggregates and some inland aggregates contain chlorides. Both should be selected carefully and marine aggregates necessitate efficient washing to achieve the 0.1% chloride ion limit. Wherever possible, the total chloride content should be calculated from the mix proportions and the measured chloride content of each of the constituents.

Concrete made with some aggregates exhibit Alkali-Silica Reaction (ASR). This phenomenon is particularly detrimental in structures subject to wetting and their use will not be allowed in such structures.

Prior to acceptance of an aggregate as inert to alkali reaction the report of a qualified geologist, appointed by the Project Manager on the suitability or otherwise of materials shall be obtained following examination of all types of material that the proposed sources will yield during the course of the contract. The Project Manager may require that samples be taken from boreholes and if the contract extends over a long period then more than one report shall be obtained.

The Project Manager may order further tests to be carried out on the aggregates proposed by the Contractor for the structures in connection with this Contract before permission is given to use the aggregates proposed by the Contractor.

Where allowed by the Project Manager to use reactive or potentially reactive aggregates in certain structures the Contractor shall take all suitable measures to prevent deterioration of concrete due to alkali-silica reaction. Such measures shall include the use of cement with an acid soluble equivalent of sodium oxide content ($\text{Na}_2\text{O} + 0.658\text{K}_2\text{O}$) of less than 0.6%. The reactive alkali content of the concrete mix shall in no circumstances exceed 3 kg/m³.

The Alkali-Silica Reaction (ASR) in hardened concrete is also affected by the water-cement ratio. Therefore, where ASR aggregates are used, with the permission of the Project Manager, the water-cement ratio shall be kept to a minimum (in the region of 0.4).

Aggregates required for use in the construction of concrete water retaining, water excluding and other similar structures shall have a low drying shrinkage and the water absorption shall not exceed 3%.

The absorption of the aggregates shall be measured in accordance with BS 812, Part 2.

Aggregates of rounded shape or otherwise capable of producing a concrete of good workability with the minimum addition of water shall be preferred.

Dust or flour resulting from crushing the aggregate shall not be allowed to contaminate the stockpiles. When, in the opinion of the Project Manager such contamination has taken place it shall be removed by an approved means or otherwise the aggregate shall be rejected.

For mass concrete, in order to improve the consistency of the mix, dust or flour resulting from crushing the aggregate, which may be subjected to test, be included in controlled quantities to supplement the fine aggregate.

Except where aggregates have been otherwise specified on the Drawings the grading of aggregates shall be as follows:

- (i) Coarse Aggregate:
 - (a) 10 mm max. size, graded, for all "fine" concrete.
 - (b) 20 mm max. size, graded, for all reinforced concrete in beams and for walls and slabs not greater than 400 mm thick.
 - (c) 40 mm max. size, graded, for all reinforced concrete walls and slabs in excess of 400 mm thick.
- (ii) Fine Aggregate:
 - (a) Where aggregates conforming to Zones 2 or 3 of BS 882 are available they shall be used.
 - (b) For Prescribed Mixes, Zones 1, 2, or 3 aggregates only shall be used.

Fine and coarse aggregates shall be as defined by and be of the quality and nature required by BS 882. In addition they shall be chemically inert to alkali reaction.

302.8 Water

The Contractor shall supply all water, make all arrangements and pay all charges in respect of such supply. Where water can be obtained from a public water supply it shall be used.

Where water cannot be obtained from a public supply it shall be tested in accordance with BS 3148 and if necessary shall be treated to assure compliance therewith.

Water for washing and curing shall be such that it will impair neither the strength of the finished concrete nor its appearance.

302.9 Admixtures

(i) General : The quantity and method of using admixture's shall be in accordance with the manufacturer's recommendations and in all cases shall be subject to the approval of the Project Manager. Unless otherwise specified or approved by the Project Manager, an admixture shall comply with one of the following :-

BS 1014 (Pigments for Portland cement and Portland cement products). BS 5075

(Concrete admixtures except chloride based admixtures).

In all cases the Contractor shall provide the following information for the Project Manager's approval :-

- (a) the quantity to be used, in kilograms per kilogram of cement and in kilograms per cubic metre of concrete;
 - (b) the detrimental effects caused by adding a greater or lesser quantity in kilograms per cubic metre of concrete;
 - (c) the chemical name (s) of the main active ingredients;
 - (d) whether by the Project Manager, the Contractor shall demonstrate the action of an admixture by means of trial mixes.
- (ii) Calcium chloride. The use of calcium chloride in any form is prohibited.

302.10 Control of Alkali-Silica Reaction

The risk of cracking and expansion due to alkali-silica reaction shall be minimised by compliance with the specification and guidance notes set out in Technical Report No. 30 of the Concrete Society, Riverside House, 4 Meadows Business Park Station Approach, Blackwater, Camberley, Surrey, GU17 9AB Fax: +44 (0) 1276 607141, Website: www.concrete.org.uk.

303 Reinforcement

303.1 Steel

Reinforcement shall be:

- (a) Plain round mild steel or High Yield steel bars conforming to BS 4449.
- (b) Cold worked steel bars conforming to BS 4449: 1988.
- (c) Fabric reinforcement made of cold drawn high tensile bars conforming to BS 4483.

The Contractor shall obtain from his suppliers certificates of the mechanical and physical properties of the reinforcement and shall submit them to the Project Manager for approval, except where reinforcement has been supplied by the Employer. The frequency of sampling and the method of quality control shall be in accordance with Table 4 and Clause 20 respectively of these British Standards. All high yield and cold worked bars (except in welded fabric reinforcement) shall be deformed bars complying with Classification Type T2 for bond strength in accordance with BS 4449. Where galvanised reinforcement is specified, galvanising shall comply with the requirements of BS 729, Part 1.

303.2 Storage

Reinforcement shall be stored on Site under cover and supported clear of the ground and in such manner as to make identification easy. Supports shall be such that distortion of the steel is avoided and contamination and corrosion prevented.

303.3 Bending and Fixing

The Contractor shall provide on Site facilities for cutting and bending reinforcement whether he is ordering his reinforcement bent or not and shall ensure that a token amount of straight bar is available on Site for bending as and when directed by the Project Manager.

Reinforcement shall be wire brushed and cleaned at the Contractor's expense, before and/or after it is placed in position, if required by the Project Manager.

The bars shall be cold bent in strict accordance with the drawings and the Contractor shall be responsible for the accuracy of the bending. Bending dimensions shall be worked to the tolerances indicated in BS 4466 and BS 8110 table 3.28. Bars in which any errors in bending are beyond the limits of the foregoing tolerances shall be replaced at the Contractor's cost by correctly bent new bars, or, may be straightened and rebent cold subject to the Project Manager's prior approval. Any discrepancy or inaccuracy found in the drawings shall be notified to the Project Manager immediately.

After bending, reinforcement shall be securely bundled and labelled with weather-proof tags or shall be marked with other approved signs by which it can readily be identified.

Before assembling or fixing the reinforcement the dimensions to which it has been bent shall be checked by the Contractor against the drawings.

The reinforcement shall be fixed in strict accordance with the drawings as regards cover, spacing and

position, and suitable precautions shall be taken by the Contractor to prevent the displacement of reinforcement during the placing and compaction of concrete.

During concreting a competent steel fixer must be in attendance to adjust and correct the positions of any reinforcement which may be displaced. The vibrators are not to come into contact with the reinforcement.

Where required to support and retain the reinforcement in its correct position the Contractor shall provide templates, stools or other supports at his own cost. He shall allow for cutting to correct length all corner lacer bars included in the bar schedules as standard lengths.

Precast concrete support blocks for reinforcement shall be manufactured from Grade C30D "fine" concrete to ensure the correct cover thickness. They shall be well cured before use and carefully stored on Site to avoid contamination. Plastic and metal supports, chairs, etc. may be used and shall be subject to the Project Manager's prior approval.

In the case of mild steel, a lap of not less than 40 diameters of the smaller bar shall be provided at the junction of two bars for which the lap is not specifically detailed on the Drawings and, in the case of High Yield steel, a lap of not less than 50 diameters.

All intersections of bars in walls and slabs and all connections between binders or links and main bars in columns or beams shall be tied with soft iron wire ties or with fixing clips which shall not be allowed to make contact with the formwork or to project materially into the specified cover.

Unless permitted by the Project Manager, welding of bar reinforcement at intersections or for the joining of bars is prohibited. Where permission is granted, welding shall be carried out in accordance with the recommendations of the Institute of Welding for the welding of reinforcing bars for reinforced concrete construction.

When fixed reinforcement is to be left exposed for more than eight weeks, it shall be thoroughly cleaned and painted with neat cement grout.

Where galvanised reinforcement is used any damage suffered by galvanising shall be made good by the application of an approved galvanising formulation, before concrete placing is commenced.

No concreting shall be commenced until the Project Manager has inspected the reinforcement in position and until his approval has been obtained and the Contractor shall give adequate notice of his intention to concrete.

303.4 Couplers

Couplers for reinforcement shall be either Standard Swaged Splices or Type II Alpha Couplers manufactured by CCL Systems, Unit 4, Park 2000 Millennium Way, Westland Road, Leeds, LS11 5AL, Telephone: +44 (0) 113270 1221, Fax: +44 (0) 113 277 8977, email: sales@cclstressing.com or similar approved. Where bars of different diameters are to be joined a CCL Reducer Sleeve or similar shall be used.

Couplers shall be suitable for the type and size of reinforcing bars and shall be capable of developing 115% of the characteristic strength of the smaller of the reinforcing bars being joined in both tension and compression. Couplers shall be installed in accordance with the manufacturer's recommendations. Square twisted reinforcing bars shall not be used with couplers.

304 Formwork

304.1 Requirements

The term "formwork" shall be taken to include centering, formwork, strutting, bracing and the like.

When called upon to do so by the Project Manager the Contractor shall submit his formwork proposals for checking and approval by the Project Manager in advance of the concreting.

Formwork shall be of such accuracy, strength and rigidity as to carry the weight and pressure from the concrete to be placed on or against it, together with all constructional, wind or other loads likely to be imparted to it, without producing deformation of the finished concrete in excess of the tolerances outlined in Clause 304 and Table 3.5.

All formwork shall be sufficiently tight, without plugging, to prevent loss of grout during the vibration of the concrete. When required by the Project Manager, joints between formwork facing boards shall be sealed with foam rubber, sealing strips or other approved material. A foam rubber or polyurethane strip shall be provided around the tops of all walls and columns before affixing the forms for the next lift.

Faces of formwork shall be clean, free from projecting nails, adhering grout and other imperfections or defects which would prevent the specified surface finish from being attained. They shall be treated with approved mould oil before positioning. Great care shall be exercised to prevent reinforcement or steelwork from being contaminated by the oil during erection of the formwork.

Formwork, which as a result of prolonged use or general deterioration does not, in the opinion of the Project Manager, conform to the particular requirements set out in this clause, shall not be used.

Through-bolts or ties will not be permitted in liquid-retaining structures. The Contractor shall use only such bolts or ties as are capable of being removed in whole or in part so that no part remaining embedded in the concrete shall be nearer the surface of the concrete than the specified thickness of cover to the reinforcement.

Beam soffits shall be erected with an upward camber of 5 mm for each 3 metres of span. Top

formwork shall be counterweighted or otherwise anchored against flotation.

Boxes for forming holes shall be constructed so as to be easily removable without damaging the concrete during removal. They shall be properly vented to permit the escape of entrapped air, and shall be capable of being sealed, subsequently to prevent the loss of grout. The use of polystyrene blocks for the forming of holes, sinkings, etc. will not be allowed except by express permission of the Project Manager.

On all external edges risers of the concrete 20 mm chamfers shall be formed.

Openings for inspection of the inside of beam, wall, column and similar formwork and for cleaning-out purposes shall be formed so that they can conveniently be closed before the placing of concrete.

All props shall be supported on adequate sole plates and shall not bear directly on or against concrete. They shall be capable of being released gently and without shock from the supported formwork. No appliance for supporting the formwork shall be built into the permanent structure without the Project Manager's prior approval. Props for upper level support shall be placed directly over those at lower levels, and the lowermost props shall bear upon work sufficiently mature to carry the load.

Formwork shall be such as to allow for its removal without damaging the concrete, and in the case of suspended floors, for the removal of the beam sides and slab soffits without disturbing the beam-bottom boards and their props.

Before concreting, the areas which are intended to receive the concrete shall be cleaned by jetting with compressed air, and all water and extraneous material removed.

Where timber is used for formwork it shall be properly cured, free from warp, straight, clean and free from loose knots.

Where metal forms are used for formwork they shall be of the type strengthened by intermediate ribs or cross bracing.

Moving formwork may be used where in the opinion of the Project Manager it is appropriate.

304.2 Sawn Formwork

Sawn formwork shall produce an ordinary standard of finish consistent with normal good practice for use where the face of the finished concrete will not be exposed. The face in contact with the concrete shall consist of sawn timber boards, sheet metal or other approved material.

304.3 Wrought Formwork

Wrought formwork for use on exposed faces and water retaining faces shall produce a high standard of finish consistent with the best practice. The face in contact with the concrete shall consist of wrought and thickened boards tongued and grooved of not less than 30 mm finished thickness, framed plywood or metal panels or other approved material. Joints between boards and/or panels shall be arranged in a uniform pattern.

304.4 Special Wrought Formwork

Special wrought formwork shall provide the highest standard of finish where the face of the finished concrete is to form a particular feature. The face in contact with the concrete shall consist of large smooth sheets, unless otherwise specified, arranged in an approved uniform pattern, with joints coinciding with possible architectural features, sills, window heads, or changes in direction or surface. Accurate alignment of all joints shall be maintained. Wrought boarding and standard steel panels shall not be used unless specially faced.

304.5 Tolerances

Unless otherwise indicated on the drawings, the tolerances of the finished concrete with respect to the dimensions shown on the drawings shall not exceed the limits set out in Table 3.5.

vi) **Table 3.5 Tolerances of Dimensions for Finished Concrete**

Items	Tolerances (mm)
Overall dimensions and Levels	±5
Column sizes) Beam sizes) Wall sizes)	±5
Vertical lines out of plumb	5 mm ± 15 mm in every 15 m height

Except that in the case of Sawn Formwork the dimensions of the finished concrete shall be not less than those shown on the drawings.

304.6 Striking and Removal

The recommendations set out in Table 3.6 are given as a minimum requirement for striking formwork:-

vii)

Table 3.6 Striking of Formwork

Item	Sulphate Resisting and Ordinary Portland Cement CEM I to KS 1725 Normal Weather (16°C and above) Days	Rapid Hardening Cement Normal Weather (16°C and above) Days	Portland Pozzolana Cement or CEM IV to KS 1725
Beam Sides, Walls, Columns	1	1	1
Slabs (props left under)	4	3	5
Beam Soffits (props left under)	7	5	9
Removal of props to slabs	8	5	10
Removal of props to beams	16	8	18.5
Shafts and Tunnels	1	1	1.5

The removal of props to slabs and beams shall, if directed by the Project Manager, be subject to satisfactory results of the relevant 7 day cube crushing tests.

The above striking times are for normal conditions and before deciding on the actual time for each case, the Contractor shall consider and extend the period as tabled if:-

- (a) the span of the structural member under consideration exceeds 6 metres for beams and 3 metres for slabs. An additional period of one day for each 500 mm of additional span shall then be allowed;
- (b) the dead load of the structural member under consideration forms a large proportion of the total design load;
- (c) constructional loads coming on to the structural member under consideration are being placed soon after the concreting operations and these loads form a large proportion of the total design load;
- (d) the setting of the concrete has been retarded for any reasons;
- (e) the temperature falls below 8°C. An additional period of half a day shall be added for each day on which the temperature falls below 8°C. For temperatures falling below 3°C the additional period to be added shall be one day for each day on which the temperature falls below 3°C;
- (f) any combination of the above points and other considerations which would call for such a precaution to be taken.
- (g) the span concerned is part of a continuous spanning system and the adjacent two spans have not been cured sufficiently.

Information regarding paragraph (b) above will be supplied by the Project Manager; any other design information relevant to the above shall be obtained by the Contractor from the Project Manager.

305 Concreting

305.1 Requirements

The finished concrete shall be dense, durable, impervious to the ingress of water, free from cracks and honeycombing, and resistant to wear and mild chemical attack. Special concretes will be the subject of their own particular sections of Special Concrete.

305.2 Transporting

Concrete shall be transported to the place of final deposit by approved means.

Barrows, spades and other equipment used in the process of transporting concrete shall be thoroughly cleaned before each day's work or after a long interruption and they shall be free from hardened concrete.

Concrete shall be transported as soon as possible after mixing, by methods which will prevent the segregation, loss or contamination of the ingredients.

Proper bridging arrangements for traffic over reinforcement shall be provided so that the reinforcement is not distorted, damaged or displaced.

Where approval is obtained for concrete to be conveyed by chutes, these shall have a slope (not exceeding 1 vertical to 2 horizontal) such as to ensure a continuous flow of concrete. Additional water shall not be introduced to assist the flow. If deposition is to be intermittent the chute shall be arranged to discharge into a storage hopper. In no case will a clear fall of more than 1 m be permitted at the discharge end of the chute.

Where approval is obtained for pumping the concrete, the pump manufacturer's recommendations shall be followed. The pumps used shall be of adequate capacity and power to ensure delivery of a continuous supply. The Contractor shall provide adequate alternative arrangements for transporting the concrete in case of a breakdown of the pumping equipment.

Wherever transport of concrete is interrupted for any length of time (periods of over half an hour shall be treated as such) the chutes, pumps, pipes and any other means of distribution shall be thoroughly flushed out and cleaned. These shall also be flushed out immediately prior to resumption of concreting and shall be kept free from hardened concrete. All washwater used shall be discharged outside the formwork and clear of any freshly placed concrete.

305.3 Placing and Compaction

No concrete shall be placed until the Contractor has obtained approval to do so from the Project Manager. When the Contractor intends to place concrete he shall inform the Project Manager in sufficient time to enable him to inspect the reinforcement, formwork and surface on which the concrete is to be placed and the Contractor shall provide all facilities for such inspection.

This approval shall be sought by presenting two copies of the completed "Structural Concrete Approval Form" (SCAF) to the Project Manager's Representative at least 24 hours before intending to concrete. (See sample page 23).

Concrete shall be placed within 30 minutes of mixing, to uniform level, in layers not exceeding 500 mm deep in such manner as to avoid segregation, and each layer shall be compacted by means of approved vibrators to form a dense material free from honeycombing and other blemishes. Compaction by hand may be used only with the prior approval of the Project Manager.

At least one internal vibrator shall be operated for every four cubic metres of concrete placed per hour and at least one spare vibrator for every three shall be maintained on Site in case of breakdown during concreting operations.

Vibration time, the effective radius and other vibration characteristics shall be in accordance with the vibrator manufacturer's recommendations.

If internal vibrators are used, they shall be withdrawn immediately when a thin film of mortar begins to appear on the surface of the concrete. Withdrawal shall be carried out slowly to avoid cavitation.

Internal vibrators shall not be inserted between layers of reinforcement less than one and one half times the diameter of the vibrators apart. Contact between vibrators and reinforcement and vibrators

and formwork shall be avoided.

Vibrators shall not be used to move concrete from place to place in the formwork.

Where two distinct batches of concrete, placed at different periods of time and forming part of the same concreting operation are required to be formed monolithically with each other, the more mature concrete shall be penetrated by the vibrator to a sufficient depth to effect plastic movement between the two batches. Where the concrete does not respond to the action of the vibrator, it shall be deemed to have set, and no further disturbance will be permitted. Unless otherwise instructed by the Project Manager the condition shall be treated as for a "stoppage of work" and the marrying up of the two concretes shall be effected only when both concretes have properly set.

If external vibrators are used, the formwork shall be strong enough to withstand the forces of vibration.

Temporary or permanent stoppages of work shall be made only against stop ends (Clause 305).

Unless otherwise specified, before placing new concrete against concrete which has already hardened, the face of the older concrete shall be prepared by the removal of any laitance and loose aggregate, and shall be cleaned by a jet of compressed air.

When displacers are permitted to be used they shall be so placed that no displacer is within 300 mm of any finished face or within 500 mm of any other displacer. On completion of any lift, displacers shall be so arranged that they project for half their height above the surface.

STRUCTURAL CONCRETE APPROVAL FORM (SCAF)

(To be filled in duplicate before any concrete pour)

Contract Details

Job _____ Job No _____

Contractor _____ Site Engineer _____

Section and Concrete Details

Section / Block _____

Level _____ Member _____

Date / Time of Request _____ Date / Time of Pour _____

Concrete Class _____ Mix: Design / Nominal (delete one) Batching: Site / Ready Mix (delete one)

Check List

Description of Check	Checked	Remarks
Reinforcement Fixing		
Chairs / Links, etc.		
Reinforcement Cover		
Shutters / Stop ends		
Shutter Props		
Tie Bolts		
Plumbness / Slope		
Dimensions		
Line and Level		
Preparation hacking of joints		
Water Stops		
Moulds for Cubes		
Materials for Curing		
Any other checks (specify)		

Approval

Approved ☐ Not Approved ☐

Date: _____ Signature: _____

Note: Approval by the Project Manager or his Representative does not relieve the Contractor of any of his contractual obligations.

305.4 Concreting in Deep Lifts

(i) Limitations

Any height exceeding 2.5 m from which concrete is poured into formwork to form sections of wall will be considered within the terms of this Clause.

Concrete in columns may be placed to a height of 4.0 m with careful placing and vibration and satisfactory results. Where the height of the column exceeds 4.0 m suitable openings must be left in the shutters so that the maximum lift is not exceeded.

Deep lift construction will not be permitted where the reinforcing bars are to be placed closer than 100 mm to one another in any direction or, where the clear width at the point of admitting the concrete between one layer of reinforcement and another (or in the case of singly reinforced walls between reinforcement and formwork) is less than 200 mm.

The method shall only be used where trial sections revealed that, in the Project Manager's opinion it can be satisfactorily employed, in which case the requirements of this Specification shall apply except where they are in conflict with the requirements of this particular clause, when the latter shall prevail.

(ii) Concrete

In order to prevent segregation of aggregates, concrete mixes shall be designed for increased cohesion, or, where suitable, on a gap-graded basis. The use of approved admixtures may be made to achieve this end (302).

At the same time, the mix shall be such as to limit the amount of bleeding in the concrete, and where in the opinion of the Project Manager the quantity of free water rising to the surface is excessive, the mix shall be corrected before further concreting is undertaken.

In order to offset any increase in the water-cement ratio at the upper levels, the Project Manager may require the concrete mix to be modified for the upper depositions.

A slump of 80 mm shall not be exceeded.

(iii) Reinforcement

In order that reinforcement is not distorted or displaced during construction as a result of it being used for gaining access in or out of the formwork, all intersections of vertical and horizontal steel shall be properly fastened.

All obstructions caused by spacer blocks or chairs shall be eliminated so as to permit an unobstructed passage for the concrete to the bottom of the formwork. The Contractor may use sliding timber spacers instead of fixed concrete or plastic spacer blocks to position the reinforcement.

(iv) Formwork

In view of the high pressures to be expected from this form of construction extra attention shall be paid to the strength and stability of the formwork, to the prevention of loss of grout, and to the prevention of displacement of adjacent panels.

The use of through-bolts and other accessories which might interfere with the free passage of concrete between and around the reinforcement shall be reduced to a minimum by the use of properly designed formwork.

(v) Concreting

Particular attention shall be paid to the concreting of the initial sections at the bottom of the formwork to prevent segregation caused by rebound from the hard surface of the kicker, base and/or lower sections. The initial depositions shall therefore be made by using trunking methods, or by placing the concrete through openings formed in the sides of the formwork. Such openings shall not be higher from the hard surface than 2.5m.

In order to reduce differential settlement, and consequently, cracking between two sections of concrete placed at different intervals of time, concreting between one section and another shall be carried out on a gap-construction basis (Clause 305). The gap shall subsequently be concreted in distinct lifts each not exceeding 2.5m in height. For the same reason, when concreting two adjacent sections placed at the same time but of different heights (e.g. where boxing out is included), the difference in height shall not exceed 15% of the height of the deeper section.

Concreting from the upper level of the formwork shall be carried out in such manner as to ensure that concrete is admitted centrally between the faces of the formwork. For this purpose the Contractor shall make use of trunking or shall use funnel-shaped hoppers extending for a distance of not less than 1.5 m into the formwork. A sufficient number of such hoppers shall be provided, and/or they shall be capable of movement along the length of the formwork, to enable the concrete to be placed in contiguous heaps at the base of the pour. Such heaps shall not exceed 460 mm in height.

Where excessive bleeding is in evidence, the excess water shall be removed before placing further concrete.

(vi) **Compaction**

Compaction shall be carried out where possible by manual operation of poker vibrators within the formwork. Where this is not possible poker vibrators shall be suspended in sufficient numbers to ensure uniform compaction along the length of wall receiving the concrete, without the need for their withdrawal and re-insertion. The means of suspension shall be such that the vibrators may be progressively and systematically lifted as the concreting proceeds to ensure that every section of placed concrete is married into adjacent and underlying sections.

The use of vibrators to reposition deposited concrete is prohibited. Surface vibrators attached to the formwork may be used only to supplement the main means of compaction.

305.5 Continuous Concreting

Where the Contractor desires to use continuous concreting method in large sections (rafts and walls), he shall submit a written request to the Project Manager for approval. In the request he shall attach details which shall include but not be limited to the following :-

- Total amount of concrete to be placed in the shift.
- Stock of approved concrete materials on site.
- Capacity of the batching plant.
- Number and type of truck mixers to be deployed for the exercise and movement logistics.
- Number of skilled and other manpower to be deployed for the exercise in shifts.
- Number and capacity of plant to be used in placing concrete (pumps, vibrators, buckets, etc).
- Method(s) of monitoring and dealing with the heat of hydration.
- Details of protection against rain and floodwaters and how to cope with it.

The Project Manager shall consider the above details and other parameters (e.g. weather, satisfactory records of cube test results, availability of adequate working sections where reinforcement placement and the necessary formwork have been approved etc), before making his decision. The Project Manager may order that additional concrete cube moulds be made available as well as arrangements be made for cube crushing with an approved laboratory to cope with the increased demand.

The Project Manager may order that the concreting works be stopped immediately if in his opinion the

quality of the works is threatened for whatever reason.

305.6 Hot Weather Concreting (for temperatures above 20 Degrees Centigrade)

Concreting shall not be permitted if its temperature at placing is in excess of 35°C. In order to maintain the temperature of the concrete below this value the following precautions shall be taken wholly or in part as instructed by the Project Manager:-

- (i) All aggregate stockpiles, water lines and tanks as well as the mixer shall be protected from the direct rays of the sun;
- (ii) Coarse aggregate shall be cooled by constant watering where possible;
- (iii) Mixing water shall be cooled by the addition of ice to the storage tanks where necessary;
- (iv) Rapid-hardening cement shall not be used;
- (v) Where the above precautions are inadequate concreting shall be carried out during the cooler parts of the day or during the night as may be directed by the Project Manager.

When the air temperature is above 20°C loss of mixing water by evaporation shall be considered in arriving at the amount of water to be added to the mix (Clause 302). In order to maintain the water/cement ratio within permissible limits an approved water-reducing agent shall be included in the mix (Clause 302).

The maximum water/cement ratios indicated in Clause 302 may be increased with the Project Manager's permission by 0.05 (or 2.5 litres/50 kg of cement) during mixing, but on no account shall water be added to concrete directly or indirectly once it has left the mixer.

In order to reduce premature drying of the concrete during transporting and placing, all chutes, formwork and reinforcement shall be cooled by watering when possible, or shall otherwise be protected from the direct rays of the sun. Any water so used shall be removed by jetting with compressed air before placing the concrete in close contact.

As soon as possible after concreting, the formwork shall be stripped (Clause 304) and the surface of the concrete shall be treated in accordance with Clause 305.

Where drying winds are encountered, wind shields shall be positioned as directed by the Project Manager to protect exposed surfaces of the curing concrete.

305.7 Wet Weather Concreting

Concreting during periods of constant rain shall not be permitted unless aggregate stockpiles, mixers and transporting equipment, and the areas to be concreted are adequately covered.

During showery weather, the Contractor shall ensure that work can be concluded at short notice by the provision of stop ends. On no account shall work be terminated before each section, between one stop end and another, is complete. Adequate covering shall be provided to protect newly placed concrete from the rain.

305.8 Holes, Cavities and Fixings

The Contractor shall be responsible for the co-ordination of all requirements of his Sub-contractors as regards provision of holes, chases, cavities and fixings and shall, if required by the Project Manager, prepare drawings giving details of his and his Sub-contractor's requirements and shall send copies of such drawings to the Project Manager prior to construction.

Holes, etc. shall be accurately marked and boxed-out for before concreting operations commence and, without the Project Manager's prior approval, no such holes, etc. shall be formed after the concrete has set.

Where bars, if placed to specified spacing would foul holes of size less than 250 mm x 250 mm the full length of the bar shall be moved to one side and in the case of holes exceeding 250 mm x 250 mm the bars shall be cut on site and lapped with additional equivalent bars, or as otherwise indicated on the drawings.

Wherever possible, the Contractor shall build in all pipework, ironwork, etc. which passes through walls and floors, and the pipework, ironwork, etc. shall first be thoroughly cleaned and freed from any deleterious matter, and every care shall be taken to ensure that it is thoroughly encased in concrete.

Unless otherwise instructed by the Project Manager all electrical conduits to be positioned within the reinforced concrete shall be fixed inside the steel cages of beams and between the top and bottom steel layers in slabs and similar members.

The proposed position of all conduits 25 mm and over in diameter which are to be enclosed in the concrete shall be shown accurately on a plan to be submitted to the Project Manager, whose approval shall be obtained before any such conduit is placed.

Bolts, hooks and other fixings shall be embedded in concrete, or holes shall be drilled and fitted with threaded expanding anchors to receive the bolts. The Contractor shall ensure that bolts, hooks, etc. are accurately positioned. Holding down bolts for machinery shall be set by means of a template.

Where brick or stonework is to form a facing to the concrete or where the end of a brick or stone wall butts against a concrete face, galvanised metal ties of approved manufacture to BS 1243 shall be incorporated. The distance between ties shall be gauged with due regard for the bonding of the walls, and at intervals required by the Project Manager.

305.9 Protection and Curing

Newly placed concrete shall be protected by approved means from rain, drying winds, sun and contact with substances which can adversely affect it.

No traffic or constructional loads shall be permitted on newly placed concrete until it has hardened sufficiently to take such traffic or load, and only then with the approval of the Project Manager.

Concrete shall at no time be subjected to loading (including its own mass) including compressive stress until it has reached 0.40 of its specified 28 day strength.

Any concrete surfaces, risers and treads of stairways which might be damaged during the construction of the Works shall be adequately protected.

All structural concrete shall be cured using methods approved by the Project Manager.

The method of curing shall prevent loss of moisture from the concrete. Immediately after compaction and for 7 days thereafter concrete shall be protected against harmful effects of weather, including rain, rapid temperature changes and from drying out.

The curing time shall be the number of days given in Table 3.7 unless the average temperature of the concrete during the required number of days falls below 10oC in which case the period of curing shall be extended until the maturity of the concrete reaches the value given in the table.

viii) **Table 3.7 Normal Curing Methods**
Minimum period of protection for different types of cement

Conditions under which concrete is maturing	Number of days (where the average temperatures of the concrete exceeds 10°C during the whole of the period)			rs calculated ete in hours of degrees the average te exceeds -	
	Type IV	Type I or Type V	Type III	Type IV	Type I or Type V
1. Hot weather or drying winds	7	4	2	3500	2000
2. Conditions not covered by 1.	4	2	1	2000	1000
Type IV - Low Heat Portland Cement/Portland - Pozzolana Type I - Ordinary Portland Cement Type V - Sulphate-resisting Portland Cement Type III - Rapid-hardening Portland Cement Hot weather - Temperature over 16oC					

Curing shall be carried out using either of the following basic methods, or any other method agreed with the Project Manager. Methods involving the use of dampened hessian coverings shall not be used. The method adopted for any particular situation shall be agreed with the Project Manager.

A. Membrane Applied by Spray

Liquid membrane compounds shall be applied to moist concrete surfaces as follows:-

(i) Unformed Surfaces

The compound shall be applied immediately after the free water has left the surface.

(ii) Formed Surfaces

The compound shall be applied immediately after removing the forms. If there is appreciable drying, the surface shall be mist sprayed with water to produce a uniformly damp appearance before the compound is applied.

The compound shall be applied in one or two separate applications to produce complete and uniform coverage of the surface. If the compound is applied in two increments, the second application shall follow the first within 30 minutes. The method and rate of application shall be in accordance with the compound manufacturer's instructions.

If rain falls on the newly coated surface before the film has dried sufficiently to resist damage, or if the film is damaged in any other manner, a new coat of compound shall be applied to the affected area equal in curing value to that originally applied.

Compound applied to construction joint surfaces, or to other surfaces to which concrete is to be bonded, shall be removed prior to placing the fresh concrete.

Depending on the surface to which it is to be applied the compound shall conform to the following requirements of AASHTO M148.

- (i) Exposed and vertical concrete surfaces - Type I-D (clear compound with fugitive dye).
- (ii) Unexposed top surfaces of foundations and superstructures - Type 2 (white pigmented).

B. Polythene Sheeting

The concrete surfaces shall be covered with white polythene sheeting as follows:-

(i) Unformed Surfaces

The sheeting shall be laid over the surface as soon as possible without marring the surface, and not until initial stiffening has taken place if a brushed or tamped finish is required.

(ii) Formed Surfaces

The surfaces shall be covered immediately after the removal of the forms.

The sheeting may be in contact with the concrete or made into portable shelters on light weight frames. In both cases, the sheeting shall be jointed and sealed against the concrete surfaces to prevent wind blowing between the sheeting and the concrete.

The white polythene sheet shall conform with the requirements of AASHTO M171. On no account shall clear or any other colour of sheeting be used.

C. Other Curing Methods

These shall be agreed with the Project Manager. Methods involving the use of damped hessian coverings shall not be used, unless at least 2 layers of continuous hessian are used and they are kept continuously wet and protected from winds which cause accelerated drying.

Where the thickness of concrete placed exceeds 1.5 m, the Contractor shall submit for the Project Manager's approval proposals to ensure that, during the curing period:-

- (a) the rate of rise of temperature in the concrete does not exceed 15°C per hour for the first 3 hours;
- (b) thereafter the rate of rise and fall of temperature in the concrete does not exceed 35°C per hour;
- (c) the maximum temperature in the concrete does not exceed 70°C; and
- (d) the maximum difference in temperature between the core and the surface of the concrete does not exceed 20°C.

The proposals shall include consideration of:-

- (a) concrete mix design;

temperature of mix at time of placing;

- (c) method of curing.

Where required by the Project Manager, the Contractor shall carry out temperature measurements in the concrete. The method and procedure of temperature measurement shall be agreed with the Project Manager.

305.10 Joints

(i) Construction Joints

The position of construction joints, when not shown on the Drawings or otherwise required by this Specification, shall be decided on site having regard to the plant and labour made available by the

Contractor for the manufacture, placing and compaction of the concrete as well as its curing, the climatic conditions prevailing at the time of concreting, the nature and size of the formwork, and the conditions of operation of the work. Waterstop shall be provided to all construction joints on water retaining or excluding structures. The Contractor shall submit his proposals to the Project Manager for his approval at least fourteen days before commencing the work.

Construction joint surfaces shall be treated by the "wash-off" method explained below, except where it cannot be practically effected, in which case they shall be treated in accordance with Clause 305 as for the placing of new concrete against hardened concrete.

When expanded metal lathing is used for the formation of construction joints a rebate will not be required to be formed. The expanded metal lathing shall be left in the work and shall not extend closer to the finished surface of the concrete than 25 mm. It shall be securely fixed to the reinforcement.

The following particular requirements shall also be observed:-

* Slabs supported on the ground

In order to ensure control in the placing of concrete the Contractor shall provide control boards to form panels not larger than 15 m² in area. These shall be lifted as the concreting proceeds except where they are of expanded metal in which case they may be left in position as part of the permanent works, provided that they shall not extend closer to the finished surface of the concrete than 25 mm. In the event of a breakdown in the supply of concrete the Contractor shall ensure that an alternative supply of concrete is made available (to finish the work against the control boards acting as stop ends). The joint so formed shall then be treated as a construction joint. Where Ready-mixed concrete is permitted the control boards shall be positioned so as to enclose a volume of concrete equal to that delivered by each truck.

Construction joints and control joints shall be formed normal to the surface of the retained concrete.

* Suspended Beams and Slabs

T-beams shall be formed to their full depth integrally with the adjacent slab and without horizontal joints.

* Columns

Where kickers are indicated on the drawings these shall be cast together with the slab or beam below. On no account shall kickers be cast as a separate operation. Alternatively, the Contractor may adopt "kickerless construction" methods providing he can satisfy the Project Manager that his system is reliable and does not compromise workmanship.

* Walls

Horizontal construction joints in walls shall be formed along straight lines coinciding with the full height of the formwork. The height of the formwork thus controlling the height of the pour shall be determined with reference to the availability of concrete, the size and amount of reinforcement and the means of compaction available.

Unless otherwise indicated on the drawings or otherwise permitted by the Project Manager for the construction of circular tanks, concreting shall be carried out continuously for the full circumference without vertical joints. Where permission is granted for the use of vertical joints the Project Manager may order, at no extra cost to the Employer, the inclusion of an approved type of water stop.

In the case of rectangular tanks, vertical joints shall not be positioned closer to any corner than one metre. They shall be formed with properly rebated stop ends or, where conditions permit, by the use of expanded metal lathing. Unreinforced manholes shall be constructed without vertical joints.

(ii) The "Wash-off Method" of preparing Construction Joints

As soon as possible after concreting, and while the surface is still green, the surface of the concrete forming the joint shall be freed of loose aggregate and sprayed with a fine spray of water to prevent the formation of laitance. Subsequently all excess water shall be removed by a jet of compressed air and the surface left clean to receive further concrete.

Where expanded metal lathing is used for construction joints, this method of surface preparation shall be used in every case.

(iii) Movement Joints

These shall include contraction and expansion joints and shall be as indicated on the drawings.

Contraction joints will be either full contraction joints or partial contraction joints. Where partial contraction joints are specified a period of at least five days shall elapse between the concreting of the section on each side of the joint.

Where the drawings indicate a contraction gap to be formed in any panel (this gap will not exceed one metre), concreting on either side of the gap shall be carried out so as to form partial contraction joints at each side of the gap. Prior to the concreting of the gap section, the joint surfaces shall be cleaned but otherwise left untreated. The concreting of the gap section shall not be carried out until a period of at least five days has elapsed after completion of the adjacent sections.

Alternate panel construction (other than contraction gap construction outlined above) will be permitted only with the approval of the Project Manager, or in those cases where either the reinforcement is not continuous through the joint or where the panels are separated by expansion or contraction joints.

Unless otherwise specified or permitted by the Project Manager all waterstop shall consist of rubber or PVC. Jointing of waterstop shall be by vulcanising, except where PVC is specified or permitted in which case joints shall be by fusing or welding. Materials shall be obtained from an approved manufacturer whose recommendations as to jointing shall be fully complied with.

(iv) Waterstop and Jointing Materials

Waterstop and jointing materials shall be obtained from an approved manufacturer.

All waterstop and jointing materials which are not required for immediate use shall be stored at all times in a cool damp place.

Waterstop shall be manufactured of rubber or PVC (polyvinylchloride) as shown on the drawings, and shall be of the type and size shown on the drawings. Site joints shall be made strictly in accordance with the manufacturer's instructions and all intersections and junctions shall be obtained prefabricated from the approved manufacturer.

Joint filler shall be manufactured of natural bonded cork or other approved material which remains serviceable when wet. Joint filler shall be cut and trimmed accurately to suit the joint profile and shall be maintained accurately in position by means of an approved adhesive. The compressibility of the filler shall be such that it can be compressed to 50% thickness with a pressure of not less than 0.07 N/m square and no greater than 0.4 N/mm square. After 50% compression, the material should recover to at least 70% original thickness within 30 minutes. On no account shall fibreboard or similar be used as filler.

Joint sealing compounds shall be approved polysulphide based compounds suitable for sealing joints in horizontal and vertical/sloping concrete surfaces as appropriate. Sealing compounds shall be applied strictly in accordance with the manufacturer's instructions and shall completely fill the joint recess. Surface primers shall be from the same manufacturer as the sealants themselves. Joint sealing compounds shall be entirely suitable for contact with potable water where these are used in water retaining structures.

Waterstop shall be located and maintained accurately in position and details of the proposed method of fixing shall be submitted to the Project Manager for approval. On no account shall waterstop be secured by nails or by any other means involving puncture of or damage to the waterstop material unless purpose made nailing flanges are incorporated in the design of the waterstop.

(v) Slip Membrane

The slip membrane shall be "slipstrip" as supplied by Serviced Limited, Ajax Avenue, Slough, Berkshire, UK or similar approved material. The slip membrane shall be not less than 1.5 mm thick and shall be a plastic preformed strip with low coefficient of friction specifically manufactured for use as a separating membrane in sliding joints between concrete surfaces. Each sliding joint shall comprise two layers of the membrane unless otherwise shown on the drawings.

The concrete surface to which the slip membrane is to be fixed shall be finished with a steel float to provide a smooth true surface free from dust and loose particles.

(vi) Expandafoam

Expandafoam shall be as supplied by Expandite Limited, 1-9 Chase Road, London, NW10 6PS, UK or similar approved material. Expandafoam is a closed cell flexible polyethylene joint filler used where a readily compressible low load transfer joint filler is required. Expandafoam shall be fixed in position using a suitable adhesive.

305.11 Finishes - General

All exposed faces of concrete unless otherwise specified shall be hard, smooth and free from honeycombing, air and water holes and other blemishes.

All projecting imperfections shall be rubbed down with carborundum stone or by other approved means and grit and dust therefrom shall be thoroughly washed off with clean water.

Surface Finishes

(a) Wood float finishes shall be formed by smooth floating the accurately levelled and screeded surface. Care shall be taken to ensure that the concrete is worked no more than is necessary to produce a uniform surface free from screed marks.

(b) Steel trowel finishes shall be formed while the concrete is still wet by means of a steel trowel applied to an accurately levelled and screeded surface (see also Clause 307).

(c) Granolithic finishes shall conform to the recommendations laid down in "Specification for Granolithic floor toppings laid in-situ concrete", as published by the UK Cement and Concrete Association with special reference to monolithic construction.

(d) Screeded finishes shall be formed by levelling and screeding the concrete to produce a uniform, plain or ridged surface as specified; surface hardeners shall be applied strictly in accordance with the manufacturer's recommendations.

(e) Bush-hammered or pattern-worked finishes.

When exposed aggregate is to be the surface texture, the Contractor shall ensure that a uniform distribution of the coarse aggregate takes place at the face. The formwork shall be removed as soon as possible from the face to be treated; the surface shall be thoroughly wetted and wire brushed, and bush-hammered or pattern-worked as and when instructed. Surface retarders shall be used only when permitted by the Project Manager.

Bush-hammering or pattern-working shall not be relied upon to obscure any defects in the concrete face which arise from formwork imperfections.

Making Good

On no account shall any faulty honeycombed or otherwise defective concrete be repaired or patched until the Project Manager has made an inspection and issued instructions for the repair.

Honeycombed or damaged surfaces of concrete, which in the opinion of the Project Manager, are not such as to warrant the cutting out and replacement of the concrete, shall be made good as soon as possible after removal of the formwork as follows:-

1:1.5 Portland Cement and sand mixture shall be worked into the pores over the whole surface with a fine carborundum float in such a manner that no more material is left on the concrete face than is necessary to fill the pores completely so that a uniformly smooth and dense surface of uniform colour is finally presented.

Removal and Replacement of Unsatisfactory Concrete

The Contractor shall on the Project Manager's instructions to do so cut out and replace any concrete in any part of the structure if in the Project Manager's opinion:-

- (a) the concrete does not conform to the Specification, or
- (b) deleterious materials or materials which are likely to produce harmful effects have been included in the concrete, or
- (c) the honeycombed or damaged surfaces are too extensive, or
- (d) the finished concrete sizes are not in accordance with the drawings within permissible tolerances, or
- (e) the setting-out is incorrect, or
- (f) the steel cover has not been maintained, or
- (g) the protection, including curing, of the concrete during the construction was inadequate, resulting in damage, or
- (h) the work of making good or other remedial measures the Project Manager may indicate are not carried out to his satisfaction, or
- (i) undue deformation of or damage to the works has taken place due to inadequate formwork, or to premature traffic or to excessive loading, or
- (j) any combination of the above points has taken place resulting in unsatisfactory work.

306 Testing

306.1 Sampling and Testing - (see also Clauses 301 and 302)

The Contractor shall provide on the Site equipment, staff and labour for carrying out the sampling and testing outlined in columns 3 and 4 of Table 3.8, and he shall carry out any or all of these tests at such times and with such frequency as may be requested by the Project Manager.

All equipment shall be calibrated and checked from time to time by an approved agency, as the Project Manager may require.

The Contractor shall provide all samples required by the Project Manager. Those samples to be tested in an offsite laboratory shall be carefully forwarded by the Contractor to an approved

laboratory. Results of laboratory and site tests shall be kept on site and copies of all test reports shall be forwarded in duplicate to the Project Manager.

Each cube shall be marked with a distinguishing number (numbers to run consecutively) and the date, and a record shall be kept on Site giving the following particulars:-

- (a) Cube No.
- (b) Date and time made
- (c) Temperature and weather conditions
- (d) Location in work
- (e) 7-day Test

Date :

Strength

- (f) 28-day Test

Date :

Strength

Cubes shall be forwarded, carriage paid, to an approved Testing laboratory in time to be tested two at 7 days and two at 28 days. No cube shall be dispatched within 3 days of casting.

Authentic copies of all Work Test results shall be forwarded to the Project Manager directly from the testing laboratory and one shall be retained on the site. The test certificates shall indicate all properties as required by BS 1881.

The Contractor must allow in his rates for concrete test cubes for all expenses in connection with the preparation and conveyance to the Testing Laboratory and testing of test cubes and no claim in respect of his failure to do so will be entertained.

Any batch of concrete which fails to achieve the required characteristic strength shall be removed and made good in accordance with this Specification. The Contractor shall carry out all such work at his own cost.

Frequency of tests and the number of samples required will be governed by the results of the previous tests, the quality of the materials revealed during the tests, and the uniformity of that quality (see Clause 302). Should it become evident that the quality of concrete is deteriorating the Project Manager may require additional samples to be taken and test cubes to be made and tested to determine the cause.

306.2 Loading Tests

The Project Manager may direct that a loading test be made on the works or any part thereof if he deems such test to be necessary for one or more of the following reasons:-

- (a) failure of "Site Cubes" to attain the strength requirements of Clause 302;
- (b) premature removal of formwork;
- (c) overloading of structure during construction;

(d) improper compaction and/or curing of concrete;

(e) any other circumstances attributable to alleged negligence on the part of the Contractor, which, in the opinion of the Project Manager, may result in a structure being of less than the required strength;

If the loading test is ordered to be made solely or in part for reasons (a) to (d) the test shall be made at the Contractor's own cost.

If the loading test is ordered to be made for reason (e), the Contractor shall be reimbursed for the cost of the test if the result is satisfactory. No extensions to the Contract Duration shall be granted for delays and disruption resulting from these tests.

Loading test shall be carried out in accordance with the requirements of BS 8110 – 2 Section 9.

If the results of the test are not satisfactory, the Project Manager will direct that the part of the work concerned be taken down or removed and reconstructed to comply with the Specification, or that such other remedial measures as he may think fit be taken to make the work acceptable and the Contractor shall carry out such work at his own cost.

ix)

Table 3.8 Sampling, Testing and Acceptance Standards

Materials	Test	Site Sampling	Testing	Accepted Standards	Remarks
1	2	3	4	5	6
Cement	Ordinary Portland Rapid Hardening Sulphate Resisting		BS 4550	BS 12 BS 12 BS 4027 KS1725	Manufacturer's Test Certificate
Aggregates	Description and Classification		BS 812 Sec 2	BS 882	
	Particle Size	BS 812 Sec 1	BS 812 Sec 3	BS 882)
	Particle Shape	BS 812 Sec 1	Visual and BS 812 Sec 3)) Mix
	Specific Gravity	BS 812 Sec 1	BS 812 Sec 3) Design
	Density	BS 812 Sec 1	BS 812 Sec 3) Requirements
	Voids	BS 812 Sec 1	BS 812 Sec 4)
	Absorption	BS 812 Sec 1	BS 812 Sec 4	BS 8007 Cl 6.2.2	See Freeze-thaw Test in this table
	Organic Impurities	BS 812 Sec 5			
	Moisture Content	BS 812 Sec 5			For adjustment of added water for concrete making
	Mechanical Properties	BS 812 Sec 6	BS 882		Ten per cent fines value
Water	Suitability	BS 3148	BS 3148	BS 3148	Not required for potable water
Concrete	Compacting Factor	BS 1881 Pt 101	BS 1881 Pt 103)
	Slump		BS 1881 Pt 102) Workability Test))
	Crushing		BS 1881	BS 5328, BS 8110	Cube test
	Water Absorption		BS 1881 Pt 122	BS 7263	Precast concrete Clause 308
	Freeze-thaw	BS 1881	BS 812 Sec. 1		Durability test for aggregate not complying with moisture absorption requirements of BS 5337 Cl.

Materials	Test	Site Sampling	Testing	Accepted Standards	Remarks
1	2	3	4	5	6
					21.2
	Electrolytic Efflorescence				As required for salt-containing aggregate or saline water
	Cores	BS 1881 Pt 6 BS 1881 Pt 120	BS 1881 Pt 6 BS 1881 Pt 120	BS 1881 Pt 120 with ref to concrete strengths this Specification	See Clause 306
Admixers	Compatibility with cement	As required by Laboratory			Tests to be carried out by independent Laboratory as required

The Project Manager may also instruct the Contractor before a loading test takes place to take out cylindrical core specimens from the structures concerned and have them tested. The cutting equipment and the method of doing the work shall be to the Project Manager's approval. The specimens shall be dealt with in accordance with BS 1881. Prior to testing, the specimens shall be available for examination by the Project Manager. If the cores are ordered to be taken solely or in part for reasons (a) and (d) above, the work involved and the testing shall be made at the Contractor's own cost. If the cores are to be taken for reasons (b), (c) and (e) above, the Contractor will be reimbursed the cost if the loading test described in the previous paragraphs proves satisfactory.

307 Special Concrete

307.1 No-fines Concrete

No-fines concrete for use in subsoil drainage shall consist of a 1:8 cement/aggregate mix by volume. Aggregate shall be 20 mm to 10 mm graded with no more than 5% passing the 10 mm sieve. Only sufficient water shall be added to ensure complete coating of the aggregate. One half of this water shall be placed into the mixer first, after which the aggregate and cement shall be admitted. After partial mixing the balance of the water shall be added until a consistency of mix is achieved.

Preliminary tests shall be carried out on the site to prove the suitability of the finished concrete, and adjustments made to the proportions and or grading as may be required by the Project Manager.

307.2 Air-Entrained Concrete

Concrete for roads and those structures where specified, shall include an approved air-entraining agent capable of producing a 5% air-entrainment with a tolerance of 0.5% (Clause 302).

The mix shall be purposely designed, having regard for the nature of grading of the aggregates and air-entraining agent being used.

Preference shall be given to the use of air-entraining agents which can be administered in fixed calibrated amounts through a dependable mechanical dispenser or sachet, and which are added to the mixing water.

Frequent air meter tests shall be carried out and the consistency of the air-entrainment maintained to the above tolerances by adjustments in the mix, as may be necessary.

307.3 Concrete in Benching

Concreting for benching in manholes, pumping stations and works structures shall consist of Grade C25P concrete unless otherwise specified. It shall be placed with low workability to the approximate shape required and, while still green, shall be finished with not less than 50 mm of Grade C25P concrete to a steel trowelled finish and to the contours indicated on the drawings.

307.4 Ready Mixed Concrete

Unless otherwise stated the relevant clauses of BS 5328 shall apply.

Ready mixed concrete shall only be used with the prior approval of the Project Manager. The Contractor shall not be relieved of his obligation to provide concrete to the standard laid down in this Specification by virtue of any approval given for the use of concrete supplied by others, and the Project Manager reserves the right to withdraw his approval at any time consequent on any deterioration in the quality of the Concrete, or unsatisfactory delivery or any other reason he considers detrimental to the Works.

Ready mixed concrete manufactured off the site shall be transported in a revolving drum and shall be continuously agitated until it is used in the work unless otherwise approved. The time interval between adding water to the drum and placing shall not exceed 90 minutes. The time interval between completion of mixing and placing shall comply with Clause 305.

307.5 Granolithic Concrete

Refer to Clause 305.

307.6 Pneumatically Applied Mortar (Guniting)

(i) Requirements

The pneumatic application of mortar shall be carried out only by Contractors experienced in this type of work and who are in possession of proper Plant and equipment. Nozzlemen employed on the works shall be skilled operators.

The finished product shall be dense, of even texture and colour, and to the requirements of strength, tolerance and finish set out in this Specification.

(ii) Strength

After curing, the mortar shall be capable of producing cored samples with a 28-day characteristic strength of not less than 27.5N/mm².

(iii) Materials

Sand, cement and water shall comply with the requirements of Clause 302 of this Specification except that the sand shall conform to the grading of Zone 2 of BS 882.

(iv) Proportions

The proportions to be used in the mix shall be determined with reference to the requirements outlined in sub-clause 307(i) and the mix shall be not weaker than one part of cement to four parts of sand by volume, having regard to the adjustments for bulking of the sand.

(v) Operation

Air and water pressures shall be such as to permit the proper application of the mortar, and shall be determined with reference to hose lengths and nozzle diameter.

Mortar rebound, recovered, cleaned and uncontaminated with extraneous matter, may be re-used but not for water-retaining structures. It shall be regarded as an equivalent volume of sand which shall not exceed 20 per cent of the total sand requirement. Rebound which has lodged in the formwork or between reinforcement shall be removed by compressed air.

Reinforcement shall be completely embedded in the mortar by the proper direction of the nozzle and the mortar shall be applied as a steady and uninterrupted flow from the nozzle.

Mortar application shall be discontinued at any section of the work where sagging of the mortar is in evidence.

(vi) Joints

These shall be formed by sloping the surface to a thin edge. Before applying new mortar, the surface shall be thoroughly wetted. Laitance shall be removed by the initial discharge of fresh mortar.

(vii) Tolerances

The thickness of applied mortar shall be not less than the dimensions shown on the Drawings nor greater than 10 mm over those dimensions, unless otherwise indicated on the Drawings or otherwise permitted.

(viii) Protection and Curing

Shall be carried out in accordance with the requirements of Clause 305.

(ix) Finishes

Unless otherwise specified all surfaces shall be brought to a granular textured finish by means of a wooden float.

(x) Cold Weather Work

No application of mortar shall be made against frozen surfaces nor when the air temperature is below 5oC.

(xi) Making Good

Any defective work shall be cut out immediately and made good with fresh mortar pneumatically applied.

307.7 Cement Grouts

Cement grout shall be mixed in the relevant proportions indicated in the following table using the minimum quantity of water to ensure the necessary fluidity and to render it capable of penetrating the work.

Class	Nominal Mix by Mass	
	Cement	Sand
G1	1	-
G2	1	3
G3	1	10

Cement grout shall be used within one hour of mixing, except where containing a retardant admixture.

307.8 Pumped Concrete

Where pumping of concrete is permitted to be used no relaxation of the requirements of this Specification will be permitted. Particular attention shall be paid to the proper grading of aggregates to prevent bleeding and/or segregation during the pumping operations. The inclusion of water-reducing additives or other materials, including flyash, to improve the flow characteristics of the concrete will only be permitted where it can be shown that they do not adversely affect the concrete either in the plastic phase or in the finished work.

308 Precast Concrete Units

308.1 Requirements

Unless otherwise agreed in writing by the Project Manager, all precast concrete units shall be manufactured on site and shall be true to dimension and shape, with true rises and with perfectly smooth exposed faces free from surface blemishes, air holes, crazing and other defects, whether developed before or after building-in. They shall comply with the appropriate BS. (Note: Coping blocks and similarly exposed units are particularly susceptible to crazing when the concrete is manufactured using high water/cement ratios)

The maximum size of coarse aggregate in precast concrete shall not exceed 20 mm except for thicknesses less than 75 mm where it shall not exceed 10 mm.

The compacting of precast concrete shall conform with requirements given elsewhere in this Specification except for thin slabs where use of immersion type vibrators is not practicable. The concrete in these slabs may be consolidated on a vibrating table or by any other methods approved by the Project Manager.

Steam curing of precast concrete will be permitted. The procedure for steam curing shall be subject to the approval of the Project Manager.

The precast work shall be made under cover and shall remain under the same for seven days. During this period and for a further seven days the concrete shall be shielded by sacking or other approved materials kept constantly wet. It shall then be stacked in the open for at least a further seven days to season before being set in position. Where steam curing is used these times may be reduced subject to the approval of the Project Manager.

Precast concrete units shall be constructed in individual forms. The method of handling the precast concrete units after casting, during curing and during transport and erection shall be subject to the approval of the Project Manager, providing that such approval shall not relieve the Contractor of responsibility for damage to precast concrete units resulting from careless handling.

Repair of damage to the precast concrete units, except for minor abrasions of the edges which will not impair the installation and/or appearance of the units, will not be permitted and the damaged units shall be replaced by the Contractor at his own expense.

Except where precast work is described as “fair face” or as having “exposed aggregate” or terrazzo finish the moulds shall be made of suitable strong sawn timber true in form to the shapes required. Unless otherwise described, faces are to be left rough from the sawn moulds.

Where precast work is described as “fair face” the moulds are to be made of metal or are to have metal or plywood linings or are to be other approved moulds which will produce a smooth dense fair face to the finished concrete suitable to receive a painted finish direct and free from all shutter marks, holes, pinnacles, etc. Where precast work is to have an “exposed aggregate” or terrazzo finish the moulds shall be constructed to the requirements given for moulds for “finished fair” work.

The method of achieving the exposed aggregate finish shall be “aggregate transfer” or other approved method.

308.2 Kerbs

Precast concrete kerb shall conform to BS 7263: Part 1: 1990, except that coarse aggregate shall conform to BS 882: 1983. Fine aggregate shall consist of sand resulting from the natural disintegration of rock.

Approved air-entraining agents may be permitted to be used providing that approved adjustments are made to the mix with regard to water and fine aggregate proportions (Clause 302). In such cases the moisture absorption limits set out in BS 340 may be neglected subject to the concrete satisfying the freeze thaw test laid down under the heading "Weir Blocks and Sills".

308.3 Paving Slabs

Paving slabs shall conform to BS 368 and shall be 50 mm thick unless otherwise specified.

308.4 Other Blocks

Blocks used for building work and filter bed walls shall conform to BS 6073: Part 1: 1981.

308.5 Wall Units

L-shaped wall units shall conform to the requirements of BS 8110. Where it is not intended to use coping blocks for the protection of the upper exposed surface of the units, the uppermost 150 mm, for the full width of the unit, shall be formed with concrete composed of aggregate complying with BS 882: 1992. Such concrete shall be formed integrally with the main body of the concrete.

308.6 Other Items

Manhole ring units, tapers, cover slabs, segments and concrete pipes are referred to under their particular heading.

309 Site Books And Standards

309.1 Instructions to be Recorded

The Contractor shall provide and keep permanently on the Site a numbered triplicate book wherein the Contractor shall record all instructions relating to concrete work issued by the Project Manager. One copy of every entry therein shall be sent to the Project Manager on the same day as the entry is made.

309.2 Site Diary

The Contractor shall provide and keep permanently on the Site a continuous entry diary wherein the Contractor shall record details of formwork, construction, placing of reinforcement, concreting and curing operations, striking of formwork, making good and daily temperature and weather conditions. This diary shall always be available for inspection by the Project Manager.

309.3 Copies of Standards and Codes

The Contractor shall provide and keep permanently on the Site copies of the following Standard Codes of Practice:-

BS 812
BS 882
BS 1881
BS 4466

BS 5328
BS 5628
BS 8007
BS 8110
KS1725

The Contractor shall in addition provide and keep permanently on the Site copies of such other Standards, Codes, Notes and Specifications as may be required by the Project Manager.

310 Water Retaining Structures - Special Clauses

Note: In the event of any differences between the "Special Clauses" and the previous Specification under Section 2.3 the provisions of these "Special Clauses" shall have precedence.

310.1 Making Good

The cement mortar used in filling recesses in the concrete formed by bobbins in connection with formwork shall contain an approved expanding admixture.

310.2 Construction Joints in Water Retaining Structures

In water retaining structures PVC waterstops not less than 130 mm wide manufactured by an approved manufacturer shall be built into all construction joints in external walls and construction joints in roofs of potable water retaining structures. Construction joints shall be formed at positions agreed by the Project Manager.

The cost of forming construction joints shall be included by the Contractor in his general concrete rates.

310.3 Watertightness of Structures

The Contractor shall be solely responsible for the watertightness of structures and any remedial measures necessary.

310.4 Hydrophilic Rubber Sealer

Hydrophilic rubber sealer shall be co-extruded from chloroprene and hydrophilic rubbers into a cellular strip approximately 25 mm x 7 mm thick which expands as it absorbs water. The strip shall incorporate an expansion delay coating to prevent activation during setting of the surrounding concrete.

Hydrophilic rubber sealer shall be applied to the perimeter of all pipes to be built into concrete structures, to existing concrete walls and slabs at or below water levels which have been demolished and require extension, and to other locations as indicated on the Drawings.

The strip sealer shall be bonded to the pipe diameter or on to the face of demolished structures on to which new concrete is to be placed so as to be at least 100 mm from the wall surface. Where dowel bars are incorporated in bonding new concrete to old, the sealer shall be placed above the dowel bars on the "wet" side of the structure. Bonding shall be accomplished using proprietary neoprene or epoxy adhesives to ensure the sealer is not disturbed during placement of the concrete.

The sealing strip shall be from an approved supplier and application shall be strictly in accordance with the manufacturer's recommendations.

310.5 Waterproof Membranes for Concrete Roofs and Gutters

Concrete roofs and gutters shall be waterproofed by the provision of a membrane to be laid on top of the slab. The membrane shall be a cold applied preformed waterproof laminated layer comprising a HDPE carrier film with a solar reflective surface and a self-adhesive rubber bitumen compound complying with the requirements of BS 8102. The membrane shall exhibit a tear resistance of at least 250 N/mm when tested in accordance with ASTM D1004. Adhesion to primed concrete to itself shall exceed 1.75 N/mm when tested in accordance with ASTM D100, and a puncture resistance of 290 N 65 mm when tested in accordance with ASTM E154. Membranes shall exhibit a water resistance of not more than 0.14% after

24 hours when tested in accordance with ASTM D574. The contractor shall submit proposals for waterproof membranes for approval, together with manufacturer's catalogues and technical literature.

Waterproof membranes shall be installed entirely in accordance with the manufacturer's instructions. Membranes shall be continued up the internal face of the parapet wall and finished centrally under the coping. Adjacent strips of membrane shall be overlapped to provide a waterproof joint. The provision of a waterproof membrane on the roof slab shall not relieve the Contractor of his responsibilities to produce a waterproof roof slab which shall have successfully passed a watertightness test before the membrane is installed.

Section 4 Pipelines, Pipework

401 General

401.1 Equivalency of Goods, Materials and Plant

Wherever reference is made in the Contract, including Specifications, Drawings and Bill of Quantities, to specified manufacturers or suppliers for the supply of goods, materials and plant for the Works, goods, materials and plant from alternative manufacturers and suppliers will be permitted, unless otherwise expressly stated in the Contract, providing these other goods, materials and plant are substantially equal or of a higher quality than those of the specified manufacturer or supplier and are approved in writing by the Project Manager. Differences between the specified goods, materials or plant and the proposed alternative shall be described in writing by the Contractor and submitted to the Project Manager, together with such manufacturer's or supplier's technical literature and samples as the Project Manager may reasonably require. At least 28 days prior to the date when the Contractor desires the Project Manager's consent. In the event the Project Manager determines that such proposed alternative goods, materials or plant do not ensure substantially equal or higher quality, the Contractor shall obtain the goods, materials or plant from the manufacturer of supplier specified in the Contract.

401.2 Materials

Any material which will come into contact with potable water or water to be used for potable supply shall comply with the UK regulations on the use of materials for potable water supply. Water Supply (Water Quality) Regulations 1989 and 15th Statement of the Department of Environment Committee on Chemical and Materials of Construction for use in public water supplies and swimming pools, published by the Department of the Environment, UK or national standards adopted for use in Kenya.

401.3 Approval

As soon as possible after commencement of the Contract, the Contractor shall submit to the Project Manager for his approval a list of his proposed suppliers, sources of materials and proposed standards. No materials, plant or equipment shall be procured for the Contract without first obtaining the Project Manager's approval. Samples of materials shall be submitted to the Project Manager for approval as required by the Project Manager. Materials subsequently supplied shall conform to the quality of the samples which have been approved by the Project Manager. No standards, method of manufacture or specification shall be changed without the approval of the Project Manager. Where possible, plant shall be supplied to the same standards or to compatible standards.

The Contractor shall provide secure storage for all samples submitted to the Project Manager.

401.4 Dimensions

Plant and materials shall be supplied to the general arrangements and dimension, or to suit the dimensions, shown on the Drawings or otherwise indicated in the Contract. Where no such dimensions are shown the Contractor shall be responsible for sizing the Plant. Any redesign, extra design, additional construction or any other costs resulting from the use of Plant to other arrangements or to other dimensions shall be the responsibility of the Contractor.

401.5 Packaging and Protections

All items shall be adequately crated or packaged to withstand damage and prevent deterioration due to shipping, handling and storage. The methods of protection and shipping shall be to the approval of the Project Manager.

401.6 Marking

All Plant shall be marked in accordance with Clause 5 of BS EN 545 and Clause 37 of BS 5163. Before shipping, all items shall be clearly marked. Crates or packages shall be marked on two sides with indelible paint with the name of the project, the Employer and the Contract number shall bear marks indicating the contents.

401.7 Receipt, Storage, Handling and Transportation

Plant, equipment and materials shall be stored in such a manner as to preserve its quality and condition to the standards required by the Contract. The Project Manager shall refuse to accept or shall reject any materials of Plant that in his opinion is defective or otherwise fails to comply with the standards required by the Contract. All such defective items shall be removed from the Site as directed by the Project Manager. Repairs shall be carried out in accordance with procedures approved by the Project Manager and shall be completed to the Project Manager's satisfaction.

401.8 Manufacturer's Certificates

The Contractor shall furnish the Project Manager with a manufacturer's certificate conforming compliance to the specification in respect of all items of Plant, equipment and materials. The original and one copy of the manufacturer's certificate shall be delivered to the Project Manager not later than 14 days prior to the intended date of delivery of the item to Site.

401.9 Proprietary Materials

Proprietary materials shall be supplied in suitable containers and in appropriate batch sizes for the work to be undertaken. The containers shall be marked with the following information:

- i. Storage instructions
- ii. The manufacturer's name
- iii. Shelf life and dates of manufacture
- iv. Material identification
- v. Batch reference number
- vi. Net weight
- vii. Mixing instructions
- viii. Any warnings or precautions concerning the contents and their safe use.

The Contractor shall supply with each consignment of proprietary material delivered to the Site, certificates furnished by the manufacturer or his agent stating:

- i. The manufacturer's name and address
- ii. The agent's name and address where applicable
- iii. Material identification
- iv. Batch reference numbers, size of each batch and the number of containers in the consignment
- v. Date of manufacture.

401.10 Rejected Materials

Should any item of plant, materials or manufactured articles be in the judgment of the Project Manager, unsound or of inferior quality or in any way unsuited for the purpose in which it is proposed to employ them, such items, materials or manufactured articles shall not be used upon the Works but shall be branded, if in the opinion of the Project Manager this is necessary, and shall forthwith be removed from the Site.

402 Samples and Storage of Materials

Where required by the Project Manager the Contractor shall submit to the Project Manager for approval samples of pipes, fittings and materials prior to procurement. The Contractor shall only store pipe, fittings and other material at places approved by the Project Manager and shall at all times provide adequate supervision and watchmen to prevent theft or damage. Any loss or damage incurred will be the Contractor's responsibility.

Pipes shall not be stacked higher than recommended by the manufacturer. The area on which the pipes are to be stacked shall be free draining, the grass or other vegetation shall be kept cut and suitable timber

cradles shall be provided on which the pipes shall be laid. End stops to all stacks shall be provided.

Fittings and valves shall not be stacked more than one tier high and they shall be supported off the ground by suitable timbers.

Air valves, rubber joint rings, gaskets, bolts and similar fittings and materials shall be kept in approved locked premises and such fittings and materials shall not be distributed to the trench side until immediately prior to laying, fitting, jointing or assemble thereof. All rubber joint rings and gaskets must be stored in a cool damp location and all fittings and materials shall at all times be stored in the shade under cover and protected from the weather to the satisfaction of the Project Manager.

403 Flanges

Flanges shall be faced and drilled to conform to the dimensions specified in BS 4504. Flanges shall be compatible with the pressure rating of the adjacent pipework or as stated on the drawings. Bolts, nuts and washers (two washers per bolt) shall be to BS EN 1092-3; 2003. No bolt shall project less than two full threads beyond its nut after tightening. In no circumstances shall the shortening of excessively long bolts by cutting be allowed.

Gaskets shall comply with replaced by BS EN 1514 (1997) and replaced by BS EN 681-2 (200) and BS 681-1 (1996) Type W. Flanges shall be painted with two coats of epoxy resin paint. Puddle flanges shall be fitted to all pipework passing through water-retaining structures and manholes greater than 2.5m deep.

404 Mechanical Couplings

Unless otherwise specified or shown in the Drawings pipes and fittings shall be supplied with flexible joints. Mechanical couplings shall be of the Dresser, Viking Johnson type without a centre register. Joints rings used shall be of the ethylene propylene rubber (EPDM) or other material approved by the Project Manager. All mechanical couplings and flange adapters including nuts, bolts and washers shall be supplied with 'Rilsan' nylon thermoplastic polyamide applied by fluidized bed dipping or similar approved.

405 Materials for the Assembly of Flexible Joints

Lubricant shall be of a kind not conducive to the growth of bacteria and shall have no deleterious effects on either the joint rings or pipes. Lubricants for water supply shall not impart to water, taste, colour, or any effect known to be injurious to health.

406 Ductile Iron Pipes

406.1 General

Ductile iron pipes and fittings for water supply shall comply with BS EN 545 (1995). Pipes and fittings shall have spigot and socket joints unless otherwise specified. Pipes shall be class K9. Spigot and socket flexible joints shall be of the push-fit type with gaskets of ethylene propylene rubber (EPDM). The Contractor shall supply 5% of the straight pipes suitable for cutting on site and these shall be clearly marked.

406.2 Corrosion Protection

Pipes and fittings shall be protected externally with an extruded polyethylene or polyurethane coating complying with DIN 30674 Part 1. Pipes and fittings shall be lined internally with centrifugally applied cement mortar and complying with DIN 30674. Joint areas shall be coated with epoxy or polyurethane to DIN 30674. All lining and coating materials shall be approved for contact with potable water by an internationally recognized body like the Drinking Water Inspectorate of UK.

407 Galvanised Steel Pipes

Galvanised steel pipes shall be medium duty manufactured to BS 1387.

408 Steel Pipes

408.1 General

Steel pipes shall be manufactured to BS EN 10224 or AWWA C200 and shall be suitable for the pressure ratings required by the Contract. Fittings shall conform dimensionally to BS EN 10224, AWWA 208-59 or AWWA M11. Unless otherwise specified or necessary to meet the requirements of the Contract steel pipes shall be manufactured as follows:

- a) DN300mm and below shall be manufactured to minimum of Grade L235 or API 5L Grade B
- b) DN350mm and above shall be manufactured to a minimum of Grade L275 or API 5L Grade X42. The pipes and fittings of diameter 600mm or less shall be supplied with push-fit spigot and socket type joints with integral gasket of EPDM rubber or similar to BS EN 10224 or BS CP 2010. Pipes greater than 600mm shall be supplied with ends cut square suitable for use with flexible couplings and the external weld ground back sufficiently.

The Contractor shall supply 5% of the straight pipes as half length pipes (not exceeding 6m). Each pipe shall be supplied complete with a coupling for jointing.

408.2 Corrosion Protection

Steel pipes and fittings shall be protected externally at the manufacturer's works with fusion bonded epoxy resin in accordance with AWWA C213. Pipes greater than 600mm and all fittings shall also be lined internally with fusion bonded epoxy to AWWA C213. Pipes 600mm or less shall be lined with cement mortar to AWWA C205 or BS EN 10298. All lining and coating materials shall be approved for contact with potable water by an internationally recognized body like the Drinking Water Inspectorate of UK.

Where required by the Bills of Quantities, the Supplier shall also price for the provision of an alternative 3LPE coating to DIN 30670 or AWWA C215 of a triple wrap system of fusion bonded or sprayed epoxy primer, an intermediate polymer adhesive layer and an extruded high density polyethylene coating in general conformance with ISO/DIS 21809-1 Class B as appropriate.

409 Glass Reinforced Plastic (GRP) Pipes and Fittings

Glass reinforced plastic (GRP) pipes and fittings for pressure water supply shall be high stiffness and shall comply with the relevant provision of BS 5480. The minimum pipe stiffness shall be 5,000 N/m².

Pipes and fittings shall be marked in accordance with Clause II g. BS 5480.

Pipes shall only be cut by techniques which can be shown not to impair the pipes pressure regression performance. Where any pipe is cut the exposed fibres at the cut pipe end shall be resealed to prevent potential long term degradation. Methods of cutting and resealing exposed fibres shall be submitted to the Project Manager for Approval. Elastomeric sealing rings and foils shall comply with BS EN 681.

On delivery to site and immediately prior to installation each pipe shall be visually inspected both externally, and where possible, internally for damage such as star cracking of the gel coat layer. Where any damage extends through the pipe wall the pipe shall be rejected or the damaged section cut out and replaced in accordance with repair methods approved by the Project Manager. If in the Project Manager's opinion the pipe is not suitable of repair it shall be rejected and removed from site.

410 uPVC Sewers and Pressure Pipes and Fittings

Unplasticised PVC pipes and fittings for water supply pressure pipes shall comply with British Standards 3505 current but also superseded by BS EN 1452 and 4346. They shall be obtained from an approved manufacturer and shall be minimum pressure rated (12 bars) unless otherwise stated.

Unplasticised PVC pipes and fittings for gravity sewers and drains shall comply with British Standards

4660 or 5481 and shall be obtained from an approved manufacturer. Restrained rubber ring type push fit flexible joints shall be used unless otherwise stated. Solvent weld joints will not normally be permitted. Pipes and fittings shall be protected from the direct rays of the sun at all times by means of reflective cover sheets.

411 Concrete Pipes, Bends and Junctions

Concrete pipes, bends and junctions for use in sewers shall be made with sulphate-resisting cement. Pipes, bends and junctions shall conform to the requirements of BS 5911 for the particular class of pipe required to be used. The internal dimensions shall be true and regular and the internal surface smooth and free from surface blemish. The actual diameter of the pipe shall be not less than the nominal diameter. All joints shall be of the gasket type with flexible spigot and socket approved by the Project Manager. Gaskets shall be elastomeric complying with BS EN 681.

The main pipe and branches of all junctions shall be of the same strength classification and shall have the same internal dimensions as the pipes with which they are to be used.

The pipes, bends and junctions delivered to the Site shall be certified by the pipe manufacturer to have complied with BS 5911, or other approved standard and one copy of the certificate shall be delivered to the Project Manager before the goods are unloaded.

Unless otherwise specified pipes are required to be of Extra Strength; they may, unless otherwise specifically called for, be reinforced either with cast-in steel or by an external wrapping of fibre glass and resin, applied by an approved manufacturer.

The Contractor shall provide all facilities for and shall carry out jointly with the Project Manager (if so required) a full visual inspection of all pipes, bends and junctions for manufacturer's defects and other faults or damage. Before any pipe, bend or junction is laid it shall again be carefully examined and sounded with a wooden mallet. Any pipe found to be cracked or otherwise defective shall not be used on the Works.

Concrete pipes shall be internally coated with a 100 percent solids coal tar epoxy lining 70 percent minimum epoxy content. Coat thickness 300 micron minimum.

412 HDPE Pipes and Fittings

412.1 General

Polyethylene pipes up to nominal size 63mm for below ground use shall be coloured blue and comply with the relevant provisions of BS 6572. Polyethylene pipes for use in nominal diameters greater than 63mm shall be as specified below.

The pipes shall be clearly and indelibly marked to show the name of the manufacturer, diameter, pressure class and date of manufacture.

House connection pipework downstream of the manifold shall be PE80; all other HDPE pipework shall be PE100.

412.2 Compound Material

The material from which the pipes are made shall be in accordance with ISO 4427-1. All pipes shall be manufactured using pre-compounded carbon black, bimodal, high density polyethylene MRS 10.0 material (PE100). The use of natural PE100 with a Carbon black master batch is strictly not allowed.

Carbon black should be well dispersed to give outstanding UV resistance, and should have a minimum carbon content of 2%. Pipes should be manufactured from certified PE100+ material with batch certification available with pipe delivery.

412.3 Identification compound

The compound used for identification stripes shall be manufactured from a PE polymer manufactured from the same type of base polymer as used in the compound for pipe production.

412.4 General appearance

When viewed without magnification, the internal and external surfaces of pipes shall be smooth, clean and free from scoring, cavities and other surface defects such as would prevent conformity of the pipe to ISO 4427. The pipe ends shall be cut cleanly and square to the axis of the pipe.

412.5 Color

The pipes shall be black with coloured identification stripes.

412.6 Dimensions

The dimensions of the pipe shall be measured in accordance with ISO 3126. Manufacturing shall be to ISO 4427 Standard, as per the approved dimensions chart.

Pipes should be manufactured in machinery capable of ultrasonic wall thickness detection with production reports provided with delivery of pipes. Where coiling is possible, the minimum internal diameter of the coil shall not be less than 18d.

The lengths shall be supplied to minimize the number of joints to be done in the field, and the size that is allowed to be legally transported on Kenyan roads by the traffic department.

412.7 Markings

All pipes shall be permanently and legibly marked in such a way that the marking does not initiate cracks or other types of failure and such that normal storage, weathering, handling, installation and use does not affect the legibility of the marking.

The colour of the printed information shall differ from the basic colour of the product. The marking shall be such that it is legible without magnification. The frequency of marking shall not be less than once per metre. Markings should be made using a hot embossed foil stamp printing.

Each pipe shall have a minimum of 3 equispaced blue longitudinal stripes indicating medium of fluid transported in the pipes. A summary of marking requirements are given in the table below.

x) Minimum required marking

<u>Aspect</u>	<u>Marking</u>
Standard Number	ISO 4427
Manufacturer's identification	Name or symbol
Dimensions ($d_n \times e_n$)	e.g. 125X11.4
SDR series (for DN > 32)	e.g. SDR 11
Material and designation	PE 100
Pressure rating in bar	e.g. PN 16
Production period (date or code)	e.g. 0204 ^a
Country of Production	Kenya

Aspect	Marking
Coils shall be sequentially marked with the metreage, indicating the length remaining on the coil.	
a - In clear figures or in code providing traceability to the production period within year month and, if the manufacturer is producing at different sites, the production site.	

412.8 Jointing of Pipes

Unless otherwise specified or approved by the Project Manager, Polyethylene pipes shall be electro fusion welded. Joints between polyethylene pipes supplied from different manufactures or not manufactured from the same grade of polymer shall only be joined by electro fusion or by push fit mechanical couplings. Mechanical couplers and compression type fittings shall incorporate a serrated internal liner to support the pipe against compression loads exerted by the fitting and to prevent pullout under axial load.

Butt or socket fusion joint techniques shall only be applied between pipes supplied from single source and manufactured from the same grade of base polymer. Fusion welding of polyethylene pipes shall only be undertaken by skilled operatives using appropriate specialized tooling. Pipes to be jointed shall be free from contamination and care shall be used to protect fusion jointing operations from wind and against the effects of inclement weather. Mechanical jigs or other approved methods shall be used to ensure correct alignment of the pipe when making butt fusion joints. Details of fusion welding procedures including details of tools, operatives, materials and method statements shall be submitted to the Project Manager for approval prior to any jointing.

Steel and iron pipe fittings shall comply with the relevant provision of BS EN 545 (1995) replaced by BS EN 10224 but also current.

412.1 General

Polyethylene pipes up to nominal size 63mm for below ground use shall be coloured blue and comply with the relevant provisions of BS 6572. Polyethylene pipes for use in nominal diameters greater than 63mm shall be coloured blue High Density Polyethylene (HDPE) suitable for a working pressure of 12 bars.

The pipes shall be clearly and indelibly marked to show the name of the manufacturer, diameter, pressure class and date of manufacture.

House connection pipework downstream of the manifold shall be PE80; all other HDPE pipework shall be PE100.

412.2 Joints

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Steel and iron pipe fittings shall comply with the relevant provision of BS EN 545 (1995) replaced by BS EN 10224 but also current.

413 Gate Valves

413.1 General

Valves for normal duty on water pipelines with pressure ratings up to PN25 shall be key operated cast iron flanged gate valves for waterworks purposes generally complying with the requirements of BS 5163 (Type B). All Gate Valves shall be supplied with a 10 year manufacturer's warranty.

Cast iron gate valves for pressure ratings to PN14 shall be cast iron flanged valves complying with BS 5150 replaced by BS EN 1171 (both BS 5150 and BS 5151) or cast iron parallel slide valves complying with BS 5151.

Butterfly valves for pressure ratings of up to PN14 shall be double flanged wafer type butterfly valves complying with BS 5155.

Unless otherwise specified valves for use on steel pipes shall be flanged, where butt-weld ends are specified valves shall comply with BS EN 1984, or BS EN 13709.

413.2 Wedge Gate Valves for Manual Operation

Valves up to and including DN 300 shall be of the resilient seal type and valves larger than DN 300 shall have metal seals.

Spindles shall be of the non-rising type and screwed so as to close the valves when rotated in the clockwise direction. The direction of closing shall be clearly cast on the valve cap or hand wheel as appropriate. The valves shall be constructed of the following materials:

body	-	cast iron;
spindle	-	forged bronze or stainless steel;
metal faces and seal	-	Gunmetal.

The valves shall be suitable for the unbalanced head as specified or indicated in the schedules.

Suitable gearing and anti-friction devices such as ball bearing thrust collars shall be provided as necessary to enable opening and closing by manual operation at the pressure stated, using an effort no greater than 26kg on the tee key or hand wheel supplied. Hand wheels shall not exceed 500mm diameter. A bypass with gate valve forming an integral part of the valve shall be provided where recommended by the valve manufacturer for the pressures specified.

Gearing on valves of DN 300 and less shall be enclosed in a sealed gearbox suitable for buried installation and operated with a tee key. Except where shown in the Drawings, all valves exceeding DN 300 shall be provided with bevel gearing and hand wheels. Valves to be used for washouts and isolating air valves shall have screwed seats.

Extension spindles shall be galvanized or stainless steel adequately supported with cast iron brackets,

and of sufficient diameter to prevent any whiplash effect through twisting when being used to operate the valves. The spindles shall be capped for key operation. Valve caps shall be fitted with hexagonal set screws.

Valves shall be coated with an approved epoxy complying with DIN 30674. Keys for valve operation shall be of sufficient length so that the valves can be operated by a man standing, but shall not exceed 1.2m in length, and shall have a detachable cross bar.

414 Butterfly Valves

414.1 General

Butterfly valves shall conform to BS EN 593. All Butterfly Valves shall be supplied with a 10 year manufacturer's warranty.

414.2 Construction

Butterfly valves shall have a high grade cast iron body to BS EN 1561 designed to the specified working and test pressures. The pressure rating valve shall be cast in the valve body. The disc shall be of high grade cast iron to BS EN 1561 or nodular cast iron to BS 2789 to the defined working and test pressures. It shall have a convex shape designed to achieve low head loss characteristics. The valve shafts shall be of stainless steel operating in self-lubricating bushes in the body.

The valve seat shall be of gunmetal to BS 1400. The sealing ring shall be a renewable Ethylene Propylene Diene Monomer (EPDM) rubber attached to the disc edge by a sectional bronze retaining ring to form a resilient and durable seal.

The valves shall be fitted with hand wheel actuators not exceeding 500mm diameter incorporating gearing to allow opening and closing by manual operation at the pressure stated using an effort no greater than 36kg on the hand wheel supplied.

In all cases the gearing shall be designed to close the valve, from fully open to fully close in a period of not less than ten minutes with this effort. Actuators shall be designed so as to close the valves when the hand wheel is turned in a clockwise direction; the direction of closing shall be clearly cast on the hand wheel. Position indicators shall be fitted to all actuators.

Where required valves shall be electrically actuated with a manual override. Remote actuation shall be provided with a visual indication of valve open, valve closed and percentage opening together with fault indication.

414.3 Valve Performance

A performance curve, relating percentage valve travel, open area and discharge coefficient shall be submitted to the Project Manager. The head loss coefficient with valve fully open shall be defined.

414.4 Testing

All valves shall be tested in accordance with BS EN 593 and pressure and material test certificates shall be submitted to the Project Manager for approval.

415 Air Valves

Air valves shall be either:

- a. Single (small) orifice valves (SAV), for the discharge of air during the normal operation of the pipeline.
- b. Double orifice valves (DAV), consisting of a large orifice and a small orifice. These shall permit the bulk discharge of air from the main during filling and air inflow when emptying in addition to

the discharge of small quantities of air during normal operating conditions.

Air valves shall be supplied with an independent isolating butterfly valve (DAV) or cock (SAV) which permits the complete removal of the air valve from the main, without affecting the flow of water in the main.

Each air valve assembly shall be suitable for connection to a flange on the pipeline.

At the connection between the air valve and its isolating valve a BSP tapping shall be made suitable for fitting of a pressure gauge. All tapings shall be sealed by a brass plug and copper compression ring gasket.

Air valves shall operate automatically and be constructed so that the operating mechanism will not jam in either the open or closed positions.

416 Non-Return Valves

416.1 Swing Check Valves

Non-return valves shall be suitable for waterworks purposes and shall be manufactured to comply with the general requirements of BS EN 12334. They shall be double flanged type, non-slamming and recoilless on flow reversal.

Valves of DN 700 and larger shall be of the multi-disc type or tilting disc type. The valves shall have a high grade cast iron body and cover to BS EN 1561 Grade 220/260 with gun metal nickel bronze alloy door seating. The hinge pin shall be of stainless steel carried on non-corrodible bearings.

416.2 Nozzle Check Valves

Nozzle check valves shall be slam free closing with a streamlined cross section as manufactured by Mannesmann Demag or similar.

417 Flow Control Valves

Flow controls unless otherwise specified shall be butterfly valves. They shall be installed complete with a headstock and position indicator showing the degree of opening.

418 Pressure Reducing Valves

Pressure reducing valves shall automatically reduce a higher inlet pressure to a steady lower downstream pressure regardless of changing flow rate or varying inlet pressure. The valve shall be a hydraulically operated pilot controlled diaphragm type, globe or angle valve.

The main valve shall have a single removable seat and a resilient disc.

419 Ball Float Valves

Ball float valves which are to be installed within reservoirs shall be the delayed action type to eliminate inflow at small valve openings. They shall be fitted with a stilling chamber, auxiliary float valve and inlet bellmouth with regulating valve. The main valve shall be fitted with a long actuating lever to provide a long float travel for slow valve closure.

Valves shall be of the right angle pattern type with flanged inlet and have a resilient synthetic rubber disc which forms a drop tight seal against a removable seat insert. Valves shall be free of cavitation and vibration under the specified working conditions. Flanged tapers shall be provided on the inlets as necessary to suit the size of valves proposed.

Valves shall be capable of withstanding the maximum static pressure and of passing the maximum flow rate shown. Orifice plates shall be provided as necessary to absorb excess working pressure at the initial flow rates indicated.

The pressure rating of the valve shall be cast into the body of the valve.

420 Constant Flow Valves

Constant flow valves shall maintain a constant rate of flow regardless of fluctuations in upstream pressure.

Valves shall be hydraulically operated, diaphragm actuated globe pattern. They shall have a resilient synthetic rubber disc which forms a drop tight seal against a removable seat insert. The diaphragm assembly and valve stem shall be fully guided at both ends by bearings in the valve cover and valve seat. The diaphragm shall consist of nylon fabric bonded with synthetic rubber. Packing glands and stuffing boxes are not permitted and there shall be no pistons operating the valve or pilot controls.

The pilot control shall be direct acting diaphragm valve designed to close when the actuating differential increases beyond the spring setting. The actuating differential pressure shall be produced by a thin edged orifice plate installed in an orifices flange downstream of the valve.

Any necessary repairs to the valve shall be accomplished without removing the valve from the main.

Valves shall be sized to pass the maximum continuous flow stated on the drawings at the working pressure given. The pressure rating of the valve shall be cast into the body of the valve.

421 Surface Boxes and Chamber Covers

Surface boxes and chamber covers shall be either cast iron or ductile iron and coated with black bituminous solution.

Surface boxes over gate valves shall be hinged and chained and shall generally comply with BS 5834. In roads,

tracks, verges: Heavy duty with 150 x 150mm nominal clear opening.

In fields and areas subjected to light wheeled or pedestrian traffic: Medium duty with 150 x 150 mm nominal clear opening.

Surface boxes for hydrant chambers shall have a 150 x 150mm clear opening and shall comply with BS 750 and shall be suitable for heavy traffic loading.

Covers to air valve and other chambers shall be to the dimensions and loading requirements shown on the Drawings or as stated in the Bill of Quantities.

Covers shall be suitable for the following maximum safe centre static loads:

Light duty	- 250kg
Medium duty	- 1500kg
Heavy duty	- 5000kg

Where applicable, covers shall comply with BS EN 124 or other appropriate Standard.

Lifting keys shall be provided for each type surface box or cover supplies. One set of keys shall be provided for every ten surface boxes or covers subject to a minimum of ten sets of keys or the actual number of covers if less than ten.

422 Gully Gratings and Frames

Road gully gratings and frames shall be of approved type and manufacture in cast Grey Ductile Iron and shall be of Heavy Duty Non-rocking Pattern designed for wheel load of 11.5 tonne and generally in accordance with BS EN 124. Single gullies of nominal size 1050mm x 750mm. Inlet gratings of other plan dimensions shall have a minimum water way area of 49% of the total inlet grating area.

Gully frames shall be set in cement mortar and haunched with Class C25 concrete. It shall be the

Contractor's responsibility to establish the finished road levels from the appropriate authority and fix the gratings accordingly.

423 Manhole Safety Chains

Mild steel chain shall be 8 mm nominal size Grade M (4) non-calibrated chain, Type 1, complying with BS withdrawn. After manufacture, mild steel safety chains shall be hot dip galvanized in accordance with BS EN 124.

424 Manhole and Chamber Access Covers

The manhole and chamber access covers shall comply with BS 497 Part 1 and be obtained from an approved manufacturer and shall be to the internal minimum clear opening as detailed in the Contract.

All manhole and chamber access covers in road shall be to an approved Heavy Duty pattern and in footpaths shall be medium/heavy duty unless otherwise specified. The frame and lid shall have key holes formed with sealed pockets underneath to prevent ingress of sand, grit and surface water and shall be of an approved non-rocking pattern. The covers and frames shall have accurate seating faces to prevent rocking and the ingress of sand or water, and it shall be tight fitting to resist overflow conditions or unauthorized removal. The seating faces shall be coated with graphite grease before installation of the cover.

A supply of keys for use with every type of manhole cover and surface box shall be handed over by the Contractor at the completion of the Contract on the basis of one set of keys for each 50 covers or part thereof.

Manhole and chamber cover frames shall be set in cement mortar and haunched with Class C30/10 concrete and shall be set to the camber or fall of the finished road surface. It shall be the Contractor's responsibility to establish the finished road surface levels from the appropriate authority and to fix the covers accordingly.

425 Manhole Step Irons

Manhole step irons shall be of galvanized malleable iron and shall conform in all particulars to BS EN 13101.

Section 4B. Pipeline Construction

426 General

The requirement of this section shall apply to the construction of potable and raw water pipelines and pipework.

Within this section 'Plant' refers to pipe fittings, valves, surface boxes and chamber covers, and other such materials required for pipelines, mains and pipework at reservoirs and elevated tanks.

All Plant shall be suitable for waterworks purposes for the conveyance of potable water in the climatic conditions prevailing in Kenya and in particular at the location of the Works.

The Project Manager shall provide details of each pipeline diameter, pressure rating, hydraulic characteristics and the approximate alignment. The Contractor shall, in consultation with the Project Manager set out the proposed pipeline alignments, making any changes that the Project Manager may deem necessary, confirming also the exact locations of all manholes, valves, air valves, washouts, hydrants, and the like.

427 Topographic Surveys

Topographic surveys along pipeline routes shall be either:-

- Plan and profile surveys, or
- Line and level traverse surveys, as

instructed by the Project Manager.

Plan and profile surveys shall cover a strip of 10.0m wide centrally on the proposed centre line of the pipeline. The survey shall be carried out in accordance with the specification detailed in Clause 106.

Line and level surveys shall comprise a traverse line along the centre line of the pipeline as established by the Project Manager.

428 Handling and Transport of Pipes and Fittings

The loading, transporting, unloading and handling of pipes and fittings shall be carried out such that no damage is caused. All in accordance with the recommendations of the manufacturer and to the approval of the Project Manager. The use of lifting hooks is not permitted. Pillows shall be provided between lashing (ropes, wires or chains) and the pipes. All cradles and lashings shall be of such widths as to prevent damage to the coating of the pipe, or distortion of the pipes.

Valves and fittings shall be transported in timber packing and where possible in the manufacturer's original packaging.

Protective cover and other protective materials provided by the manufacturer shall not be permanently removed until immediately prior to installation.

In the event of any damage being caused to a pipe, the Project Manager shall determine whether damaged piece shall be replaced or repaired. Repair to coating only shall be allowed and shall be as directed by the Project Manager.

In all instances when along trench sides, ferrous pipes shall be supported within 1 metre of either end on sand filled bags such that no part of the wall of the pipe touches the ground, and in the case of pipes over 6 metres long with additional central sand bags.

When pipes are being loaded into vehicles care shall be taken to avoid their coming into contact with any

sharp corners such as cope irons, loose nail heads, etc. Whilst in transit, pipes shall be well secured over their entire length and not allowed to project unsecured over the tailboard of the lorry.

Pipes may not be offloaded from lorries by rolling them, suitable carnage shall be used. Pipes shall not be rolled or dragged along the ground.

429 Stringing and Examination of Pipes Prior to Laying

All DI and Steel Pipes and their coatings and linings shall be carefully inspected on Site prior to laying.

Inspection of the pipe will be made by the Project Manager after delivery and again immediately prior to laying. Any pipe shall be subject to rejection at any time on account of failure to meet any of the Specification requirements, even though pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall immediately be removed from the site.

All pipe or fittings shall be examined before laying and no piece shall be installed which is found to be defective. Any damage to the pipe linings or coatings shall be repaired as directed by the Project Manager. Handling and laying of pipe and fittings shall be in accordance with the Manufacturer's written instructions and as specified herein.

Before lowering into the trench or placing in position each ductile iron pipe or casting shall be slung and sounded with a mallet to test for hair cracks. Pipes that do not ring true will be discarded.

All cement mortar linings shall be visually inspected for defects such as cracking or spalling and crack widths shall be measured to confirm that width is such that natural re-sealing will occur once put into service; otherwise cracks as well as any spalling shall be made good before laying in accordance with the manufacturer's written instructions.

All epoxy linings and all coatings shall be subjected to holiday detection tests, in accordance with NACE RP 0490, the voltage of the holiday detector being selected appropriate for the material and its thickness. No pipe shall be laid having failed the holiday tests until the defective area is made good in accordance with the manufacturer's written instructions and retested satisfactorily before use.

All pipe and fittings shall be thoroughly cleaned before laying, and shall be kept clean until they are used in the work, and when laid, shall conform to the lines and grades required. Pipe shall not be laid unless the trench is free of water and in a satisfactory condition. Ductile iron pipe and fittings shall be installed in accordance with the requirements of AWWA C600 except as otherwise provided herein. If any defective pipe is discovered after it has been laid, it shall be removed and replaced with a sound pipe in a satisfactory manner by the Contractor, at his own expense.

When laying is not in progress, including any work break exceeding 30 minutes, the open ends of the pipe shall be closed by watertight plugs or other approved means. Good alignment shall be preserved in laying. The deflection at joints shall not exceed that recommended by the Manufacturer. End caps shall not be removed until such time as the pipe is to be inspected and laid.

Where the pipeline crosses roads, tracks or any other access or where directed by the Project Manager, the Contractor shall place the pipes so that access to the public is not in any way prohibited.

Shortly before laying or fixing any valve, pipe or fitting, the Contractor shall examine each valve, pipe and fitting to ascertain that there is no damage or defect. The Contractor shall give the Project Manager not less than 48 hours notice of his intention to undertake such examination. The Contractor shall not lay such pipes and fittings until he has received approval from the Project Manager.

Linings shall be inspected prior to laying and any defect made good.

430 Laying Pipes

Immediately before any pipe is lowered into the trench the plug shall be removed from the end of the last pipe laid and the new pipe shall be carefully lowered into the trench.

Each pipe and fitting shall be laid true to alignment curve and gradient in accordance with the Drawings or as directed by the Project Manager. The minimum gradient shall not be flatter than 1 in 500.

Pipes shall be boned to gradient and sight rails shall be provided for this purpose at intervals not exceeding 50m and at all changes in grade. No dips or summits shall be permitted other than as shown on the Drawings.

430.1 Embedment and Compaction

All ductile iron and steel pipes shall be embedded using a sand or coarse grained soil with less than 12% fines, which if necessary shall be imported if excavated material is found to be unsuitable:

In areas prone to water logging or where specifically called for on the Drawings or in the Bills of Quantities a single size or graded gravel shall be used as a special lower bedding, with grading as indicated below.

Nominal Pipe Diameter (mm)	Grading for Special Lower Bedding [to ASTM Sieve Sizes]	
	Single size Gravel	Graded gravels
< 200	10 or 14 single-size gravel	14 to 5 graded
200 to 500	10, 14 or 20 single-size gravel	14 to 5 graded or 20 to 5 graded
> 500	10, 14, 20 single-size crushed rock, or gravel	14 to 5 graded or 20 to 5 graded

The suitability of as-dug trench material as an embedment material and where imported, the source shall be approved by the Project Manager. Any delays as a result of not seeking this approval in good time shall be entirely to the Contractor's account

All layers of the embedment shall be thoroughly compacted, and shall not exceed 150 mm and be raised evenly on both sides of the pipe as it is placed. A minimum compaction of 90% MPD shall be achieved at all times, this being confirmed by sampling and testing at intervals on different levels of embedment at intervals of not more than 50 m with testing in accordance with BS 1377 or ISO 22476 using the "sand replacement" method.

Should any results fail to achieve this absolute minimum level, then the pipes, embedment material and layer shall be removed for an equal distance on either side of the failed test, the total distance being equal to the length between adjacent sampling locations, and re-laid appropriately but with compacted layer thickness halved. In addition the distance between sampling and testing shall also be halved until in the opinion of the Project Manager's Representative a sufficient number of consecutive passes allows both individual layer thickness and the distance between sampling and testing to be returned to the previous thickness and spacing.

All backfill soil above the embedment shall be free from clay lumps, boulders and rock fragments greater than 50 mm and as far as practicable, given the nature of the soil, 90 % MPD shall be attained. However, this requirement may be relaxed to 85% MPD by the Project Manager's Representative if he considers the circumstance warrant it.

430.2 Pipes Laid in Trench

Pipes and fittings laid in trench shall have at least the minimum cover stated in the Drawings.

Long radius curves in buried pipelines shall be negotiated by deflections taken up in the joints of one or more pipes. The deflection at joints shall not exceed 75% of the manufacturer's maximum specified limits. Designs have been based upon the use of 6m long pipes. If the Contractor provides longer pipes sufficient short lengths shall be provided to enable the proposed pipe curvature without additional bends or deep excavation.

Pipes shall not be dragged along the trench bottom. Pipes laid in trenches shall be laid and firmly bedded on an even and uniform bed. Where pipes are not laid on a granular bed, the bottom of the trench shall be smooth and free from stones or other projections.

Joint holes shall be excavated below the trench bottom and shall be as small as possible and shall be filled in and compacted after the pipes are laid and before the refilling of the trench is commenced.

430.3 Pipe Bedding and Surround

For polyethylene, uPVC and GRP pipelines, Class S bedding shall be used where the cover is equal to or greater than 1.0m. Where there is less than 0.6m cover, Class A concrete surround shall be used. In between the Project Manager shall decide upon the bedding type dependent upon the assessed risk of damage to the pipe.

430.4 Pipes Laid Above Ground

Pipelines to be laid above ground shall be constructed of flanged ductile iron pipes with mechanical type expansion joints. Supports shall be provided at a maximum spacing of one pipe length and adjacent to the flanged joints.

The expansion joints shall compensate for a variation of ambient temperature between zero and 40° C on the adjoining pipeline. Anchorages shall be provided immediately uphill of each expansion joint and at each change in vertical and horizontal alignment. The ground/rock surface under the pipeline shall be re-graded as necessary to allow a satisfactory vertical alignment of the pipeline.

The Contractor may propose, as an alternative to the use of mechanical expansion joints, either of the following methods for accommodating thermal expansion:

- (1) A zigzag pipeline alignment whereby the thermal movement is accommodated by deflection of the bends.
- (2) A rigid form of construction with the thermal movement being constrained within the pipe walls by the use of substantial anchor blocks.

Joints shall be made in compliance with the manufacturer's instructions as approved by the Project Manager. Care shall be taken to ensure the absolute cleanliness of the pipe ends and joint components. Only the recommended approved lubricants shall be used.

Jointing shall only be carried out by experienced personnel under close supervision by the Contractor.

The Contractor shall ensure that no dirty water or other extraneous matter is allowed to enter the pipes during or after laying. In the event of dirty water or extraneous matter entering the pipes the Contractor shall immediately carry out cleaning and disinfection as directed by the Project Manager.

Except when necessary for jointing, the end of the last pipe laid shall be kept plugged to the satisfaction of the Project Manager to prevent the ingress of dust, dirt, rocks and other debris.

The Contractor shall be liable for any damage caused to the Employer's Plant and apparatus or other equipment as a result of foreign matter of any kind not having been cleared out of pipelines before Taking-Over.

Pipe trenches shall not be backfilled until approved by the Project Manager. Once approved trenches shall be backfilled without delay to at least the minimum extent required for pressure testing.

431 Cutting Pipes

The edges of the cut pipes shall be clean, true and square. Ductile iron pipes shall only be cut with an approved mechanical pipe cutter in conformity with the pipe manufacturer's recommendations. The use of oxyacetylene flame cutter will not be permitted. The edges of the cut together with those parts of the pipes from which the coating has been removed shall be given two coats of bituminous paint and the internal lining repaired. When the cut pipe is to be inserted in a "Tyton" type joint it shall be bevelled for 10mm at 30° to pipe the axis.

Asbestos Cement, HDPE, uPVC and GRP pipes shall be cut with an approved mechanical pipe cutter and in conformity with the pipe manufacturer's recommendations. Where the cut end of the pipe is to be incorporated in a joint the pipe shall be turned down to the correct diameter required for forming the joint by an approved mechanical turning machine. The length of turning shall be accurately bevelled by mechanical means to the dimensions specified in the manufacturer's recommendations.

Steel pipes shall be cut by using a mechanical pipe cutter approved by the Project Manager. The use of an oxyacetylene flame cutter will not be permitted. The edges of the cut shall be given two coatings of liquid epoxy compatible with the original coating. The external coating and the internal lining shall be repaired to the approval of the Project Manager. The cut end shall be bevelled as required to suit the form of joint used.

432 Proprietary Joints and Couplings

Proprietary joints and couplings shall be assembled in accordance with the manufacturer's instruction as approved by the Project Manager. Where pipes are laid above ground and jointed with bolted couplings the joint shall be protected against vandalism by sheathing with an approved heat-shrink moulding as manufactured by Raychem of Swindon UK or similar approved.

433 Flanged Joints

Flanged joints shall be made with two washers per bolt, one under the bolt head and the other under the nut. The tightening of the bolts shall be carried out in the sequence and to the torque recommended by the manufacturer. A torque wrench shall be used.

Buried flange joints shall be protected by painting with approved bitumen paint and by wrapping using 'Denso' paste, mastic tape and outer wrap, or similar approved materials all in accordance with the manufacturer's instructions as approved by the Project Manager, unless supplied with epoxy coating and galvanized bolts.

Flanged adaptors and mechanical couplings shall have a RILSAN nylon coating applied by the manufacturer.

434 Steel Pipelines Welded Joints

If specifically required under the contract pipes shall not be welded. If permitted by the Project Manager for particular conditions the Contractor shall submit to the Project Manager a detailed method statement for constructing the pipeline using welded joints which shall include, but not be limited, to:

- (i) details of the Contractor's skilled labour and supervision staff who have direct experience in the construction of welded steel pipe;
- (ii) details of the Contractor's plant to be deployed;
- (iii) details of temporary staging, access and craneage;
- (iv) procedure for construction of supports and anchorages, and welding joints;
- (v) quality assurance proposals for testing the integrity of the welds.

These details shall be submitted to the Project Manager for his approval not later than 21 days before the Contractor wishes to commence pipe laying.

All field welds shall be inspected visually with special attention given to the line up and down the root run

or stringer beads. Non destructive testing of the completed weld shall be carried out using radiographic methods with procedures in accordance with BS 2910.

On completion and inspection of joint welding, remedial works shall be carried out on the internal lining and external coating. No more than five pipe joints shall be welded without completion of remedial works to joints.

435 Fixing Valves and Penstocks

Valves, penstocks and other fittings shall be securely fixed. Extension spindles and headstocks shall be properly aligned and fixed in a vertical position and valve caps shall be fixed securely using the locking nut.

436 Thrust and Anchor Blocks

Concrete thrust and anchor blocks shall be formed at bends, tees and valves in accordance with the details shown on the Drawings or as directed by the Project Manager. Excavation shall be made after pipelaying and the blocks concreted immediately after excavation. The back supports and blocks shall abut in to solid undisturbed ground with all loose material being removed before concreting.

No pressure shall be applied in any section of main until the concrete has achieved adequate strength and at least three day's curing.

Flexible joints shall not normally be cast in. Where the size of the block does not make this possible, additional flexible joints shall be provided no greater than half a pipe diameter beyond each face of the block.

437 Concrete Surround to Pipes

Where pipelines pass under streams and rivers or where directed by the Project Manager, the pipeline shall be surrounded with concrete as shown on the Drawings.

Concrete surround shall be "broken" at all pipe joints to retain flexibility in the pipeline. No joints shall be concreted in without the prior approval of the Project Manager.

438 Flotation of Pipelines

The Contractor shall ensure that flotation of the pipeline does not occur during construction. Sufficient backfill shall be placed over each pipe after laying and before testing to prevent flotation.

439 Pressure Rating

The pressure rating of pipes shall be as indicated on the drawing or Bill of Quantities or if not indicated then selected such that the maximum pressure in the pipeline inclusive of surge pressures shall not exceed the maximum allowable sustained working pressure rating of the pipe;

The surge pressure amplitude (the difference between maximum and minimum surge pressures) shall not exceed one half of the maximum allowable sustained working pressure rating of the pipe.

440 Testing of Water Supply Pipelines

All pressure pipelines shall be hydrostatically tested. Site test pressures shall be 1.5 times the maximum working pressure or allowance pressure plus 5 bar whichever is the smaller measured at the lowest part of the pipeline, unless otherwise specified on the drawings.

The Contractor shall give the Project Manager not less than 48 hours notice of his intention to carry out a pressure test. Testing shall not commence without the Project Manager's approval. Before a length of pipe is tested, each pipe shall be securely anchored. All thrust and anchor blocks shall have been constructed and, the barrel of each pipe shall be backfilled to the extent necessary to prevent flotation or movement of the pipeline and shall be not less than 600mm.

Normally joints shall be left exposed until pressure testing has been satisfactorily completed. Any need to backfill a pipeline before pressure testing shall not relieve the Contractor of his responsibility to excavate to locate and repair any leaks.

Pressure testing shall be carried out as the work proceeds in such lengths as are convenient but not exceeding 500m. The ends of the length of pipeline under test shall be closed by means of securely anchored caps or blank flanges. Pipeline valves shall not be used for this purpose. All washout valves shall be fitted with blank flanges and the valves opened before the commencement of any pressure test. At each air valve location, a special air release arrangement shall be provided to allow manual release of air during filling operations. Pressure testing shall not be carried out with permanent air valves in place.

The pipeline to be tested shall be filled slowly with water in such a manner that all air is expelled. Air vents shall be checked to ensure that no air is trapped at high points.

The pressure in the pipeline shall slowly be raised to the working pressure, the test pump disconnected and the pipeline left charged under pressure with air valves opened for a period of not less than 24 hours to allow air in the pipeline to be expelled and pipe linings and pipe walls of absorbent materials to become saturated. At the end of this period of time air valves shall be closed and the test pump shall be reconnected and the pressure in the pipeline raised to the test pressure and this pressure maintained for a period of 24 hours or such other period as directed by the Project Manager.

Throughout this period the pressure in the pipeline shall not be allowed to fall or rise more than 6m head of water above the test pressure and this shall be accomplished by pumping water into or releasing water from the pipeline as required. The volume of water pumped into or released from the pipelines shall be carefully measured. At the end of the test period the pressure in the pipeline shall be adjusted to the test pressure by pumping water into or releasing water from the pipeline as required.

The apparent leakage from the pipeline shall be ascertained from the net volume of water that has been pumped into the pipeline during the test period. The permissible loss shall not exceed 2 litres per metre nominal bore per kilometre length per m head per 24 hours.

During the pressure test exposed joints shall be inspected and any leakage or seeping joints shall be remedied. All signs of leakage shall be remedied whether total apparent leakage from the pipeline under test is less than the apparent allowable leakage or not. Should any length of pipeline fail to pass the pressure test the Contractor shall at his own expense carry out all work necessary to locate and remedy the faults and to retest the pipeline until it satisfactorily passes the test.

A low pressure air test (not exceeding 0.3 bar) may be used as a preliminary joint tightness test prior to backfilling and hydrostatic testing. The water used for pressure testing shall be provided by the contractor and shall be free from impurities and of such a quality which will not pollute or injure the pipeline. The Contractor shall be responsible for obtaining the water, transporting it and for its safe disposal on completion.

441 Cleansing and Sterilizing of Pipelines

After the pipelines have been completed and pressure tested satisfactorily as herein specified the Contractor shall flush out and cleanse the pipelines. Where water is provided by the Employer, the cost of this will be reimbursable under a provisional sum.

Diameters 300 mm and greater:

Pipelines shall be cleansed in sections and this shall be carried out by means of passing through polyurethane foam swabs. The swabs shall be to the approval of the Project Manager.

Diameters less than 300 mm:

Pipelines shall be cleansed in sections by flushing with potable water, for a period of time to be decided by the Project Manager's Representative.

Cleansing of any section shall be repeated as required by the Project Manager's Representative in the event of the initial or subsequent operation not being to his satisfaction. The cost of such water shall be charged to the Contractor.

The Contractor shall supply all necessary equipment for the cleansing and sterilizing operations, including all swabs and swab detectors which shall be handed over to the Employer on completion of the Works.

Swabs shall be passed through pipelines at speeds of between 0.2 and 0.4 metres per second to obtain the best cleaning results with the minimum number of passes. Should it be apparent from the debris collected by the swab that damage to the lining has occurred, the Contractor shall be wholly responsible for repairing the lining to the satisfaction of the Project Manager's Representative.

The swabbing operation shall be controlled by an experienced Project Manager to ensure that no undue surges in the pipeline, heavy docking of the pig or pressurising of the pipeline occur causing damage to any of the permanent works. Any damage caused shall be made good by the Contractor to the satisfaction of the Project Manager's Representative.

The Contractor shall make all necessary arrangements for the transportation of water from the point of supply from the Employer to the required location, and make all arrangements for the disposal of the water. All disposal methods and locations shall be to the approval of the Project Manager's Representative.

When the pipelines have been cleansed to the satisfaction of the Project Manager's Representative the Contractor shall introduce at a slow rate of water flow by a portable chlorinator or other approved means of a solution of sterilizing agent in such quantity and of such strengths as will result in the concentration of chlorine throughout the length of the pipelines of not less than 30 parts per million. This sterilizing charge shall be allowed to remain in the pipelines for 24 hours after which time the pipelines shall be thoroughly flushed using the supply water to remove chlorine in excess of that in the supply water.

When this flushing has been satisfactorily completed samples of water will be taken by the Project Manager's Representative for bacteriological analysis by the Employer. If any of the results of the analyses are unsatisfactory when compared with those of the control sample of the supply water the sterilizing process shall be repeated until satisfactory results are obtained. On completion of sterilizing and flushing the pipelines shall be left full of supply water.

The Contractor shall be solely responsible for the provision of all labour, materials and chemicals necessary for carrying out the foregoing operations.

The cost of water used for repeated cleansing, sterilizing and flushing pipelines in accordance with this clause of the Specification will be charged to the Contractor and the Contractor shall be responsible for all temporary works and other arrangements in connection with cleansing, sterilizing and flushing the pipelines.

The costs of the initial sampling analyses and preparing reports on the bacteriological quality of the water shall be borne by the Employer but the costs of any subsequent sampling analyses and preparing reports should the initial reports be unsatisfactory shall be borne by the Contractor.

442 Painting

All steel or ductile iron pipes and fittings exposed to view including above ground pipelines shall be painted after making good the external protection with two coats of “Bitumastic Aluminium solution D. 5909” manufactured by Wailes Dove Bitumastic Ltd, Hebburn, Durham, England, or similar approved.

Pipes and fittings in chambers shall be painted with two coats of “Bituros Solution” manufactured by Wailes Dove Bitumastic Ltd, or similar approved. Valves and Surface Boxes shall be similarly painted.

443 Connections to and Diversions to Existing Pipework

443.1 General

The Contractor shall be responsible for connecting new pipework and service connections laid under the Contract to existing pipework, and for blanking-off existing pipework and service connections. The connection shall be made in a manner to minimize any disruption to supply.

Before blanking-off or making a connection to existing pipework the Contractor shall notify the Project Manager in writing no less than 14 days in advance of the date on which he proposes to carry out the work. After giving such notice the Contractor shall obtain from the responsible Authority agreement on the precise date, times and method that the connection will be made. The connection or blanking-off shall be made at such times of the day or night as stipulated by the Project Manager.

The Contractor shall prepare a detailed method statement, programme of the work and a schedule of all plant and materials to be used and shall obtain the approval of the Project Manager not less than 72 hours before commencement of the work. The programme shall allow for the immediate re-commissioning on completion of the work.

The Contractor shall be responsible for locating the exact line and level of the existing pipework and service connections and shall agree with the Project Manager and the responsible Authority the precise location of the connection or blanking-off.

443.2 Materials

Before commencing the connection the Contractor shall excavate trial pits as necessary and shall check the outside diameter of the existing pipework and ensure that the couplings to be used for making connections to the existing pipework and the materials used for blanking-off existing pipework are dimensionally suitable.

The Contractor shall ensure that all the materials are on site not less than 24 hours before the commencement of the work.

443.3 Personnel

The Contractor shall ensure that at least one senior member of his field supervisory staff, who is experienced in such operations and fluent in both English and the language of his labourers is on site throughout the duration of the work.

The Contractor shall also ensure that all necessary skilled artisans and an adequate number of labourers for the operation are on site throughout the work.

443.4 Preliminary Work

The Contractor shall execute all works possible before disconnection of the supply including:-

- a. Excavation and supports to the excavation.
- b. Blinding with concrete the immediate working areas, but not less than the whole of the bottom of the excavation.
- c. Putting in all drains, or where this is not possible a sump of adequate size from which a pump may operate.

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- d. Casting the floor of any chamber which is later to be constructed around any of the works.
 - e. Casting the thrust blocks or any other works which may be required.
 - f. Exposing and cleaning pipes in readiness for the work.

443.5 Carrying out the Work

The Contractor shall be responsible for emptying the section of existing pipework on which the work is to be carried out, by a method agreed with the Authority and approved by the Project Manager.

The Contractor shall take all precautions necessary to prevent dirt and other foreign matter entering the pipelines.

The Contractor shall provide at the Site a sufficient quantity of clean water containing approximately 10 parts per million (10mg/l) of chlorine before proceeding with the cutting of the existing pipeline. Each item of pipework including the joints shall be submerged in the solution for a minimum period of 15 minutes immediately prior to installation.

443.6 Water Pipes and Chambers to be abandoned

Where existing water pipes are to be replaced with new pipework the existing pipework is to be abandoned. Where new works conflict with existing pipework to be abandoned, abandonment of pipework shall consist of removal and disposal to a site approved by the Project Manager. Water supply pipework shall not be abandoned until suitable alternative means of supply are in place and ready for connection.

Where chambers are to be abandoned these shall be broken down and disposed of and the void filled and compacted with suitable material approved by the Project Manager. Chambers deeper than 1 metre will be broken down to 1 metre below finished ground level and the remaining void filled and compacted with suitable material approved by the Project Manager.

Section 4C. Drains, Sewers and Manholes

444. Excavation for Drains, Sewers and Manholes

The ground shall be excavated to the lines and depths shown on the drawings or to such other lines and depths as the Project Manager may direct. Trenches shall be of sufficient width to enable the pipes to be properly laid and jointed. In case of pipes of greater diameter than 300mm, the width of trench shall be external diameter of pipe, plus 400mm.

When any excavation has been taken out and trimmed to the levels and dimensions shown on the drawings or as directed by the Project Manager, the Project Manager shall be informed accordingly so that he may inspect the completed trench and no excavation shall be filled in or covered with concrete until it has been so inspected and the Contractor has been authorised to proceed with the work. All surplus materials from such excavations not required for refilling shall be carted away to tips, or otherwise disposed of, as directed.

All excavations shall be kept dry, and all bailing and pumping, timbering, shoring and supporting of sides that may be required, and any refilling, ramming and disposal of surplus materials necessary in carrying out the excavations and backfilling of trenches shall be taken to provide a solid and even bed for barrels of the pipes and, where a concrete bed is not specified, the floor of the trench shall be properly shaped to receive the sockets and the backfill must be thoroughly rammed along the sides of the pipe.

445. Supports for Pits, Trenches and Other Excavations

The sides of pits, trenches and other excavations shall, where necessary, be adequately supported to the satisfaction of the Project Manager, and all such excavations shall be of sizes sufficient to enable the pipes and bedding to be laid accurately, and proper refilling and compacting to be carried out.

The Contractor shall take all precautions necessary for the safety of adjoining structures and building by shoring, opening in short lengths or otherwise, during the time the trenches are open.

446. Rock Cutting in Trenches for Pipes

Where solid rock is met within trenches, it shall be cut out to a depth of 100mm below the intended level of the bottom of the pipes, and replaced with 100mm of approved material as specified. In measuring such rock excavation the Contractor will be allowed a width of 400mm more than the external diameter of the pipes to a level of 100mm below the bottom of the pipes. The Contractor shall dispose of all surplus material arising from rock excavation in a manner to the approval of the Project Manager.

447. Water in Trenches for Pipelines

Trenches shall be kept free from water at all times during construction of works until, in the opinion of the Project Manager, any concrete or other works therein are sufficiently set, and the Contractor shall construct any sumps or temporary drains that the Project Manager may deem necessary.

The Contractor shall be responsible for the removal and disposal of all water entering the excavations from whatever source and shall deal with and dispose of such water in a manner approved by the Project Manager so as to ensure that excavations are kept dry while ensuring that the disposal of this water does not cause a nuisance to adjacent plot holders or works. The Contractor shall provide all plant, labour and materials required for such work.

448. Laying and Jointing Rigid Jointed Concrete Pipes

Concrete pipes shall be laid true to line and level, each pipe being separately boned between sight rails.

For spigot and socket joints, the spigot of each pipe shall be placed home in the socket of the one previously laid, and the pipe then adjusted and fixed in its correct position with the spigot of the pipe accurately centred in the socket. A ring of tarred rope yarn shall next be inserted in the socket of each

pipe previously laid and driven home with a wooden caulking tool and wooden mallet, such yarn when in position shall be 25mm in depth. The socket shall then be completely filled with cement mortar 1 to 2 and a fillet of the same worked all round the side. The fillet shall be levelled off and extend for a length of not less than 50mm from the face of the socket.

For 'Ogee' jointed pipes, the joints shall be thoroughly cleaned before laying, and cement mortar, shall be applied evenly to the ends for jointing so as to completely fill the joint. The pipes shall then be neatly pointed with a band of cement mortar approximately 125mm wide and 20mm thick. The inside of each joint shall also be pointed up as the work proceeds.

Special care shall be taken to see that any excess of cement mortar etc. is neatly cleaned off while each joint is being made and any earth, cement or other material cleaned out of the pipes by drawing a tight-fitting wad through them as the work proceeds, or by other approved means. A properly fitting plug shall be well secured at the end of the last laid pipe and shall be removed only when pipe laying is proceeding. The trenches, pipes and joint holes shall be kept free from water until the joints are thoroughly set.

Where shown on the drawings or directed by the Project Manager, concrete pipes shall be bedded and haunched or surrounded with concrete.

449. Pipes Laid with Open Joints

O.G. porous concrete pipes shall be laid unjointed with a space of 12mm between the spigot and the inner end of the socket.

All pipes shall be packed and surrounded as directed by the Project Manager with approved broken stone, sand or gravel aggregate, to the gradings as shown on the drawings or stated in the Bill of Quantities.

450. Drains to be Left Clean on Completion

On completion, all drains, manholes, etc. shall be flushed from end to end with water from an approved source and left clean and free from obstructions.

451. Refilling Trenches

Trenches shall be refilled with suitable excavated material of 100mm surround but not before the work has been measured and approved by the Project Manager. For pipes which are not surrounded with concrete, the first layer of filling material shall be free from stones and shall not be thrown directly on to the pipes, but shall be placed and packed with care all round them. All filling shall be deposited and compacted in layers, not exceeding 225mm loose depth, to a dry density not less than that of the adjoining soil. The last 450mm of filling must be returned in the order in which it has been removed. Timber and framing shall be withdrawn ahead of the layer to be compacted, care being taken to keep the sides of the trenches solid and to fill all the spaces left by the withdrawn timber.

452. Connections of Existing Sewers and Drains

Where shown on the drawings, existing sewers and drains shall be properly extended, connected and jointed to new sewers, culverts, drains or channels. All such connections shall be made during the construction of the main sewer, drain or other work and a record of their positions kept for future use or reference. Where pipe connections are made to a sewer, stone pitched or lined channel, the pipes shall be well and tightly built into the concrete, or masonry work and be so placed as to discharge in the direction of the main sewer, drain or channel and with the end of the pipe carefully cut to the necessary angle. Where the connections are between pipe sewers or drains, special connecting pipes as shown on the drawings shall be supplied and be truly laid and properly jointed.

453. Manholes and Inspection Chambers

Manholes and inspection chambers shall be constructed in accordance with the drawings and in the position shown on the drawings or directed by the Project Manager. The side walls shall be fair faced or rendered internally as specified on drawings. They shall be brought up vertically to receive a precast slab formed of concrete of the appropriate classes specified and reinforced all as shown on the drawings. Cast iron manhole covers and frames shall be provided and frames shall be bedded in cement mortar 1 to 3 and so set that the tops of the covers shall be flush at all points with surrounding surface of the footway, verge or carriageway, as the case may be. Any slight adjustment of the slab level which may be necessary to accomplish this shall be effected by topping the side walls with concrete integral with the slab.

If required, half channel pipes, bends and junctions as specified shall be laid and bedded in cement mortar 1 to 3 to the required lines and levels, and both sides of the channel pipes shall be benched up with concrete of the appropriate class and finished smooth to the slopes and levels as shown on the drawings or directed by the Project Manager. The ends of all pipes shall be neatly built in and finished flush with cement mortar 1 to 3. Where the depth of the invert exceeds 1 metre below the finished surface of the carriageway or the adjacent ground, iron steps shall be built in with alternate steps in line vertically and with such additional hand irons as the Project Manager may direct.

All manholes when completed shall be watertight and to the satisfaction of the Project Manager. The prices inserted in the Bill of Quantities shall include for excavation, provision of all materials, construction, refilling and disposal of surplus.

454. Precast Concrete Manholes

Precast concrete manholes shall be supplied and laid generally in accordance with the drawings.

455. Gully Connections

Connections from gullies to sewers and surface water drains or ditches shall consist of concrete pipes and fittings jointed with cement mortar 1 to 3. All pipes, bends and junctions shall be laid to the lines and levels shown on the drawings or as directed by the Project Manager.

456. Surface Boxes, Covers Etc.

Surface boxes, manholes and other covers lying within the site of the works, shall be raised, lowered, altered or removed as directed by the Project Manager.

457. Gullies

Gullies complete with gratings and with rodding eyes where necessary shall be supplied and laid in accordance with the drawings. Where directed by the Project Manager, precast concrete gullies shall be laid on and surrounded with 100mm of concrete of the appropriate grade. The concrete surround is to be brought up to the underside of the frame or flush with the top surface as the case may be. Masonry gullies shall be constructed from 225mm building stone and rendered internally. Gullies shall be trapped where leading into foul sewers or into combined foul and surface water sewers.

458. Completion of Drainage Works

All sub-soil and surface water drains shall be completed in advance of the construction.

459. Temporary Stoppers

Junction pipes which are laid but not immediately connected to gullies shall be fitted with temporary stoppers or seals, and the position of all such junctions shall be clearly defined by means of stakes or training wires properly marked and labelled.

460. Provision for Future Connection to Manholes

Inlet pipes of the required diameters shall be built into the walls of manholes and elsewhere for future use and shall be of the diameters shown on the drawings. The external ends of all such connections shall be sealed off with temporary stoppers, approved by the Project Manager. The pipes shall be laid and jointed and during the placing of the concrete they shall be adequately supported.

461. Surrounding or Haunching of Pipes with Concrete

Surrounding or haunching of pipes shall be carried out using fine concrete. In carrying out this work the Contractor shall take care to pack the concrete under and around the pipes to ensure even bedding and solidity in the concrete and the concrete shall not be thrown directly on to the pipes. The upper surface of the concrete shall be struck off with a wooden screed or template and neatly finished off.

462. Invert Block and Stone-Pitched Drains

Precast concrete invert blocks and side slabs shall be formed of concrete of the appropriate grade and dimensions shown on the drawings. Each course of side slabs required in the Bill of Quantities shall be interpreted as one complete row of side slabs to one side of the channel concerned. Stone used for channels shall be 225mm x 100mm building stone. Drains should not normally be laid to a radius of curvature less than 10 times the actual width of the drain.

Invert block and stone-pitched drains shall be constructed in the positions and to the levels and dimensions shown on the drawings and laid to true line and even fall. Where under-filling is required it shall be in 100mm maximum thickness layers of compacted murrum. The earth sides to such channels shall be neatly finished to a slope of 1 to 1 or such other slope as the Project Manager may direct.

Invert blocks and side slabs shall be laid on a 100mm minimum thickness of compacted murrum and be neatly jointed with cement mortar 1 to 3 as the work proceeds. The excavation, murrum bedding, providing, laying and jointing invert blocks or stone, backfilling and disposal of surplus shall all be as specified and all in-situ connections shall be in concrete of the appropriate grade.

463. Testing of Jointed Pipes and Manholes

Sealed jointed drains, up to and including 600mm diameter shall be tested in sections (e.g. between manholes) by filling with water under a head of not less than 1 metre. Drains found to be water-tight after a period of 30 minutes will be passed as satisfactory but the water must be retained in the pipes until a depth of at least 450mm of filling has been deposited and compacted on top thereof. Drains failing to stand the test shall be taken out and the pipes re-laid and re-jointed until completely water-tight.

Drains exceeding 600mm in diameter shall be tested by means of a smoke test before they are covered up. Both ends of the lengths of drain to be tested shall be sealed to the satisfaction of the Project Manager, and smoke shall then be pumped into the section from an approved machine. Should any joint in the section show an escape of smoke, the section shall be taken out and the pipes re-laid and re-jointed until there is no further escape of smoke.

Should the Project Manager so direct, manholes shall be tested by completely filling with water, and there shall be no appreciable loss over a period of 2 hours.

On completion of the works, or at suitable intervals during construction, infiltration tests will be carried out. The permissible amount of infiltration shall be 1 litre per hour per linear metre of nominal internal diameter.

The Contractor shall provide all labour and apparatus for the above tests.

All testing will be done in accordance with the procedure of the British Standard Code.

464. Pipes with Rubber Ring Joints

Rubber rings shall be entirely suitable for the pipe being used and will be provided by the Contractor. They will be laid in the socket and the pipes then jointed as specified. The jointing of pipes shall be carried out in accordance with manufacturer's instructions and in conformity with any modifications proposed by the Project Manager.

465 Laying, Jointing and Backfilling for Flexible Jointed Pipes

The Contractor shall ensure that any hard spots and loose stones are removed from the formation prior to laying of bedding materials. The Contractor shall lay a bed of thickness 100mm consisting of granular material i.e. sand, gravel, or approved soil of friable nature.

After laying of pipes the Contractor shall lay bedding material on the sides of the pipe compacted by tamping into soffit of sewer.

After completion of this operation the Contractor shall lay the bedding material on top of the pipe in 150mm layers to a thickness of 300mm. The material is to be compacted by tamping. However, precautions are to be taken to avoid excessive tamping on top of the pipe. The remaining trench excavation is to be backfilled.

The pipes shall be laid with flexible ring seal joints provided that solvent cement joints could be used for fittings where necessary subject to the approval of the Project Manager. Pipes and fittings shall be checked for deformities prior to laying. Deformed pipes and fittings shall not be accepted.

Flexible Rubber Ring Joints

The Contractor shall ensure that the spigot end is free from grit, dust or dirt and sealing rings should be seated evenly in the socket groove. Pipe lengths and fittings are supplied with a chamfer on the spigot. Where pipes are to be cut or are supplied without a chamfer on the spigot end the Contractor shall ensure that the pipe is cut square and then form a chamfer on the spigot end with a medium file to an angle of 15 degrees. Remove saw flashing by scraping with a pen-knife.

Expansion Gap

It is necessary to leave a gap between the edge of the spigot end and the base of the socket to allow for expansion. Moulded fittings are supplied with an embossed line indicating the correct depth of insertion. In other cases where the marking is not done, the Contractor shall ensure that an expansion gap of at least 3mm per metre length of pipe or at least 15mm per pipe length is provided. This can be done by marking spigot ends or by pushing spigot fully home, making a small mark on pipe and then withdrawing the pipe by 15mm.

After completing jointing the pipe shall be laid on the prepared bed making sure that a suitable depression is created in the bed for the socket.

Solvent Cement Joints

For solvent cement joints make sure that mating surfaces are clean and free of grease and dirt. Roughen mating surface with sandpaper, clean both surfaces with cleansing fluid using a clean cloth. Apply solvent cement on both mating surfaces. Without delay bring mating surfaces together and hold in position firmly for a few seconds. A layer of cement should be visible at the edges. Joints should not be disturbed for at least 10 minutes after assembly.

Section 5. Building and Structures

501 Concrete Building Blocks

Concrete building blocks shall be of approved manufacture and shall be formed in a press. The blocks manufactured in Class C30 concrete shall be cured for at least 10 days before use.

Blocks shall be well and evenly formed with true corners and unbroken arises, and shall be carefully handled and stacked.

502 Laying Building Blocks

Joints between blocks shall be filled solid with mortar and shall be of regular thickness of 5 to 10mm. The blocks shall be laid in level courses and bonded so that each vertical joint is midway above the face of the block below, except at junctions and piers where a bond of not less than 100mm shall be provided. The walls shall be raised in lifts not exceeding three metres in height in any one day, and truly vertical. All blocks shall be wetted before being laid.

Joints of exposed work shall be raked out and neatly flush-pointed in the same mortar. The whole of the visible faces of the walls shall be left perfectly cleans and all surface mortar and droppings shall be removed before they have set.

Joints in work to be rendered shall be raked out to a depth of 8mm to provide a key for the rendering.

Blockwork shall be tied into adjoining structural members at the same level as blockwork reinforcement using 150mm long butterfly tangs or equivalent fixed and mortared into proprietary vertical strips.

503 Precast Concrete Units Generally

All precast concrete units shall include all fixing plugs and strips to enable screw ties or other fixing devices to be firmly attached. For all precast units to be set in block of masonry walls the plugs and strips shall be so positioned as to provide fixing at course and in no case exceeding 450mm centres.

504 Masonry Using Natural Irregular Stones

Stones shall come from selected quarry layers to the approval of the Project Manager. They shall be homogeneous, frost resistant, flawless, free of any cracks or bousins, solid, and of equal grain and shall have all the required quantities to give a regular facing. They shall give out a clear sound when hit by a hammer.

Mortar shall be removed from the external surface of the wall. The Contractor shall prepare a wall sample approved by the Project Manager which shall be kept at the construction site until all the masonry is completed.

505 Screen Walling

Screen walling shall consist of perorated precast concrete blocks 100mm thick of approved shape, design and manufacture laid to an approved pattern in cement mortar wit perfectly even joints which shall be neatly flush or recess pointed as directed.

506 Damp-Proof Course

All external walls of buildings are to be provided with damp-proof course (DPC) of textured PVC strip of width equal to the total thickness of the wall and any external rendering. The DPC is to be lapped with the damp-proof membrane and bedded in mortar specified for the type of block used. The greatest lengths possible are to be used for the DPC's but any end laps required are to be at least 200mm long made dry without intervening mortar. Piers are to have complete DPC's lapped with the wall DPC.

507 Damp-Proof Membrane

Damp-proof membranes shall be laid, as directed by the Project Manager, beneath all floor slabs resting on the ground. They shall be composed of single sheets of minimum thickness 0.300mm black

polyethylene film of an approved manufacturer specially made for use as damp-proof membrane.

The film shall be laid on sand and turned up around all edges of the slab and with 150 mm margin above the top of the slab to be tucked into the perimeter walls of the building. Where the building is so large as to exceed the maximum sheet size available, several sheets shall be used and the joints shall be lapped 150mm and fused together using a welding tool designed for that purpose. Every care should be taken by the following trades to prevent perforation of the membrane but in the event of the puncture the perforation shall be covered by a patch of similar material of dimensions exceeding the area of the puncture by 300mm and the two sheets welded together as described above.

508 Composition of Mortars

- a. Cement mortar for bonding concrete shall be composed of cement and sand mixed in the proportion of the jointed concrete.
- b. Cement mortar for setting precast concrete or pitching shall be composed of cement and sand mixed in the proportion of 50kg of cement to 0.14m³ of sand, with the addition of an approved plasticizer.
- c. Cement mortar for blockwork in concrete blocks shall be composed of cement and sand mixed in the proportion of 50kg of cement to 0.14m³ of sand.
- d. Sand and Cement for mortars shall be as described in the specification for concrete.

509 Mixing of Mortars

The materials of mortars shall be measured out in their correct proportions and shall first be thoroughly mixed together in a dry state by turning them over upon a clean wooden stage until they are of a homogeneous appearance in consistency and colour. Clean water shall then be added while the mixture is being turned over until it attains a suitable consistency. Plasticizer shall be added in accordance with the manufacturer's recommendations as approved by the Project Manager.

The mortar shall be used immediately after it has been mixed. No mortar which has commenced its first set shall be used, or mixed up again. Mortar shall, where possible in hot weather, be protected from too rapid action by covering with impervious material such as polyethylene film.

Mixing by hand will be allowed only if the Project Manager gives specific approval. Mixing by machine using the same sequence of operations described above shall be carried out whenever possible.

510 Cement Rendering

Rendering shall be in a 50 kg to 125kg cement: sand mix but where approval had been given to the use of a plasticizer or other additives these proportions may be modified to the approval of the Project Manager.

All surfaces to receive a finishing coat of cement rendering or fine concrete shall be thoroughly prepared and cleaned and the rendering or screeding shall be placed immediately after such surfaces have been thoroughly wetted.

All rendering shall be put to a minimum of two coats, the first being left rough to a minimum of 10 mm thickness, but the second coat shall be trowelled up to a fair faces as soon as possible after it is applied.

All internal rendering shall be finished to an even and polished surface with a float, trowel or other suitable tool, special care being taken to obtain perfectly smooth and glazed faces. It shall not be less than 15mm thickness when finished unless instructed otherwise.

All external rendering shall be brought to an even surface with a wood float following which a tyrolean finish of approved colour shall be applied unless otherwise stated.

All rendering shall be protected from sun and rain by adequate and suitable coverings which shall be supplied and fixed in advance of these conditions arising. The renderings shall be kept damp while setting and protected from drying winds.

511 Tanking to Buried Concrete Surfaces

External concrete surfaces to be tanked shall be coated with a bituminous waterproofing membrane 3mm minimum thick. The tanking shall be dressed into structure as shown in the Drawings and be protected by non-rotting boarding prior to backfilling.

512 Waterproof Rendering

Waterproof rendering slurry shall comprise a 50kg to 125kg cement sand mix with an approved waterproofing admixture such as styrene acrylate copolymer.

The material shall block capillaries and minor shrinkage cracks to prevent water ingress while allowing the passage of water vapour through the structure.

The render shall be applied to a total thickness of not less than 20mm the first coat shall be applied levelled scratched and left to dry for not less than 3 days.

513 Grouting in Ironwork

All brackets, rag-bolts and other ironwork for which holes have been boxed out or left in the concrete of a structure shall be carefully grouted in to their correct positions in all particulars. The grouting in shall be carried out with cement and sand grout in such a manner that there shall be no apparent difference in the texture or colour throughout the face of the finished structure and that there shall be no seepage of water either between the ironwork and the set grout or between the set grout and the surrounding structure.

The above instructions shall apply also to the building-in of pipes except that Class C25/10 concrete shall be used in lieu of cement grout.

All holes left for building-in shall be free from any sign of infiltration of water before the building-in is carried out. No reliance shall be placed upon the building-in process for the sealing of such leakage.

514 Cable Duct Covers and Frames

514.1 Recessed Covers

Cable duct covers recessed for flooring finishes shall be provided with galvanized rolled steel angles of height equal to the thickness of the floor finishing and fixed to the surface of the structural floor slab along all edges of the trenches so that the top edge is level with the finished floor level. The angle shall be laid so as to form seating for duct covers and all additional galvanized rolled steel tee sections shall also be provided to support the duct covers.

The duct covers shall be galvanized to suit the ducts and the seating described above. A lightweight galvanized steel mesh shall be fixed to the upper surface of the trays to provide a key for floor finishes. The seating and trays shall be so laid that the finished floor is perfectly level and all trays fully supported at all edges without the use of loose packing. At least one tray in every series of trays covering a length of duct shall be provided with cast-in lifting eyes and a pair of suitable lifting keys shall be handed to the Project Manager on completion.

514.2 Checker Plate Covers

Checker plate covers shall be hot dipped galvanized mild steel fitted flush with the floor surface and fully

supported.

515 Fences and Gates

Fences generally shall be in accordance with the relevant parts of BS 1722 Part 1: 1986. Chain link fencing shall be Type PL.213 Grade A with 1.8 m high plastic covered chain link mesh. The mesh and line wires shall be galvanized prior to being plastic covered. The posts shall be reinforced concrete.

The straining posts, intermediate posts and struts shall be manufactured and erected complete as specified in BS 1722. The fencing shall be true to line and vertical, following profile of the ground, previously graded so as to prevent access beneath the bottom wire. Gates shall be hung on adequate post, and shall be truly vertical.

Ornamental fabricated metalwork fences and gates shall be constructed of mild steel bar, strip or tube in accordance with the Drawings. All welded joints and drillings for bolts shall be made before painting, and all bolts, nuts and washers shall be galvanized or plated in an approved manner. Any metalwork sunk into the ground shall be treated with two coats of bituminous paint.

516 Joint Sealing Compound and Sealants

Joint sealing compounds shall be impermeable ductile materials of a type suitable for the conditions of exposure in which they are to be placed, and capable of providing durable, flexible and watertight seal by adhesion to the concrete throughout the range of joint movement.

Hot poured joint sealants shall comply with BS 2499, Ordinary Type A1 sealant.

Cold poured polymer-based joint sealants shall comply with BS 5212: Part 1, Normal Type N sealant.

Two part polysulphide based sealants shall comply with the relevant provisions of BS 4254. Pouring Grade shall be applied to horizontal upward facing joints and Gun Grade to joints of any other aspect or inclination. Other two part polymer based sealants of Gun or Trowel Grade shall comply with the physical and test requirements of BS 4254.

Silicon bases building sealants shall comply with the relevant provisions of BS 5889. Primers for use with joint sealants shall be compatible with, and obtained from the same manufacturers as, the adjacent sealant. Primers shall have no harmful effects on the concrete.

Sealants and primers which will be in contact with water to be used for potable supply shall not impart to water taste, colour, or any effect known to be harmful to health, and shall be resistant to bacterial growth. Sealants and primers which will be in contact with sewage or sewage sludge shall be resistant to biodegradation.

517 Openings in Walls, Floors and Ceilings

The Contractor shall chase put and/or cut openings through walls, floors and ceilings for the passage of pipes and cables where described in the contract shall provide and fix in position approved tube sleeve cut off flush with the finished surface. All openings and ducts shall be sealed on completion to prevent the passage of toxic or explosive gases.

518 Structural Steelwork

Material for structural steel work shall comply with BS EN 10137 and workmanship with BS 5950. The steelwork shall be securely fixed to the foundations or building and designed to have such strength and stiffness that its deflection and movement under the loads to be applied shall be within tolerable limits.

All bolts and nuts shall comply with the requirements of BS 3693 except for High Strength Friction Grip Bolts which shall comply with BS 4395.

Mild steel electrode shall comply with the requirements of BS EN 499 and High Yield Steel with BS 2540.

All structural steel fabrication shall conform to the requirements of BS EN 5400. The use of High Strength Friction Grip Bolts shall be in accordance with BS withdrawn.

All structural steel work shall be fabricated using welded joints where possible for shop joints and bolted joints for field assemble.

519 Open Mesh Walkways and Covers

Open mesh type walkways, platforms and covers shall be of aluminium or galvanized steel, suitable for a superimposed load of not less than 6kN/m². The walkways, platforms and covers shall include all necessary supports not detailed on the Drawings.

Open mesh panels shall be trimmed with full depth nosing bar along all edges and bolted to each other when in place to help ensure a firm walkway. Panels shall be cut in such a way and fixing so as to provide a continuity of pattern.

Covers shall incorporate a hinged lockable open mesh access panel with a 750 x 750mm clear opening, strong durable hinges and heavy duty non-corrodible padlock. Openings for valve keys shall be just sufficient in size for the valve key and shall incorporate a cover hinged only.

All panels shall be securely bolted to the supporting structure. Where the supporting structure is concrete, galvanized mild steel angle curbs shall be provided and securely grouted into rebates left in the concrete such that the tops of the panels are flush with the top of the concrete.

520 Handrailing

Hand railing shall be approximately 1000mm in height with an intermediate horizontal rail with standards not more than 2000mm apart. Hand railing shall be designed for a horizontal loading of not less than 220N/mm. Hoops shall be welded on where required for fixing guard chains. Standards and rails shall be manufactured from black mild steel tube to BS 1387:1985, from steel tubing to BS 1775 or from extruded aluminium alloy approved by the Project Manager. The nominal bore of steel tubing shall be not less than 32mm. Adequate provision shall be made for thermal movement. Steel hand railing shall be hot dipped galvanized after fabrication.

521 Guardrail

Guardrails shall be 750mm in height with a single top rail. In all other respects it shall comply with the specification for hand railing.

522 Chains

Chains across openings in handrails at tops of ladders shall be galvanized mild steel having 3 SWG x 3 links per 100mm and shall be supplied complete with 'S' hooks and split rings.

523 Steel Access Covers

Steel access covers shall be to the duty required and sized to suit the opening shown on the Drawings. They shall be complete with frame and shall be weatherproof (prevent ingress of water) when closed and shall in all respects be strong and durable.

The covers shall be hinged and lockable and provided with stays to prevent the covers opening more than 105°. The Contractor shall provide with each cover a heavy duty non-corrodible padlock and four keys. The covers and frames shall be galvanized.

524 Isolation of Aluminum

All items of aluminium construction shall be isolated from concrete by the use of bituminous felt or DPC

material or two coats of bituminous paint. The aluminium shall be isolated from dissimilar metal by the use of fibre washers and spacers.

525 Galvanising

Where galvanizing has been specified the items shall after fabrication be hot dipped galvanized in accordance with BS 6530 Part 1 to a thickness of 0.15mm (005'). All items to be protected shall be prepared as specified in the above standards. Articles altered at the manufacturer's works in any way after galvanizing are to be re-galvanized as specified. Articles subject to minor alternations at site or requiring minor repair at site shall be wired brushed to remove all rust and coated with 3 coats of approved zinc rich cold galvanizing compound.

526 Fixings to Structure, etc.

Where fixings to structures previously constructed are to be made by setting a bolt system into performed holes, such fixings shall be made either by Rawlbolt Projecting Bolt Type or by using an approved proprietary resin anchor system. Where performed holes have not been provided a self-drilling expanding bolt system shall be used.

Where thin sections are involved or where stresses are likely to be set up which might cause damage to the structure the use of the resin anchor system only will be permitted. Only in special circumstances will the Project Manager or the Project Manager's Representative permit rawlbolts to be used. Performed holes shall be accurately set to template prior to placing the surrounding concrete and shall be kept rigidly in place until the concrete has properly set.

Where resin anchorage is used the Contractor shall ensure that the setting time of the resin is appropriate to the requirements for setting up, plumbing and aligning the work before it sets. Bolts shall be set to template and hole diameters shall conform to the recommendation of the suppliers. Whatever system is used, all bolts shall be plated to resist corrosion.

Section 6. Roads and Surfacing

601 Access Tracks

Permanent access tracks shall be constructed only where shown on the Drawings. Tracks shall be unsurfaced. Filling to bring formation to the required level shall be locally excavated material which shall be placed in layers and compacted by tracking with the excavation plant. The road formation shall be tracked and graded with a dozer blade or bucket to give a cross fall of not less than 1 in 40. Surface undulations shall not exceed 200mm over a length of 3.0m, unless otherwise approved by the Project Manager.

The maximum gradient shall not exceed one vertical to 6 horizontal and the minimum turning circle radius measured to track centre line shall not be less than 15.0m.

602 Access Roads

The road formation shall be the surface obtained after completion of any earthworks. Filling to bring the formation to the required level shall be selected material. It shall be laid and compacted in layers not exceeding 150mm in thickness, the compaction being carried out by a roller of not less than 8 tonne weight.

The Employer and the Contractor may at any time after the completion of the access road (after 14 days in the case of concrete surfaces) use them or allow their use by their employees or sub-contractors.

At such times during the Period of the contract or Period of Maintenance as the Project Manager may direct, the Contractor shall at his own expense make good any deterioration which may have occurred in the condition of the roads, whether as result of the use of roads by the Employer or otherwise. In particular, any parts of the foundations into which soil has penetrated shall be dug out and replaced with clean materials.

602.1 Macadam Roads and Macadam Hardstandings

(i) The sub-base shall consist of 150mm compacted thickness of free draining granular material conforming to the grading limits specified in the contract. The plasticity index shall be 0-6% maximum and the California Bearing Ratio at maximum density (Test 12, BS 1377:1990) shall be 25% minimum. The material shall be compacted to 95% of the maximum density as determined by Test No. 13, BS 1377:1990 (heavy compaction) by means of a roller of not less than 8 tonnes weight.

If the quality of foundation soil is considered inadequate, the Project Manager may direct that the sub-base be 300mm thick, in which case construction shall be carried out as described above but as two 150mm thick layers.

The road base shall consist of 150mm compacted thickness of free draining crushed limestone conforming to the grading limits stated in the Contract. The plasticity index shall be 0-6% maximum and the California Bearing Ratio at maximum density (Test 13, BS 1377:1990) shall be 80% minimum.

The base shall have a prime coat applied not more than seven days after the completion of the base and not later than twenty four hours after approval by the Project Manager. The asphalt used for the prime coat shall generally conform to the relevant AASHTO specification.

Before laying the tarmacadam base course onto the primed base, all loose blinding material shall be brushed off the road and removed. The tarmacadam base course shall consist of 60mm compacted thickness of 20mm nominal size dense base course macadam. The aggregate and asphalt shall be generally in accordance with the relevant AASHTO specification.

A tack coat shall be applied between successive layers of asphalt material and shall generally conform to the relevant AASHTO specification. Machine laying shall normally be used and compaction shall be carried out with a roller of not less than 12 tonnes weight so as to achieve a dense, smooth and even

surface. Where new road construction is to be joined to an existing road, the surface shall be cut back to a straight line and primed.

(ii) Should the Contractor wish to lay Macadam on the roads early in the Contract for use by the construction traffic, he may do so provided construction is stopped at completion of the Macadam base course and this single layer blinded with bituminous grit to seal the surface.

When all concreting, earth moving and heavy crainage and haulage has been completed, and in general towards the end of the Contract, the base course so provided shall be thoroughly cleaned off and repaired, and re-levelled where necessary, and a suitable cold bituminous emulsion tack coat generously applied by spray in accordance with the manufacturer's instructions, care being taken to avoid spattering kerbs or other adjacent concrete. The wearing course may then be laid and blinded as described in sub-section (i) above. Any additional costs involved in the adoption of the method of laying described in this sub-section shall be included by the Contractor in his rates for road making.

(iii) Notwithstanding the time of placing of the roadworks, the condition of the finished road at the completion of the Contract shall be of 'as new' quality, with clean, accurately profiled, rolled and sealed surface throughout, free from concrete spotting or staining, patch marks, trench outlines, paint, oil or fuel spillages or other visible or structural defects.

602.2 Unsurfaced Roads and Hardstandings

Unsurfaced roads and hardstandings shall be constructed from 300mm of crushed lime stone conforming to the grading limits specified in the Contract, laid in two layers of 150mm.

Each layer shall be compacted to 95% of the maximum density (Test 12, BS 1377:1990).

602.3 Pea Shingle Surfaced Areas

The sub-base to pea shingle areas shall be as defined in 801.1 above. Pea shingle consisting of 20mm thick 5mm nominal single sized stone laid and raked to a level finish.

603 Precast Concrete Kerbs and Channels

Kerbs shall be laid before the adjacent carriageway is constructed and sufficiently in advance to meet the Project Manager's requirements. Kerbs shall be bedded solidly and accurately in their concrete foundations before the initial set of the concrete has started. Each kerb shall be set solidly and accurately to the required line and level with joint no more than 6 mm wide, neatly pointed with cement mortar and filled for their full depth with cement grout as specified. At every tenth kerb joint, the pointing and grout shall be omitted. A piece of 4mm thick approved jointing material shall be placed in these joints, neatly trimmed to be flush with the face of the kerb. The bedding shall be well haunched up to the back of the kerb, to within 100mm of the top of the kerb. All cutting shall be neatly formed so as to show no damage to the exposed faces and to leave the ends square for the full width of the kerb.

The kerbs and channels shall be 130mm wide by 250mm deep. Kerbs shall be half battered. Kerbs damaged at the exposed faces will not be accepted.

604 Precast Concreting Edging

Edging shall be 50mm x 150mm in size. Edging shall be laid in the same manner as kerning and in short lengths, where required to be circular on the plan.

605 Footpaths and Paving

For surfaced footpaths and similar paved the base material shall be laid on hard fill or selected materials as directed by the Project Manager's Representative and compacted by a roller of 0.75 to 3 tonnes weight. The footpath base shall be formed of crushed rock graded from 50mm to 10mm suitable for the purpose and laid as wet-mix or dry macadam and rolled or compacted to the final form and grading of the

final surfacing to a thickness of 100mm.

The base course shall consist of 100 mm compacted thickness of bituminous macadam of 14mm nominal sized material. After laying and rolling the base course, a wearing course shall be laid to provide a final finish. This shall consist of 15mm compacted thickness of 100mm nominal size bituminous macadam. As soon as possible after laying the wearing course, it shall be blinded with bituminous grit (fine cold asphalt) to weather-seal.

For concrete paving, the precast concrete flags shall be of approved colour and size not less than 30mm thick unless otherwise indicated. They shall be laid and bedded in cement mortar upon a 100mm thick bed of compacted crushed limestone.

The Contractor will be required to lift and relay at his expense flags which have sunk through consolidation of settlement of the ground beneath and the Project Manager's maintenance certificate will not be issued until such work has been completed to his satisfaction.

606 Laying to Grade

All new and reinstated roads, alleyways and hard standings shall be completed in a manner that ensures cross-falls are towards the storm water drainage intakes.

Section 7 Safety, Health and Environment

701 Introduction

The prevention of injury and/or illness to the site personnel and the public, damage to the Works and to public and private property, protection of the environment, and compliance with applicable laws, are primary objectives of the Employer. Because of the importance the Employer places on meeting these objectives, selected minimum requirements are outlined in these Safety, Health and Environmental Specifications with which Contractors shall comply while working on this contract. Given that these Specifications cannot cover every eventuality, the Contractor shall be expected to exercise good judgment in all such matters, even though not mentioned in these Specifications, and shall take any and all additional measures, as required or necessary, to meet his responsibility for safety, health and environmental matters during the period of the Contract.

The Employer nor its representatives shall not be held liable for any actions taken by the Contractor that are attributed to following the minimum requirements stated hereinafter.

The Contractor shall throughout the execution and completion of the Works and the remedying of any defects therein:

- (a) have full regard for the safety of all persons on the Site and keep the Site and the Works in an orderly state appropriate to the avoidance of danger to any person;
- (b) know and understand all laws governing his activities along with any site requirements and work site hazards. Such information shall be communicated by the Contractor to his personnel and subcontractors;
- (c) take all necessary measures to protect his personnel, the Employer's personnel, other persons, the general public and the environment;
- (d) avoid damage or nuisance to persons or to property of the public or others resulting from pollution, noise or other causes arising as a consequent of carrying out the Works.

702 Compliance with Specifications

The Contractor shall comply with the requirements of these Safety, Health and Environmental Specifications and all other applicable regulations or requirements under Kenyan laws, laid down by relevant authorities or issued by the Employer or the Project Manager concerning safety, health and the environment, in force or introduced or issued from time to time during the period of the Contract.

In so far as these Specifications are applicable, they shall apply to sites and personnel outside the Site associated with the performance of the Contract.

The Specifications equally apply to subcontractors and all other parties engaged by the Contractor and their personnel. The Contractor shall ensure all such parties are fully aware of and comply with the Specifications.

The Contractor shall comply with all notifications and written or verbal instruction regarding safety issued pursuant to these Specifications by the Employer, Project Manager or relevant authorities within the time specified in the notification or instruction.

The Contractor shall adopt a positive approach, awareness and responsibility towards safety, health and the environment, and take appropriate action, by:

- (a) ensuring the Specifications are enforced and followed by the Contractor's personnel. Any failure by the Contractor's personnel to follow the Specifications shall be regarded as

a failure by the Contractor.

- (b) paying attention to possible injury to unauthorized persons entering the site, particularly children.

Whenever in these Specifications the Contractor is required to provide test certificates for equipment and personnel and to comply with the relevant authorities' requirements and no independent test facilities are available or no relevant authorities exist in Kenya, the Contractor shall provide:

- (a) in lieu of independent test certificates:
- for equipment – details of the tests that have been carried out by the Contractor and a written statement that the Contractor has satisfied himself that the item of equipment is fit and safe for use;
 - for personnel – details of the training and experience of the personnel and a written statement that the Contractor has satisfied himself that they have the required level of competency;
- (b) in lieu of relevant authorities' requirements – details of the Contractor's own rules, regulations, requirements and procedures regarding safety, health and the environment.

If the Project Manager is dissatisfied with the details provided by the Contractor, the Contractor shall provide further details or carry out further tests or provide further written statements as may be reasonably required by the Project Manager.

When the Project Manager has satisfied himself regarding the Contractor's own rules, regulations, requirements and procedures provided in accordance with (b) above, such rules, etc. shall be deemed to form part of these Specifications and to which Clause 3 shall equally apply.

703 Failure to Comply with Specifications

703.1 General

Should the Contractor fail to comply with any of the Specifications or requirements of the Project Manager:

- (a) the Project Manager may suspend the Works of part of the Works until the Contractor has taken the necessary steps, to the satisfaction of the Project Manager, to comply with the Specifications or requirements.
- (b) the Employer may, following written notice to the Contractor, carry out themselves or arrange for another contractor to carry out such measures as they may consider appropriate on behalf of the Contractor. Any such actions by the Employer shall not affect or diminish the Contractor's obligations or responsibilities under the Contract.
- (c) the Project Manager may, by written notice of suspension to the Contractor, suspend all payment to the Contractor under the Contract if the Contractor fails to rectify any breach of the Specifications within the period specified by the Project Manager, provided that such notice of suspension:
- (i) shall specify the nature of the failure or failures; and
 - (ii) shall request the Contractor to remedy each such failure within a specified period after receipt by the Contractor of such notice of suspension.

Such suspension of payment shall remain in force until such time as the Contractor has rectified the breach or breaches to the satisfaction of the Project Manager. No interest shall be paid on the suspended payments.

Failure to comply with the Specifications or requirements shall be considered a breach of the Contract by the Contractor and may result in termination of the Contract by the Employer. In the event of the Employer taking action based on this Clause, the Contractor shall not be entitled to any additional costs or extension to the Contract Completion Date. All costs incurred by the Employer pursuant to Sub-Clause 703.1.1 (b) shall be deducted from the amounts otherwise due to the Contractor.

704 General Requirements

Preamble

All references to safety shall be deemed to include health and the environment.

Safety Officer

The Contractor shall appoint a competent Safety Officer who shall be responsible for safety, health and the environment. The Safety Officer shall be given sufficient time by the Contractor to carry out his duties; minimum requirements shall be as follows:

Workforce on site of over 250	- full time Safety Officer;
Workforce on Site of 100 – 250	- 50% of Safety Officer's time;
Workforce on site below 100	- as required for the Works but a minimum of 5 hours per week of Safety Officer's time where more than 20 workers.

The Contractor shall provide the Safety Officer with appropriate identification, including a white hard hat with red cross symbol and an identification badge. The appointment of the Safety Officer shall be in writing and copied to the Project Manager. The appointment shall include specific instructions to enforce these Specifications and delegated authority to take any action, measure or to issue instruction regarding their enforcement. All persons on Site shall be made aware of the name and authority of the Safety Officer and instructed to comply with any instruction or direction in safety matters, verbal or in writing issued by the Safety Officer.

The Safety Officer shall be provided with a mobile phone or other similar means of communication. The Safety Officer shall be accessible and available at all times including normal working hours.

Safety Training

The Contractor shall provide safety induction training for all site personnel upon starting on site. The

Contractor shall provide safety refresher/reinforcement training at regular intervals for his staff.

Safety Meetings

The Contractor shall hold regular safety meetings to provide safety instructions and receive feedback from site personnel on safety, health and environmental matters. A weekly safety Meeting shall be chaired by the Safety Officer and minutes shall be taken of the meeting. The meeting/minutes shall be given to the Project Manager. The Safety Officer should attend the Contractor's weekly site meetings and "Safety" shall be an item on the agenda.

Safety Inspections

The Safety Officer shall make regular safety inspection of the work site. The Safety Officer shall prepare a report of each inspection. This report shall include details of all breaches of these Specifications and any other matters or situations relating to safety found during the inspection, instructions issued by the

Safety Offices and actions taken by the Contractor. A copy of the Safety Officer's reports shall be given to the Project Manager.

Control of Substances Hazardous to Health

Hazardous materials shall be stored in approved safety containers and handled in a manner specified by the manufacturers and/or prescribed by relevant authorities.

Only properly trained and equipped personnel shall handle hazardous materials.

Potential Hazards

The Contractor shall inform employees of potential hazards, take the appropriate steps to reduce hazards and be prepared for emergency situations. The Contractor shall make an assessment of every operation involving hazardous substances. The assessment shall be recorded on a Hazardous and Flammable Substances Assessment Method Statement which shall be submitted to the Project Manager prior to the delivery and use of the substance on Site.

Accident Reporting

The Contractor shall report all accidents and dangerous occurrences to the Project Manager. The Contractor shall prepare a report on each accident or dangerous occurrence and a copy of the report, together with witness statements and any other relevant information, shall be submitted to the Project Manager. A reportable accident or dangerous occurrence shall include any accident to any person on site requiring medical attention or resulting in the loss of working hours or any incident that resulted, or could have resulted, in injury, damage or a danger to the Works, persons, property or the environment.

In the event of an accident or dangerous occurrence, the Contractor shall be responsible for completing all statutory notifications and reports. Copies of all statutory notifications and reports shall be passed to the Project Manager.

All accidents and dangerous occurrences shall be recorded in a Site Accident Book. The Site Accident Book shall be available at all times for inspection by the Project Manager.

The Contractor shall immediately rectify any situation or condition that could result in injury, damage or a danger to the Works, person, property or the environment. If the situation or condition cannot be corrected immediately, the Contractor shall provide temporary barriers and appropriate warning signs and devices and/or take other appropriate action necessary for the protection of persons, property and the environment.

Notices, Signs, Etc.

All safety, health, environmental and other notices and signs shall be clearly displayed and written in English. All requirements, instructions, procedures, etc. issued by the Contractor concerning these Specifications shall be printed in English and displayed and readily available to the Contractor's personnel.

First Aid and Medical Attention

The Contractor shall have comprehensive First Aid Kit(s) on Site at all times. First Aid Kits shall be conveniently located and clearly identifiable.

The Contractor shall have one employee on site trained in first aid for every 25 employees. Such persons shall be provided with appropriate identification, including a red hard hat with a white "red cross" symbol; and an identification badge.

The Contractor shall make contingency arrangements for calling a Doctor and transporting injured persons to hospital. The telephone numbers of the emergency services and the name, address and

telephone number of the Doctor and nearest hospital shall be prominently displayed in the Contractor's site office.

Employee Qualification and Conduct

The Contractor shall employ only persons who are fit, qualified and skilled in the work to be performed. All persons shall be above the minimum working age. Contractor's personnel shall use the toilet facilities provided by the Contractor.

The Contractor shall ensure:

- (a) that no firearms, weapons, controlled or illegal substances or alcoholic beverages are brought onto the Site and that no personnel under the influence of alcohol or drugs are permitted on Site.
- (b) That all personnel obey warning signs, product or process labels and posted instructions.
- (c) That drivers or operators of vehicles, machinery, plant and equipment follow the rules for safe operations. Drivers shall wear seat belts and obey all signs and posted speed limits.

705 Safety Requirements

Personal Protective Equipment

The Contractor shall provide personal protective equipment, including hard hats, safety glasses, respirators, gloves, safety shoes, and such other equipment as required, and shall take all measures or actions for the protection and safety of Contractor's personnel.

Non-metallic hard hats shall be worn at all times by all personnel at the worksite with the exception of those areas where the Project Manager has indicated it is not necessary to do so. Safety glasses shall meet international standards and be available for use and worn in specified worksite areas. As a minimum, safety glasses shall be worn for the following types of work: hammering, chipping, welding, grinding, use of electrically powered or pneumatic equipment, insulation handling, spray painting, working with solvents, and other jobs where the potential of an eye injury exists. Face shields and/or goggles shall be worn where possible exposure to hazardous chemicals, cryogenic fluids, acids, caustics or dust exists and where safety glasses may not provide adequate protection.

When handling acids, caustics and chemicals with corrosive or toxic properties, suitable protection, such as acid suits or chemical resistant aprons and gloves, shall be worn to prevent accidental contact with the substance.

Personnel shall not be permitted to work whilst wearing personal clothing or footwear likely to be hazardous to themselves or others.

The wearing of safety shoes with steel reinforced toes is recommended for all Contractor's personnel on site. In all cases, Contractor's personnel shall wear substantial work shoes that are commensurate with hazards of the work and the work site area.

Hearing protection, including muffs, plugs or a combination thereof, shall be provided for all personnel operating in areas where the noise level exceeds 90 decibels. Such protections shall also be provided for operators working with equipment exceeding such a level. This may include equipment such as excavators, shovels, jackhammers, saws, drills, grinders and the like are being used.

The Contractor shall encourage employees to wear substantial work gloves whenever practical and safe to do so.

Fire Protection and Prevention

The Contractor shall comply with fire protection instructions given by the Authorities having jurisdiction in regard to fire protection regulations. The Contractor shall, upon moving on site, provide to the Project Manager and the Authorities a fire prevention and evacuation plan. This shall include drawing(s) showing the fire assembly points. The fire prevention and evacuation plan and drawing(s) shall be updated from time to time as the Works progress. The Contractor shall ensure all personnel are fully informed on escape routes and assembly points and any changes thereto. Fuel storage will not be permitted in construction work areas. Contractors may establish fuel storage tanks in specified areas set aside for the purpose and approved by the Project Manager. Storage tanks shall be adequately banded to control spillage. Fire extinguishers shall be provided and installed in a suitable nearby location.

Highly combustible or volatile materials shall be stored separately from other materials and as prescribed by relevant authorities and under no circumstances within buildings or structures forming part of the permanent Works. All such materials shall be protected and not exposed to open flame or other situations which could result in a fire risk.

No combustible material shall be located inside or within 10 metres of a building or structure forming part of the permanent Works. Where units have to be used in these circumstances, they shall be constructed of non-combustible materials and have a half-hour fire rating inside to outside and outside to inside. Non-combustible furniture shall be used where practical.

All temporary accommodation and stores shall be provided with smoke detectors and fire alarms. Smoking shall be banned in high risk areas.

Expanded polystyrene with or without flame retarding additive, polythene, cardboard and hardwood shall not be used as protection materials. Plywood and chipboard shall only be used as protection on floors. Vertical protection shall be non-combustible. Debris netting and weather protection sheeting shall be fire retardant.

When using cutting or welding torches or other equipment with an open flame, the Contractor shall provide a fire extinguisher close by at all times. All flammable materials shall be cleared from areas of hot works or work locations prior to welding or oxy/gas burning operations. All hot works shall cease half an hour before the end of a work shift to allow for thorough checking for smouldering materials. Where appropriate, areas of hot works are to be soaked in water before the shift ends.

An adequate number of fire extinguishers of types suited to the fire risk and the material exposed shall be provided. These shall be placed in accessible, well-marked locations throughout the job site. Contractor's personnel shall be trained in their use. Extinguishers shall be checked monthly for service condition and replaced or recharged, as appropriate after use.

Only approved containers shall be used for storage, transport and dispensing of flammable substances. Portable containers used for transporting or transferring gasoline or other flammable liquids shall be approved safety cans. Fuel burning engines shall be shut off while being refuelled. Adequate ventilation to prevent an accumulation of flammable vapours shall be provided where solvents or volatile cleaning agents are used.

Flammables shall not be stored under overhead pipelines, cable trays, electrical wires or stairways used for emergency egress. Paints shall be stored and mixed in a room assigned for the purpose. This room shall be kept under lock and key.

Oily waste, rags and other such combustible materials shall be stored in proper metal containers with self-closing lids and removed every night to a safe area or off site. Every precaution shall be taken to prevent spontaneous combustion.

Electrical Safety

All temporary electrical installations, tools and equipment shall comply with current regulations dealing with on-site electrical installations. The Contractor shall establish a permit-to-work system for work in or in proximity to energized circuits of any voltage. Contractor's personnel shall not commence work on such circuits unless a permit to work has been issued and adequate safety measures have been taken and the work operation has been reviewed and approved by the Project Manager.

Only authorized personnel shall be allowed to work or repair electrical installations and equipment. Portable tools and equipment shall be 240 volt, unless otherwise agreed by the Project Manager.

When portable or semi-portable equipment operates at voltages in excess of 240 volts, the supply shall be protected by a Residual Current Device (RCD) regardless of any such device fitted to the equipment. The RCD must have a tripping characteristic of 30 milliamps at 30 milliseconds maximum.

All static, electrically powered equipment, including motors, transformers, generators, welders and other machinery, shall be properly earthed, insulated, and/or protected by a ground fault interruption device. In addition, the skin metal buildings and trailers with electric service shall be earthed. Metal steps, when used shall be securely fixed to the trailer.

Lampholders on festoon lighting shall be moulded to flexible cable and be of the screw in type. Clip on guards shall be fitted to each lamp unit.

All tungsten-halogen lamps shall be fitted with a glass guard to the element. These lamps must be permanently fixed at high level.

Electrical equipment shall be periodically inspected and repaired as necessary by competent persons.

Any work in electrical equipment and systems shall be made safe through locking, tagging, and/or isolation of the equipment before work commences. Prior to the start of the work, the equipment or systems shall be tested to ensure that they have been properly de-energised and isolated.

Electrical repair work on energized systems shall be avoided whenever possible.

Electrical trouble shooting shall be conducted only after getting written approval of the Project Manager.

Unauthorized personnel shall not enter enclosures or area containing high voltage equipment such as switchgear, transformers or substations.

Oxygen/Acetylene/Fuel Gases/Cartridge Tools

Compressed oxygen shall never be used in the place of compressed air. Flash-back (Spar) arrestors shall be fitted to all gas equipment. Liquid petroleum Gas (LPG) cylinders shall not be stored or left in areas below ground level overnight. Cylinders must be stored upright.

The quantity of oxygen, acetylene and LPG cylinders at the point of work shall be restricted to a maximum of one day's supply. Cylinders shall be kept in upright vertical rack containers or be safely secured to a vertical support.

Cartridge tools shall be of the low velocity type. Operators must have received adequate training in the safe use and operation of the tool to be used.

Scaffolding/Temporary Works

No aluminium tube shall be used, except for proprietary mobile towers, unless otherwise agreed with the Project Manager.

Drawings and calculations shall be submitted to the Project Manager, prior to commencement of work on the site, for all Temporary Works, including excavations, falsework, tower cranes, hoists, services and

scaffolding. Designs shall conform to international standards.

The Project Manager will not approve Temporary Work designs but the Contractor shall take account of any comments on such designs made by the Project Manager.

The Contractor shall inspect and approve all Temporary Works after erection and before access, loading or use is allowed. Completed and approved Temporary Works shall be tagged with a scaff-tag or similar safety system and the Safe Structure insert displayed. For scaffolding, one tag shall be displayed every 32 m² of face area. A central record system shall be kept on all Temporary Work. Temporary Works shall be inspected weekly and similarly recorded.

All mobile scaffold towers shall be erected in accordance with the manufacturer's instructions and a copy of these shall be submitted to the Project Manager prior to any use on site. Additionally, all towers shall be erected complete with access ladder, safety rails and kick boards whatever the height.

The Contractor shall repair or replace, immediately, any scaffold, including accessories, damaged or weakened from any cause.

The Contractor shall ensure that any slippery conditions on scaffolds are eliminated as soon as possible after they occur.

All scaffolds used for storing materials, for brick or block laying, for access to formwork or for any other purpose where materials may be accidentally fall, shall be provided with wire mesh guards of a substantial material, in addition to kick boards.

Use of Ladders

Manufactured ladders shall meet the applicable safety codes for wood or metal ladders. Metal ladders shall not be used where there is any likelihood of contact with electric cables and equipment. All metal ladders shall be clearly marked: "Caution – Do not use around electrical equipment". Job made ladders shall not be permitted.

Extension or straight ladders shall be equipped with non-skid safety feet, and shall be no more than 12 m in height. The maximum height of a step ladder shall be 2 m. Ladders shall not be used as platforms or scaffold planks.

Ladders rungs and steps shall be kept clean and free of grease and oil.

Extension and straight ladders shall be tied off at the top and/or bottom when in use. Only one person shall be allowed in a ladder at a time.

Defective ladder shall be taken out of service and not used. Ladders shall not be painted and shall be inspected for defects prior to use.

Elevated Work

The Contractor shall provide all personnel, while working at an elevated position, with adequate protection from falls. Details of such protections shall be submitted to the Project Manager.

The Contractor shall carry out daily inspections of all elevated work platforms. Defects shall be corrected prior to use.

• 705.7.1 Roofing and Sheet Metal Laying

- (a) A Method Statement detailing the procedures to be adopted shall be submitted to and agreed with the Project Manager prior to commencement of work on the site.
- (b) Mobile elevating work platforms or the equivalent shall be used to install roofing and sheet materials wherever practicable and a suitable base is available.

- **705.7.2 Erection of Structures**

- (a) A Method Statement detailing the procedures to be adopted shall be submitted to and agreed with the Project Manager prior to commencement of work on the site.
- (b) Safety harness and lines shall be provided by the Contractor for use by the erection personnel and worn at all times.
- (c) Mobile elevating work platforms or the equivalent shall be used to erect structures wherever practicable and a suitable base is available.

- **705.7.3 Mobile Elevating Work Platforms**

Operators shall be trained in the safe use of such platforms and hold a current Certificate of Competence.

- ☐☐☐ **705.7.4 Hoists**

- (a) A copy of the current Test Certificate shall be submitted to the Project Manager before any hoist (personnel or material) is brought into operation on the site. Where the range of travel is increased or reduced a copy of the revised Test Certificate shall be submitted.
- (b) Each landing gate shall be fitted with a mechanical or electrical interlock to prevent movement of the hoist when any such gates is in the open position.
- (c) Safety harness must be worn and used by personnel erecting, altering and dismantling hoists.

- **705.7.5 Suspended Cradles**

- (a) Suspended cradles shall be installed, moved and dismantled by a specialist contractor.
- (b) Suspended cradles shall comply with local regulations.
- (c) All powered suspended cradles shall incorporate independent safety lines to overspeed braking devices and independent suspension lines for personal safety harness attachment.

Use of Temporary Equipment

The safe design of any piece of equipment shall not be exceeded, nor shall the equipment be modified in any manner that alters the original factor of safety or capacity. Mobile equipment shall be fitted with suitable alarm and motion sensing devices, including back-up alarm, when required. The Contractor shall ensure that the installation and use of equipment are in accordance with the safety rules and recommendations laid down by the manufacturer, taking into account the other installations already in place or to be installed in the future.

The contractor shall inspect Equipment prior to its use on the Works and periodically thereafter to ensure it is in safe working order. Special attention shall be given to such items as cables, hoses, guards, booms, blocks, hooks and safety devices. Equipment found to be defective shall not be used and immediately removed from services, and a warning tag attached.

Natural and synthetic fibre rope made of material such as manila, nylon, polyester, or polypropylene shall not be used as slings. Only trained, qualified and authorized personnel shall operate equipment. All drivers and operators shall hold a current Certificate of Training Achievement for the equipment being used. A safety observer shall be assigned to watch movements of heavy mobile equipment where hazards may exist to other personnel from the movement of such equipment, or where equipment could hit overhead lines or structures. The observer shall also ensure that people are kept clear of mobile equipment and suspended tools.

When mobile or heavy equipment is travelling onto a public thoroughfare or roadway, a flagman shall ensure that traffic has been stopped prior to such equipment proceeding. While the mobile or heavy equipment is travelling on a public roadway, a trailing escort vehicle with a sign warning of a slow-moving vehicle that is dangerous to pass shall be provided.

Cranes:

- (a) The Contractor shall give a minimum of 48 hours' notice to the Project Manager prior to bringing a crane on site.
- (b) No cranes shall be erected in the site without the prior approval of the Project Manager. The Project Manager may direct the Contractor as to location where cranes may not be located. The Contractor shall take such directions into account when submitting his proposals for crane location points, base footings, pick up points and swing radius. Compliance with any such direction shall not entitle the Contractor to any extension of the Period of Completion or to any increase of the Contract Price.
- (c) Safety harness shall be worn and used at all times by personnel engaged on the erection, alterations and dismantling of tower cranes.
- (d) The Contractor shall provide a copy of the current Test Certificate (see Sub-Clause 702) to the Project Manager before any crane (tower or mobile) is brought into operation on the Site.
- (e) All lifting tackle must hold a current Test Certificate. All lifting tackle must be thoroughly examined every 6 months and an inspection report raised.
- (f) All fibrous/web slings shall be destroyed and replaced 6 months after first use.
- (g) All crane drivers/operators shall hold a Certificate of Training Achievement for the class of crane operated.
- (h) All banksman/slingers shall hold a Training Certificate from a recognized training agency.
- (i) The maximum weekly working hours of a crane driver or banksman shall be restricted to 60 hours.
- (j) Under no circumstances shall a crane or load come within 4 m of any energized overhead power line or other critical structure.

Locking-out, Isolating and Tagging Equipment.

Equipment that could present a hazard to personnel if accidentally activated during the performance of installation, repair, alteration, cleaning, or inspection work shall be made inoperable and free of stored energy and/or material prior to the start of work. Such equipment shall include circuit breakers, compressors, conveyors, elevators, machine tools, pipelines, pumps, valves, and similar equipment.

Where equipment is subject to unexpected external physical movement such as rotating, turning, dropping, falling, rolling, sliding, etc., mechanical and/or structural constraints shall be applied to prevent such movement.

Equipment which has been locked-out, immobilized, or taken out of services for repair or because of a potentially hazardous condition shall be appropriately tagged indicating the reason it has been isolated and/or taken out of service.

Where safety locks are used for locking out or isolating equipment, the lock shall be specially identified and easily recognized as a safety lock.

Installation of Temporary or Permanent Equipment

During installation and testing the Contractor's specialists Project Manager shall be in attendance. All control mechanism panel and wiring diagrams shall be available and printed in English.

Laser Survey Instruments

Details of the types and use of laser instruments shall be submitted and agreed with the Project Manager.

Working in Confined Spaces

Confined spaces, including tanks, vessels, containers, pits, bins, vaults, tunnels, shafts, trenches, ventilations ducts, or other enclosures where known or potential hazards may exist, shall not be entered without prior inspection by and authorization from the Site Safety Officer and the issuance of a Hazardous Work Permit.

Prior to entering the confined space, the area shall be completely isolated to prevent the entry of any hazardous substances or materials which could cause an oxygen deficient atmosphere. All equipment that could become energized or mobilized shall be physically restrained and tagged. All lines going into the confined space shall be isolated and/or blanked.

Personnel working in a confined space where emergency escape or rescue could be difficult, shall wear a safety harness attached to a lifeline. A qualified attendant(s), trained and knowledgeable in job-related emergency procedures, shall be present at all times while persons are working within the confined space. The attendant shall be capable of effecting a rescue, have necessary rescue equipment immediately available, and be equipped with at least the same protective equipments as the person making entry.

All equipment to be used in a confined space shall be inspected to determine its acceptability for use. Where a hazard from electricity may exist, equipment utilized shall be of low voltage type. The atmosphere within the confined space shall be tested to determine if it is safe to enter. Acceptable limits are:

- oxygen: 19.5% lower, 22% higher;
- flammable gas: not to exceed 10% of lower explosion limit;
- toxic contaminants: not to exceed the permissible exposure limit.

Subsequent testing shall be done after each interruption and before re-entering the confined space, as well as at intervals not exceeding 4 hours. Continuous monitoring is preferable and may be necessary in certain situations.

Adequate ventilation shall be provided to ensure the atmosphere is maintained within acceptable limits.

Demolition

A detailed Method Statement detailing the demolition procedures/techniques to be used shall be submitted to and approved by the Project Manager prior to commencement of work on site.

The Method Statement must include full details of measures to be taken to ensure that there are no persons remaining in the building/structure and to distance members of the public and Contractor's personnel from the building/structure prior to demolition.

Use of Explosives

The Contractor shall not use explosives without the written permission from the Project Manager and relevant authorities.

The Contractor shall observe all regulations regarding proper purchasing, transportation, storage, handling and use of explosives.

The Contractor shall ensure that explosives and detonators are stored in separate special building. These secured buildings shall be constructed, located and clearly marked in English:

xi) **“DANGER – EXPLOSIVES”**

all as approved by the Project Manager and relevant authorities. The Contractor shall ensure that all possible precautions are taken against accidental fire or explosion, and ensure that explosives and detonators are kept in a proper and safe condition. The contractor shall ensure that explosives and detonators are always transported in separate vehicles and kept apart until the last possible moment and that metallic tools are not used to open boxes of explosives or detonators.

Blasting Procedure: the contractor shall carry out blasting operations in a manner that will not endanger the safety of persons or property. The Contractor shall, along with other necessary precautions:

- (a) clear all persons from building and the area affected by the blasting. All such persons shall be given adequate notice of the actual time and date of blasting;
- (b) ensure that police and other local authorities are kept fully informed, in advance, of the blasting programme so that they may be present when blasting takes place if they so require;
- (c) erect warning notices around the area affected that blasting operation are in progress;
- (d) carry out a thorough search of buildings and the area affected prior to blasting;
- (e) ensure that blasting is only carried out by experienced shot firers. Priming, charging, stemming and shot firing shall be carried out with greatest regard for safety and in strict accordance with the rules and regulations of the relevant authorities.
- (f) ensure that explosive charges are not excessive, charged boreholes are properly protected and proper precautions are taken for the safety of persons and property.

The Contractor shall maintain an up-to-date inventory of all explosives and explosive devices and shall submit a monthly report to the Project Manager, detailing the use of all explosives by date and location.

Excavation and Trenching

An excavation permit signed by the Project Manager must be issued before excavation proceeds in any work location. The contractor shall investigate and identify the location of existing services by study of the drawings, a visual/physical study of the site, sweeping by appropriate detection equipment and where necessary hand excavation of trial holes.

Following this investigation, the Contractor shall submit a written request for an excavation permit to the Project Manager.

The Project Manager will return the permit signed and dated to indicate:

- services which are to be maintained.
- services which are to be isolated.
- any special precautions to be taken.

A sample Excavation Permit is given in Annex 1 to this Specification. The issue of an Excavation Permit by the Project Manager shall not relieve the Contractor of his responsibilities under the Contract.

The side of all excavations and trenches which in the opinion of the Project Manager might expose personnel or facilities to danger resulting from shifting earths shall be protected by adequate temporary

supports or sloped to the appropriate angle of repose.

All excavations, slopes and temporary supports shall be inspected daily and after each rain, before allowing personnel to enter the excavation.

Excavations 1.3 metres or more in depth and occupied by personnel shall be provided with ladders as a means for entrance and egress. Ladders shall extend not less than 1 metre above the top of the excavation.

The Contractor shall provide adequate barrier protection to all excavations. Barriers shall be readily visible by day of night.

Excavated or other materials shall be stored at least 0.65 metres from the sides of excavations.

Concrete Reinforcement Starter Bars

The Contractor shall ensure concrete reinforcement starter bars are not a danger to personnel. Where permitted by the Project Manager, starter bars shall be bent down. Alternatively, the starter bars shall be protected using either hooked starters, plastic caps, plywood covers or other methods agreed with the Project Manager.

706 Environmental and Health Requirements

Contractor environmental and social management plan

The Contractor shall develop his own Environmental and Social Management Plan to ensure actions and mitigation necessary to protect the environment as contained in the Project ESIA Report and License, are incorporated into all site procedures. At a minimum, the contractor's ESMP must address the following:

- Policy
- Planning
- Implementation and Operation

706.1.1 Policy

The Contractor shall develop an environmental policy that includes, as a minimum, the following:

- A commitment to comply with applicable regulations and other requirements that the construction company subscribes to;
- A commitment to provide a safe work environment;
- A commitment to provide the training and equipment necessary for employees to conduct their work safely;
- A commitment to continuously improve performance and to pollution prevention; and
- A commitment to communicate the policy to all persons working for and on behalf of the company.

706.1.2 Planning

Environmental issues and the legal and other requirements in construction of the project have been identified in the project's ESIA Report. The Contractor must demonstrate within his plan that he has read and understood the ESIA Report and its provisions for environmental management and monitoring.

706.1.3 Implementation and Operation

Roles, responsibilities and authorities must be defined, documented and communicated to ensure effective environmental and social management. A specific management representative with requisite qualifications shall be assigned the responsibility for ensuring that the ESMP is established, implemented and maintained and shall be responsible for reporting performance, reviewing the Plan and making recommendations for improvement. Documented confirmation is required that the training needs of all persons working for or on the company's behalf whose work pose significant hazards to their health and

safety and/or may create a significant impact on the environment has been identified. Records of all training must be maintained.

Management, supervisory, and employee responsibilities must be communicated to all employees through training, formal job descriptions, work experience, hiring practices, etc. Awareness training shall be provided that include the importance of conforming to the policy and procedures, the significant environmental issues, and the roles and responsibilities of management and staff.

Records shall be legible, identifiable and traceable to the activity. Records shall be stored and maintained in such a way that they are retrievable and protected against damage, deterioration or loss.

The Contractor shall establish, implement and maintain procedures to identify potential emergency situations and potential accidents that can have an impact on the environment, surrounding communities, the employees, and/or the public.

The Contractor shall be prepared to respond to actual emergency situations and accidents and prevent or mitigate associated adverse environmental or social impacts. The ESMP must also address how the Contractor will receive, document and respond to external interested parties.

706.2 Protection of the Environment

The Contractor shall be knowledgeable of and comply with the Environmental Management Plan (EMP) and with all environmental laws, rules and regulations for materials, including hazardous substances or wastes under his control. The contractor shall not dump, release or otherwise discharge or dispose of any such materials without the authorization of the Project Manager.

Any release of a hazardous substance to the environment, whether air, water or ground, must be reported to the Project Manager immediately. When releases resulting from Contractor action occur, the Contractor shall take proper precautionary measures to counter any known environmental or health hazards associated with such release. These would include remedial procedures such as spill control and containment and notification of the proper authorities.

706.3 Air Pollution

The Contractor, depending on the type and quantity of materials being used, may be required to have an emergency episode plan for any releases to the atmosphere. The Contractor shall also be aware of local ordinances affecting air pollution.

The Contractor shall take all necessary measures to limit pollution from dust and any windblown materials during the Works, including damping down with water on a regular basis during dry climatic conditions.

The contractor shall ensure that all trucks leaving the Site are properly covered to prevent discharge of dust, rocks, sand, etc.

706.3 Water Pollution

The contractor shall not dispose of waste solvents, petroleum products, toxic chemicals or solutions on the city drainage system or watercourse, and shall not dump or bury garbage on the Site. These types of waste shall be taken to an approved disposal facility regularly, and in accordance with requirements of relevant Authorities. The Contractor shall also be responsible for the control of all run-offs, erosion, etc.

706.4 Solid Waste

706.4.1 General Housekeeping

- (a) The Contractor shall maintain the site and any ancillary areas used and occupied for performance of the Works in a clean, tidy and rubbish-free condition at all times.

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- (b) Upon the issue of any Taking-Over Certificate, the Contractor shall clear away and remove from the Works and the Site to which the Taking-Over Certificate relates, all Contractor's Equipment, surplus material, rubbish and Temporary Works of every kind, and leave the said Works and Site in a clean condition to the satisfaction of the Project Manager. Provided that the Contractor shall be entitled to retain on Site, until the end of the Defects Liability Period, such materials, Contractor's Equipment and Temporary Works as are required by him for the purpose of fulfilling his obligations during the Defects Notification Period.

706.4.2 Rubbish Removal and Disposal

- (a) The Contractor shall comply with statutory and municipal regulations and requirements for the disposal of rubbish and waste.
- (b) The Contractor shall provide suitable metal containers for the temporary storage of waste.
- (c) The Contractor shall provide suitable metal containers from site as soon as they are full. Rubbish containers shall not be allowed to overflow.
- (d) The Contractor shall provide hard standings for and clear vehicle access to rubbish containers.
- (e) The Contractor shall provide enclosed chutes of wood or metal where materials are dropped more than 7 meters. The area onto which the material is dropped shall be provided with suitable enclosed protection barriers and warning signs of the hazard of falling materials. Waste materials shall not be removed from the lower area until handling of materials above has ceased.
- (f) Domestic and biodegradable waste from offices, canteens and welfare facilities shall be removed daily from the site.
- (g) Toxic and hazardous waste shall be collected separately and be disposed of in accordance with current regulations.

706.4.3 Asbestos Handling and Removal

The Contractor shall comply with all local regulations regarding the handling of asbestos materials. In the absences of local regulations, relevant International Standards shall apply.

706.4.4 Pest Control

The Contractor shall be responsible for the rodent and pest control on the Site. If requested, the contractor shall submit to the Project Manager, for approval, a detailed programme of the measures to be taken for the control and eradication of rodents and pests.

706.5 Noise Control

The Contractor shall ensure that the works is conducted in a manner so as to comply with all restrictions of the Authorities having jurisdiction, as they relate to noise.

The Contractor shall, in all cases, adopt the best available plant/and or machinery shall be used. All equipment shall be maintained in good mechanical order and fitted with the appropriate silencers, mufflers or acoustic covers where applicable. Stationary noise sources shall be sited as far away as possible from noise-sensitive areas and, where necessary, acoustic barriers shall be used to shield them. Such barriers may be proprietary types, or may consist of site materials such as bricks or earth mounds

as appropriate.

Compressors, percussion tools and vehicles shall be fitted with effective silencers of a type recommended by the manufacturers of the equipment. Pneumatic drills and other noisy appliances shall not be used during days of rest or after normal working hours without the consent of the Project Manager.

Areas where noise levels exceed 90 decibels, even on a temporary basis, shall be posted as high noise level areas.

707 Additional Requirements for Work in Public Areas

General

Those additional requirements shall apply to all works carried out in Public Areas.

Public Areas are defined as areas still used by or accessible to the public. These include public roads and pavements, occupied buildings and areas outside the Contractor's boundary fencing.

All work in Public Areas shall be carried out to minimize disturbance and avoid dangers to the public.

Before commencing work, the Contractor shall ensure that all necessary resources, including labour, plant and materials will be available when required and that the works will proceed without delays and be completed in the shortest possible time. Period of inactivity and slow progress or delays in meeting the agreed programme for the Works, resulting from the Contractor's failure to provide necessary resources or other causes within the control of the Contractor, will not be accepted. In the event of such inactivity, slow progress or delays, the Contractor shall take immediate action to rectify the situation, including all possible acceleration measures to complete the works within the agreed programme. Details of the actions and acceleration measures shall be submitted to the Project Manager. If the Project Manager is dissatisfied with the Contractor's proposals, the Contractor shall take such further actions or measures as required by the Project Manager. All costs incurred shall be the responsibility of the Contractor.

Method Statement

The Contractor shall submit to the Project Manager a method statement for each separate area or work in Public Areas. The Method Statement shall include:

- (a) a general description of the Works and methodology of how it will be carried out.
- (b) Details of the measures and temporary works to minimise disturbance and safeguard the public. These shall include temporary diversions, safety barriers, screens, signs, lighting, watchmen and arrangements for control of traffic and pedestrians and advance warning to be given to the public.
- (c) Details of temporary reinstatement and maintenance of same prior to final reinstatement.
- (d) For works involving long lengths of trenches or works to be completed in sections, the lengths or sections of each activity (e.g. up to temporary reinstatement, final reinstatement) to be carried out at any one time.
- (e) Details of the availability of necessary resources (labour, plant, materials, etc.) to complete the work.
- (f) A programme showing start and completion dates and period for all activities of each length or section, including temporary works, and the works overall.

(g) Such further information as necessary or required by the Project Manager.

The Contractor shall not commence work, including temporary works, until after the approval of the Contractor's Method Statement by the Project Manager.

Method Statements shall be updated bases on actual progress or as and when required by the Project Manager.

Closure of Roads, Etc.

The closure or partial closure of roads, pavements and other public areas will only be permitted if approved by the Project Manager and Relevant Authorities. The Contractor shall detail for each closure the extent of area to be closed, the reasons and duration of the closure, and where appropriate, proposed diversions. A sample Street Closure Permit is given at Annex 2 to this Specification.

Trench and Other Excavations

The requirements covering trench and other excavations will depend on the location and type of the excavation and the potential risks to the public.

The following guidelines apply particularly to trenches but shall also apply to other types of excavations:

- (a) before commencing work the Contractor shall:
- notify the Project Manager of the location and duration of the work. An excavation permit signed by the Project Manager must be issued in accordance with Sub-Clause 705.16 before excavation proceeds in any work location;
- obtain permission from relevant authorities including the police when required;
- erect all temporary works such as barriers, warning signs, lighting, etc.;
- have available adequate materials for temporary supports to sides of excavations and necessary labour, plant and materials to complete the work within the shortest possible time.
- (b) in carrying out the works the Contractor shall, unless otherwise permitted or required by the Project Manager:
- not open more than one excavation within a radius of 250 metres;
- limit the length of trench excavation open at one time to 150 metres;
- maintain and alter or adapt all temporary works including supports to sides of excavations;
- remove all surplus excavated material the same day it is excavated;
- complete the works, including final reinstatement within ten days;
- where final reinstatement is not achieved within the required time, to carry out temporary reinstatement;
- ensure that any temporary reinstatement is maintained at the correct level until final reinstatement is achieved.

The above guidelines shall not relieve the Contractor of his obligations and responsibilities.

Safety Barriers

Safety barriers shall be provided to the perimeter of work areas and to trench and other types of excavations and to existing openings such as manholes, draw pits and the like. When exposed to the public, safety barriers shall be provided to both sides and ends of trenches and around all sides of openings.

The Contractor shall provide details of the type or types of safety barriers for each excavation for the approval of the Project Manager prior to commencing work. No work shall commence until the safety

barriers are in place.

The type of safety barrier used shall be appropriate to the particular location and the potential risks to the public. Examples of different types of safety barriers are given below:

- Type 1 - excavated material;
- Type 2 - non-rigid barrier of rope or florescent tape strung between metal rods driven into the ground;
- Type 3 - rigid barrier of timber, steel or concrete. Such barriers could be in the form of horizontal rail(s) or sheet material secured to posts driven or concreted onto the ground.

The following are guidelines on the type of safety barriers that could be used in differing situations. They apply particularly to trenches but also apply to other types of excavation, existing openings onto the perimeter of work areas:

- areas not subject to vehicular traffic - Types 1 or 2;
- roadways (low traffic speed) - Types 1 or 2;
- roadways (high traffic speed or where excavation are greater than 2 m) - Type 3.

The above examples of the types of barriers and the guidelines on situations in which they could be used shall not relieve the Contractor of his obligations and responsibilities.

Section 8 Contractor's Site Check List

801 Contractor's Site Check List

A sample Contractor's Site Check List is included in Annex 1,2 & 3 to this Specification. This is included to assist contractors should they wish to introduce such a system as part of their site management procedures. The list is not exhaustive and further items will need to be added by the Contractor.

The list is issued for guidance only, and does not, in any way, revise or limit the requirements covered elsewhere in these Specifications.

xii) **Annex 1**
Sample Excavation Permit

To: (Project Manager)

From: (Contractor)

Date:

xiii) **Contract No:**
Request for Excavation Permit No:

Please give approval for excavation to proceed in the following area: Work to
start on:

Existing services have been checked and identified by:

Drawings # Physical Survey #

Catscan # Trial Holes Excavation #

Signed (Contractor):

xiv) **Approval by Project Manager**

The above excavation may proceed, subject to the following: Service
to be maintained:

Services to be isolated before work proceeds:

Other matters:

Signed (Project Manager):

Date:

xv) **Annex 2**

Sample Street Closure Permit

To: (Project Manager)

From: (Contractor)

Date:

xvi) **Contract No:**

Request for Street Closure Permit No:

Please give approval for the closure of the following street(s) from to (dates) Street(s):

Reasons:

Proposed diversions:

Signed (Contractor):

xvii) **Approval of the Project Manager**

The above street(s) may be closed for the periods stated subject to the following conditions: Approval has
been given by the relevant authorities and the police;

Other:

Signed (Project Manager):

Date:

xviii) **Annex 3**

Sample Contractor's Site Check List

Safe Access:

- arrangements for visitors and new workers to the site
- safe access to working locations
- walkways free from obstructions
- edge protection to walkways over 2m above ground
- holes fenced or protected with fixed covers
- tidy site and safe storage of materials
- waste collection and disposal
- chutes for waste disposal, where applicable
- removal or hammering down of nails in timber
- safe lighting for dark or poor light conditions
- props or shores in place to secure structures, where applicable

xix) **Ladders:**

- to be used only if appropriate
- good condition and properly positioned
- located on firm, level ground
- secure near top. If not possible, to be secured near bottom, weighted or footed to prevent slipping
- top of ladder minimum 1 metre above landing place

xx) **Scaffolding:**

- design calculation submitted
- proper access to scaffold platform
- properly founded uprights with base plates
- secured to the building with strong ties to prevent collapse
- braced for stability
- load bearing fittings, where required
- uprights, ledgers, braces and struts not to be removed during use
- fully boarded working platforms, free from defects and arranged to avoid tipping or tripping
- securely fixed boards against strong winds
- adequate guard rails and toe boards where scaffold is 2m above ground
- designed for loading with materials, where appropriate
- evenly distributed materials
- barriers or warning notices for incomplete scaffold (i.e. not fully boarded)
- weekly inspections and after bad weather by competent person
- record of inspections

xxi) **Excavation:**

- underground services to be located and marked, precautions taken to avoid them
- adequate and suitable timber, trench sheets, props and other supporting materials available on site before excavation starts
- safe method for erecting and removal of timber supports
- sloped or battered sides to prevent collapse
- daily inspections after use of explosives or after unexpected falls of materials
- safe access to excavations (e.g. sufficiently long ladder)
- barriers to restrict personnel/plant
- stability of neighbouring buildings
- risk of flooding
- materials stacked, spoil and vehicles away from top of excavations to avoid collapse
- secured stop blocks for vehicles tipping into excavations

xxii) **Roof Work:**

- crawling ladders or boards on roofs more than 10 degrees
- if applicable, roof battens to provide a safe handhold and foothold

-
- barriers or other edge protection
 - crawling boards for working on fragile roof materials such as asbestos cement sheets or glass. guard rails and notices to same
 - roof lights properly covered or provided with barriers
 - during sheeting operations, precautions to stop people falling from edge of sheet
 - precautions to stop debris falling onto others working under the roof work
- xxiii) **Transport and Mobile Plant:**
- in good repair (e.g. steering, handbrake, footbrake)
 - trained drivers and operators and safe use of plant
 - secured loads on vehicles
 - passengers prohibited from riding in dangerous positions
 - propping raised bodies for tipping lorries prior to inspections
 - control of on-site movements to avoid danger to pedestrians, etc.
 - control of reversing vehicles by properly trained banksmen, following safe system of work
- xxiv) **Machinery and Equipment:**
- adequate secured guards in good repair to dangerous parts, e.g. exposed gears, chain drives, projecting engine shafts
- xxv) **Cranes and Lifting Appliances:**
- weekly recorded inspections
 - regular inspections by a competent person
 - test certificates
 - competent and trained drivers over 18 years of age
 - clearly marked controls
 - checks by driver and banksman on weight of load before lifting
 - efficient automatic safe load indicator, inspected weekly, for jib cranes with a capacity of more than one tonne
 - firm level base for cranes
 - sufficient space for safe operation
 - trained banksman/slinger to give signals and to attach loads correctly, with knowledge of lifting limitation of crane
 - for cranes with varying operating radius, clearly marked safe working loads and corresponding radii
 - regular maintenance
 - lifting gear in good condition and regularly examined
- xxvi) **Electricity:**
- measures to protect portable electric tools and equipment from mechanical damage and wet conditions
 - checks for damage to or interference with equipment, wires and cables
 - use of correct plugs to connect to power points
 - proper connections to plugs; firm cable grips to prevent earth wire from pulling out “permit-to-work” procedures, to ensure safety
 - disconnection of supplies to overhead lines or other precautions where cranes, tipper lorries, scaffolding, etc. might touch lines or cause arcing
- xxvii) **Cartridge Operated Tools:**
- maker’s instruction being followed
 - properly trained operators, awareness of dangers and ability to deal with misfires
 - safety goggles
 - regular cleaning of gun
 - secure place for gun and cartridges when not in use
- xxviii) **Falsework/formwork:**
- design calculations submitted method statement dealing with preventing falls of workers
 - appointment of falsework coordinator

- checks on design and the supports for shuttering and formwork
- safe erection from steps or proper platforms
- adequate bases and ground conditions for loads
- plumb props on level bases and properly set out
- correct pins used in the props
- timberwork in good condition
- inspection by competent person, against agreed design, before pouring concrete

xxix) **Risks to the Public:**

- identify all risks to members of the public on and off site, e.g. materials falling from scaffold etc., site plant and transport (access/egress) and implement precautions, e.g. scaffold fans/nets, banksmen, warning notices, etc.
- barriers to protect/isolate persons and vehicles
- adequate site perimeter fencing to keep out the public and particularly children. secure the site during non-working periods
- make safe specific dangers in site during non-working periods, e.g. excavations and openings covered or fenced, materials safely stacked, plant immobilized, ladders removed or boarded

xxx) **Fire – General:**

- sufficient number and types of fire extinguishers
- adequate escape routes, kept clear
- worker awareness of what to do in an emergency

xxxi) **Fire – Flammable Liquids:**

- proper storage area
- amount of flammable liquid on site kept to a minimum for the day's work
- smoking prohibited; other ignition sources kept away from flammable liquids
- proper safety containers

xxxii) **Fire – Compressed Gases, e.g. Oxygen, LPG, Acetylene:**

- properly stored cylinders
- valves fully closed on cylinders when not in use
- adopt "hot work" procedures
- site cylinders in use outside huts

xxxiii) **Fire – Other Combustible Materials:**

- minimum amount kept on site
- proper waste bins
- regular removal of waste material

xxxiv) **Noise:**

- assessment of noise risks
- noisy plant and machinery fitted with silencers/muffs
- ear protection for workers if they work in very noisy surroundings

xxxv) **Health:**

- identify hazardous substances, e.g. asbestos, lead, solvents, etc., and assess the risks
- use of other substances where possible
- control exposure by means other than by using protective equipment
- safety information sheets available from the supplier
- safety equipment and instructions for use
- keep other workers who are not protected out of danger areas
- testing of atmosphere in confined spaces; provision of fresh air supply if necessary. Emergency procedures for rescue from confined spaces

xxxvi) **Manual Handling:**

- avoid where risk of injury
- if unavoidable, assess and reduce risks

xxxvii) **Protective Clothing:**

- suitable equipment to protect head, eyes, hands and feet where appropriate

-
- enforce wearing of protective equipment

xxxviii) **Welfare:**

- suitable toilets
- clean wash basin, hot/warm water, soap and towel
- room or area where clothes can be dried
- wet weather gear for those working in wet conditions
- heated site hut where workers can take shelter and have meals with the facility for boiling water
- suitable first aid facilities

xxxix) **Work in Public Areas:**

- all risks to the public identified
- method statement approved
- road closures approved
- temporary diversions in place
- safety barriers erected/maintained
- labour, materials, plant and other resources sufficient to meet programme
- temporary reinstatement completed and properly maintained
- permanent reinstatement completed at earliest possible date.

902 Construction Environmental Management Plan

A Construction Environmental Management Plan (CEMP) is a practical and achievable plan of management to ensure that any environmental impact during the design, planning and construction phase are minimised. CEMP's have been proposed to deal with the following issues during Project construction:

Compensation and land take
Physical setting, flora and fauna;
Interruption of key infrastructure installations; Water
quality and energy management;
Dust and air quality; Occupational
health and safety; Noise and
vibration; and
Waste management.

Detailed CEMP's are presented below.

CEMP for Compensation and land take

Objective	To ensure that the land owners are properly compensated and avail land for the proposed Project.			
Management strategy	Since compensation is an integral part of Project design ensure it is dealt with from the earliest stages of Project preparation and comply with the laws of Kenya.			
	Activities	Responsibility	Timing	Costs (KES)
Actions	Land take should be minimized where feasible, exploring all viable alternative Project designs e.g. realignment of the pipeline may significantly reduce compensation; and Where displacement is unavoidable, compensation and resettlement plans should be developed with adequate compensation under guidance of various lead agencies including Ministry of Lands, TWSB, Local Councils and the District Development Committees.	Proponent	Prior to construction	TBD
Performance indicators	Lack of complaints / Complaints.	Proponent	Construction Phase	
Monitoring requirements	Documentation; and Land easement	Proponent	Construction Phase	
Reporting	Documentation	Proponent	Construction Phase	
Corrective actions	Implement recommendations.	Proponent	Construction Phase	
Interface	Ensure compliance with the Law of Kenya and the requirements of any donors involved in the Project.	Proponent	Construction Phase	

CEMP for Physical setting, flora and fauna

Objective	Maintain the existing balance within the physical, fauna and flora components in the Project area setting.			
Management strategy	Provide for appropriate measures that guarantee the protection of habitats, flora and fauna.			
	Activities	Responsibility	Timing	Costs (KES)
Actions	Provide structures that will not hinder free movement of animals and dispersal of propagation components; Maintain as much as possible the natural drainage systems and patterns; Grade sites to original levels to maintain topography; As much as practical limit the amount of vegetation cleared during works; Discourage bush meat hunting; In the event that considerable damage to vegetation is envisaged, set out a plan for replacement or grading to encourage natural rejuvenation; and Design and plan for use of wayleave by pedestrians and non-motorised systems.	Consulting Engineers Contractor AWWDA	Planning. Design & construction	TBD
Performance indicators	Presence of a good balance of flora and fauna; and Minimal or no flooding in Project area.	AWWDA	Construction Phase	
Monitoring requirements	Baseline data/Project completion Baseline; and Changes in local hydrology.	AWWDA	Commissioning stage.	
Reporting	Site log book and EMCA requirements.	Contractor	Construction Phase	
Corrective actions	Rehabilitation	AWWDA	Commissioning stage	
Interface	EMP complies with the EMCA and other applicable laws.	AWWDA	Construction	

CEMP for management of infrastructure installations

Objective	Plan construction activities to minimise interruptions of infrastructure and ensure smooth Project implementation while complying with the laws of Kenya			
Management strategy	Liaise with stakeholders in the project area to ensure that access on protected or private areas is granted in good time in order to achieve Project milestones.			
	Activities	Responsibility	Timing	Costs (KES)
Actions	Establish the nature of all stakeholders; Identify key interests of each of the stakeholders; Formally liaise with the stakeholder and communicate the Project details to them with a view of developing a work plan; Implement work plan; and Acquire notes on Satisfactory Completion of Works by each affected party.	AWWDA Consultant Contractors	Planning, Design and Construction phase	TBD
Performance indicators	Level of complains.	All	Construction phase	
Monitoring requirements	Timely achievement of milestones; and Lack of interruption of services.	All	Construction	
Reporting	Site log book	Contractor	Construction phase	
Corrective actions	Investigate cause of interruptions; Implement corrective measures.	AWWDA Stakeholders	Construction phase	
Interface	Comply with the EMP contained in this report.	Contractor	Construction phase	

CEMP for water and energy management

Objective	Minimise impact on water and energy resources within the Project area due to the construction works.			
Management strategy	Conserve water and energy resources, abate pollution and comply with the laws of Kenya.			
	Activities	Responsibility	Timing	Costs (KES)
Actions	Provide appropriate and adequate drainage infrastructure where required; Ensure machinery is regularly serviced to avoid leakages and/or spillages; Oils, fuels and other materials to be stored in accordance with the manufacturers' safety data sheets (MSDS); Train staff on spill response; Implement erosion and sedimentation controls; Proper handling/disposal of liquid waste; Energy management through use of sound/appropriate equipment; Application of rated equipment in welding and related works; and Use of efficient mechanical plant and energy savers on sites.	Contractor	Construction phase	TBD
Performance indicators	Minimal interference of water and energy resource in the area.	Contractor	Construction phase	
Monitoring requirements	Physical inspection; and Level of complains.	Consultant	Construction phase	
Reporting	Site activities log book.	Contractor	Construction phase	
Corrective actions	Implementation of monitoring findings and recommendations.	Contractor	Construction phase	
Interface	Comply with laws and guidelines.	Contractor	Construction phase	

CEMP for dust and air quality

Objective	Maintain the quality of the air and minimise any harmful emissions into the atmosphere and comply with the laws of Kenya			
Management strategy	Abate pollution of the atmosphere by airborne particulate matter.			
	Activities	Responsibility	Timing	Costs (KES)
Actions	Dampen work areas materials heaps and mulch bare ground to minimise dust emissions; Maintain equipment and machinery to manufacturers' specifications; Use environmentally friendly fuels; Minimise the period for machinery idling; Pursue good practices in energy use and sensitise staff; and Provide appropriate personnel protective equipment to site workers.	Contractor	Construction phase	TBD
Performance indicators	Lack of complaints / Complaints; and Reports / Log book entries.	AWWDA	Construction phase	
Monitoring requirements	Physical inspection Site Log books	Consultant	Construction phase	
Reporting	Site logs of inspections and corrective actions.	Contractor	Construction phase	
Corrective actions	Implement recommendations	Contractor	Construction phase	
Interface	Review and comply with laws and regulations.	Contractor	Construction phase	

CEMP for occupational health and safety

Objective	Ensure the safety and health of all the Parties involved in the Project implementation and comply with the laws of Kenya			
Management strategy	Provide proper safety equipments, facilities and conditions that will eliminate or reduce the risk to the Project workers and all those present therein.			
	Activities	Responsibility	Timing	Costs (KES)
Actions	Comply to the OSHA; Provide for appropriate signage and warnings at work sites; Provide appropriate personnel protective equipment (PPE) to workers and any visitors; Provide for First Aid facilities as per the Occupational Safety and Health Act; Provide and clearly display emergency contacts; and Develop and implement a detailed and site specific Emergency Response Plans.	AWWDA Consulting Engineers Contractor	Construction phase	TBD
Performance indicators	Health and safety awareness among staff; and Frequency of incidents/accidents and fatalities.	Consultant AWWDA	Construction phase	
Monitoring requirements	Daily inspection of work sites; and Tool box meetings.	Consultant	Construction phase	
Reporting	Log incidents/accidents and fatalities; and Tool box minutes.	Consultant	Construction phase	
Corrective actions	Investigate incident/accidents and fatalities; and Follow up on complains and other issues from tool box meetings.	Consultant	Construction phase	
Interface	Updates on the OSHA and orders from Directorate	AWWDA	Construction phase	

CEMP for noise and vibration management

Objective	Manage activities at construction sites to reduce impacts of noise on surrounding properties and comply with the laws of Kenya.			
Management strategy	Noise to be managed through administrative and maintenance controls during construction.			
	Activities	Responsibility	Timing	Costs (KES)
Actions	All construction activities to be limited to between 7am to 6pm; All equipment used during the construction phase to be regularly maintained to ensure efficient operation; Noise dampening materials to be used where excessive noise generating-equipment are in use; Use of appropriate cushioning for heavy equipment; and Use of personal protective equipment by operations staff.	Contractor	Construction phase	TBD
Performance indicators	Lack of complaints / Complaints.	Contractor	Construction phase	
Monitoring requirements	Periodic inspection of work sites; and Service log for equipment / machinery.	Contractor	Construction phase	
Reporting	Complaints / incidents should be recorded in a log book on location.	Consultant	Construction phase	
Corrective actions	Investigate cause of noise and vibrations; Implement corrective measures prior to commencement of works; and Consider possibility of rescheduling noise and vibration generating activities.	Contractor AWWDA	Construction phase	
Interface	Ensure that if the Contractors or subcontractors have an EMP and that it complies with the EMP contained in this report.	AWWDA	Construction phase	

CEMP for waste management

Objective	Minimise the potential for environmental impact of wastes generated due to the construction activities and comply with the laws of Kenya.			
Management strategy	Effectively manage the sites and activities that may lead to generation of wastes.			
	Activities	Responsibility	Timing	Costs (KES)
Actions	All wastes shall be contained on site prior to disposal using appropriate storage containers; All wastes shall be regularly cleared from the site and disposed of in approved manner; High level of housekeeping shall be maintained; and Staff shall be trained / sensitised about waste management at the start of the Project and regularly as may be found appropriate.	Contractor	Construction phase	TBD
Performance indicators	No waste at work sites except in approved and marked locations.	Contractor	Construction phase	
Monitoring requirements	Regular site inspections; and Waste disposal documentation and tracking.	Contractor	Construction phase	
Reporting	Review of waste handling slips and other related documentation.	Contractor	Construction phase	
Corrective actions	Provide reports, corrective actions and recommendations where non-conformities occur.	Contractor	Construction phase	
Interface	Ensure that Contractors or subcontractors EMP complies with the EMP contained in this report.	Contractor	Construction phase	

Section 10 – Mechanical and Electrical Plant

1001 Scope of Mechanical and Electrical Work

The electromechanical equipment to be provided and installed by the Contractor should have capacity to handle 1,500m³/d of sewer flow. Contractor to provide shop drawings and power loading capacities for Engineer approval. This specification below are for general guide purpose

- Site Lighting
- Flowmeters
- Laboratory Equipment

Instrumentation

Electromagnetic Flow Meter

The electromagnetic flow meter uses the principle, that an electrical conductor (in this case the floating medium) induces a voltage if moved in a magnetic field that is proportional to the average flow velocity. This voltage is measured with two electrodes inside the pipe, while two coils mounted on the pipe generate the alternating magnetic field. From this the measuring transmitter determines the flow value of the medium.

The measuring sensor should provide:

- Flow rate: suitable for the required purpose
- Diameter of the sensor: adequate to the media pipe
- Magnetic field: alternating by pulsed direct current
- Protected against flooding: min. 24 h, 3m, according to location
- Permissible pressure: min. PN10, according to location
- Materials, pipe: Steel, coated with PTFE
- electrodes: High grade steel 1.4571
- casing: Aluminium, powder coated
- Medium temperature: 0°C....90°C
- Min. conductivity of medium: 5 µS/cm
- Degree of protection: IP 67

The measuring transmitter should provide:

- Digital display for momentary flow rate and total quantity, separately mounted (8 digits) at a location, where it can be easily calibrated, operated and read
- Monitoring of pulsed magnetic field
- Automatic zero calibration
- Field-mounted housing, powder coated die-cast aluminium, IP 67
- Output signals, 0/4...20 mA, counting pulse, status output
- Power supply, 230 VAC, 50 Hz

All surfaces being in contact with the medium have to be coated with suitable material, so that cleaning is not necessary and accuracy is not impaired during operation. The selected material must be suitable for use in wastewater, sewage sludge, and chemicals or as required by the respective purpose.

The flow meter must be mounted to the pipes, regarding the right location where no turbulent disturbances may cause false results. Mounting material, construction pipes, replacement pipes to install while the sensor is removed, telescopic pipes to ease the removal of the sensor, earthing system, reference electrode system and all electrical connections have to be provided. The measuring transmitter shall be mounted separately so that it can easily be checked and calibrated.

Electromagnetic flow meters shall be preferably used. Other kinds of flow measurement shall only be installed, if electromagnetic flow meters are not applicable (e.g. in open channels, concrete pipes, etc.).

Ultrasonic Flow Meter

At these flow meters the water flow is measured with a Venturi channel, where the channel profile is constricted in a way, that the flow changes from laminar to turbulent. In this case the flow can be determined by a single level measurement upstream of the throat. For this an echo measurement is used: An echo system transmits ultrasonic pulses towards the surface from above and receives the returning echo. It determines the level from the speed of sound, the propagation time, the devices' height and the channel construction. Variations of the ambient temperature must not influence the measurements' accuracy and therefore have to be compensated automatically by use of a temperature sensor. The complete measuring system consists of the Venturi channel, the ultrasonic level meter, the measuring transmitter and the signal processor to calculate the flow rate and to generate count pulses according to the quantity of water passing the sensor.

The Venturi channel shall provide:

- Type: Khafagi-venturi, rectangular cross section
- Size: Fitting to the channel
- Materials: Sealed polypropylene, zinc plated steel reinforcements
- Flow rate: suitable for the required purpose

The ultrasonic sensor shall provide:

- Integrated temperature sensor for compensation
- Temperature: -20°C...+80°C
- Measuring range: suitable for the required purpose
- Degree of protection: IP 68
- Connection to processor: Via 5 m cable

The signal processor shall provide:

- Digital display for momentary flow rate and total quantity (4 digits)
- Continuous flow measurement
- Field-mounted housing, IP 65
- Output signals, 0/4...20 mA, 1 status contact, counting pulse, all potential-free
- Power supply, 230 VAC, 50 Hz

The sensor shall be mounted above the channels' middle to a cantilever that is fixed to poles on both sides of the channel. The distance to the water surface must be more than the sensors block distance. The measuring ultrasonic signal must not be disturbed by any fittings inside the channel to get reliable results. The original manufacturer shall calibrate the flow meter on site. A certificate stating the accuracy at least at 10 different flow rates within the total range after installation at the wastewater plant must be submitted.

All fittings must be easy to access and to remove for maintenance or repair. All mounting material also shall be provided.

Ultrasonic Water and Sludge Level Meter

At this measuring instrument an echo system transmits ultrasonic pulses towards the medium surface from above and receives the returning echo. It determines the level from the speed of sound, the propagation time, and the sensors' height. The complete measuring system consists of the ultrasonic level meter and the fitting-measuring transmitter.

The ultrasonic sensor should provide:

- Integrated temperature sensor for compensation
- Temperature: -20°C...+80°C
- Measuring range: suitable for the required purpose
- Degree of protection: IP 68
- Connection to transmitter: Via 5 m cable

The measuring transmitter should provide:

- Digital display for momentary level respectively level difference (m, %) and volume (cum, %), 4 digits
- Permanent measurement of the medium level
- Field-mounted housing, IP 65
- Output signals, 0/4...20 mA, 1 status contact, 2 limit contacts, potential-free
- Power supply, 230 VAC, 50 Hz

The installed meter shall be resistant against gases, humidity and weathering. The function and accuracy of the meter must not be affected by these phenomena.

The sensor shall be mounted according to the purpose. At open channels or tanks it is fitted to a cantilever that is fixed to a pole on the edge of the channel or tank. Closed pipes or tanks must be supplied with a suitable flange fitting with gaskets. The material of the mounting devices shall be suitable for the material of the respective tank or pipe and shall be thermo-insulating. The distance to the medium surface must be more than the sensors block distance. The measuring ultrasonic signal must not be disturbed by any fittings inside the channel, tank or pipe to get reliable results. All fittings must be easy to access and to remove for maintenance or repair. All mounting material shall be included. In order to avoid excessive condensation at the sensors membrane, the sensor shall be mounted in a thermal-insulated manner so that the temperature of the sensor

follows the air temperature. The membrane of the sensor must be water-repellent and shall be shaped in a way that there is no built-up of water films.

Hydrostatic Level Meter

The hydrostatic level meter is mounted at the bottom of the respective tank to measure the pressure caused by the medium. From this the level can be determined, if the medium density is known. Thus effects like foam on the medium surface do not influence the measuring unit.

The sensor should provide:

- Suitable for installation in potentially explosive atmosphere (if required)
- Measuring range: suitable for the required purpose
- Output signal: 0/4...20 mA
- Degree of protection: IP 65
- Medium temperature: -30 ... +100 °C
- Housing and mounting material made of high grade steel (material 1.4301)

The measuring transmitter should provide:

- Self monitoring
- Noise-free, two wire signal transmission
- integrated linearisation
- two limit contacts with adjustable hysteresis
- power supply for measuring sensor
- Suitable for installation in potentially explosive atmosphere (if required)
- Field-mounted housing, IP 65
- Input signal: 0/4...20 mA
- Output signals: 0/4...20 mA, 4 limit contacts, potential-free
- Power supply, 230 VAC, 50 Hz
- LCD display, 4 digits

The sensor shall be mounted to a suitable flange fitting with shutoff valve and vent valve. The material of the mounting device shall be suitable to the material of the respective tank or pipe. All fittings must be easy to access and to remove for maintenance or repair. All mounting material is also included.

PH-Meter

The pH-probe consists of a measuring electrode with membrane glass, a reference electrode and a temperature sensor Pt100 for temperature compensation and temperature measurement, all combined in one sensor. The sensor is mounted inside and protected by a PVC armature. An adequate measuring transmitter is required with automatic temperature compensation and self-monitoring. The sensor is mounted to the channel or the pipe with a suitable flanged fitting, whereby the sensor shall be installed within a protective pipe that allows the sensor to be taken out without interruption of the process.

The pH-probe should provide:

- Measuring range: pH 1...13

- Temperature range: -5°C...+80°C
- Permissible pressure: 6 bar
- Shaft length: suitable for the required purpose
- Temperature compensation: -10°C...+55°C

The armature should provide:

- Shaft length according to on site conditions
- Preamplifier and 5 m shielded coaxial connecting cable with watertight and reliable connectors for probe, amplifier and measuring transmitter
- Submersible armature, self-cleaning to be lowered into the medium from suitable high grade steel fitting

The measuring transmitter should provide:

- Display: LCD, range pH 0...14, -5°C...+80°C, status-indication, 4 digits
- Output: 2 x 0/4...20 mA for pH value and temperature
- Power supply: 230 VAC, 50 Hz
- Field-mounted housing
- Degree of protection: IP 65
- Output signal: 1 status contact, potential-free

Furthermore the service includes one complete spare sensor, materials and calibration solutions for two years of operation. All fittings must be easy to access and to remove for calibration, maintenance or repair. All mounting material is also included.

Oxygen Measuring Device (DO-Meter)

A membrane-covered, amperometric sensor following the potentiostatic principle measures the oxygen content. This kind of sensor provides two measuring electrodes in an electrolyte, which is separated from the liquid being measured by a membrane, which allows oxygen to diffuse into the electrolyte.

A third electrode used as a reference electrode is used for several functions: Reduction of measuring errors, monitoring of calibration, membrane faults, and electrolyte quality, self-monitoring. The life-span of the probe is at least 1.5 years without refilling of electrolyte.

To complete the measuring system an additional measuring transmitter is required. This should be a continuously working microprocessor-based O₂-transmitter. An alternative value can be provided to the control system by an extra switch to avoid control errors, if the oxygen measurement is not working due to maintenance or repair.

The selected probe should provide:

- Automatic zero calibration
- Self monitoring
- Construction: Compact probe with cable (6.5 m) and plug-in
- Mechanical fitting: Screw-in thread R1"
- Material:

Casing: High grade steel / PVC

Counter-electrode: Silver

Reference-electrode: Silver

Working-electrode: Gold

- Membrane-thickness: 45 µm
- Flow rate: > 0.005 m/s
- Max. permissible temperature: 50°C
- Temperature compensation: 0 - 50°C by two thermistors
- Degree of protection: IP 68
- Accessories for 2 years of operation, at least:
 - ☐ 2 spare membranes as exchangeable cartridges
 - ☐ 50 ml cleaning solution
 - ☐ 50 ml electrolyte

□ 50 ml cathode-cleaner

The selected measuring transmitter should provide:

- Amperometric three-electrode measuring principle
- No zero calibration
- Automatic calibration
- Automatic air-pressure compensation
- Self monitoring
- Display: LCD, range 0...60 mg O₂/l, selectable scale, 4 digits
- Input: Socket for plug-in from the probe
- Output signals: 0/4...20 mA, 1 status contact, potential-free
- Power supply: 230 V, 50 Hz
- Field-mounted housing
- Degree of protection: IP 65
- High grade steel protective roof

The sensor shall be fixed to a submerged fitting made of PVC that can be lowered into the water from a high grade steel cantilever mounted to the edge of the tank. Before installation the best location shall be determined together with the other engineers to get a reliable result from the measurement. All fittings must be easy to access and to remove for calibration, maintenance or repair. All mounting material is also included.

Temperature Measuring Device

The temperature-measuring unit consists of a sensor Pt100 and the transmitter. The sensor is mounted to the channel or the pipe with a suitable flanged fitting, whereby the sensor shall be installed within a protective pipe that allows the sensor to be taken out without interruption of the process.

The sensor should provide:

- Measuring range: suitable for the required purpose
- Temperature range: -20°C...+75°C
- Shaft length: suitable for the required purpose

The measuring transmitter should provide:

- Display: LCD, 4 digits
- Output: 0/4...20 mA, 1 status contact, potential-free, 2 limit contacts
- Power supply: 230 VAC, 50 Hz
- Field-mounted housing
- Degree of protection: IP 65

The service includes installation, all fittings and mounting material. All fittings must be easy to access and to remove for maintenance or repair.

Laboratory Equipment

The Contractor shall deliver and furnish the laboratory room with sufficient laboratory equipment to facilitate the execution of all necessary wastewater, sludge, and digester gas analyses as required by the current National Legislative, in accordance to the requirements.

1. All laboratory furniture shall be manufactured according to the relevant DIN or acceptable standards, the electrical devices shall be suitable for 230/380 V, 50 Hz. Power supplies shall be in accordance with the relevant VDE (or comparable) directions.

2. The Contractor shall install, calibrate and connect to water or drainage services as necessary all such equipment to the approval by the Project Manager. The intake points of the electric supply shall be provided in the same line as the service supply points.
3. The Contractor shall supply and assemble parts and materials for adapting the furniture to wall, floor and ceilings and shall deliver detailed layout schemes of service connecting and drainage points as well as schematic wiring diagrams.
4. The Contractor shall submit layout plans for the arrangement of the laboratory furniture in the building to the Project Manager for approval, in accordance to the Contractors Design Proposal.
5. All stainless steel items mentioned below that are used in connection with laboratory tests and operations shall be of special stainless steel type, suitable for laboratory use and highly resistant to corrosion.
6. For comprehensive interchange-ability purposes, e.g. spare part stocking, the furniture has to be assembled from standardised components. The widths shall be multiples of 150 mm. The permissible module widths shall be 600, 900, 1200 and 1500 mm for plumbing units, and 450, 600, 900 and 1200 mm for storage cabinets. The laboratory furniture shall consist of self-contained components, which can be assembled together. Working heights shall be 900 mm for standing work and 750 mm for sitting work.
7. The Contractor shall provide and assemble all necessary equipment for cleaning, disinfection, refuse, first aid, fire-fighting, etc., including life vests, life belts and an automatic oxygen life-saving device with casing.
The Contractor shall submit a detailed inventory listing the complete laboratory equipment to the Project Manager. The Contractor shall provide the manuals for all laboratory equipment in English and Kenyan language, including the relevant standards, three-fold/language.

Chemicals

The Contractor shall provide a sufficient amount of chemicals for carrying out all the required tests for a period of 2 years after the end of the defects liability period, restocking after the end of the Contractors O&M period, respectively.

Chemicals and reagents with storage periods shorter than 1 year shall be supplied in quantities that will be completely used up in the laboratories with the maximum storage life. The Contractor shall submit a complete and detailed list of all chemicals and reagents and the quantities thereof to the Project Manager for approval prior to placing any order.

Laboratory Equipment

The following items shall be included in the Contractors scope of supplies as a minimum requirement.

Item	Volume	No. Req.
General Laboratory Basic Equipment		
Measuring pipettes glass	5 ml	10
Measuring pipettes glass	10 ml	20
Measuring pipettes glass	20 ml	3
Suction flask pipettes	5 ml	3
Suction flask pipettes	10 ml	3
Suction flask pipettes	20 ml	3
Suction flask pipettes	25 ml	3
Full pipettes glass	5 ml	5
Full pipettes glass	10 ml	5

Item	Volume	No. Req.
Full pipettes glass	20 ml	3
Full pipettes glass	25 ml	3
Full pipettes glass	50 ml	2
Full pipettes glass	100 ml	3
Pipettes bulb (ball)		4
Test glasses (Tubes) 16 x 160 mm - pkg. 100 piece		5
Test glasses stand for 12 tubes		5
Feeder machine, complete	0 - 30 ml	4
Feeder machine, complete	0 - 50 ml	4
Bottles NS narrow neck - clear glass	50 ml	15
Bottles NS narrow neck - clear glass	100 ml	15
Bottles NS narrow neck - clear glass	250 ml	15
Double Spatula 18 / 8 , 210 mm long		5
Tweezers 18 / 8 , blunt , 115 mm long		2
Test tube mixer		2
Drip stand - metal (wire)		3
Glass dishes, low form	100 ml	10
Glass dishes, low form	400 ml	10
Glass dishes, low form	1000 ml	10
Erlenmeyer flask, narrow neck	500 ml	20
Erlenmeyer flask, large neck	500 ml	20
Brush for funnels		4
Brush for test glasses		4
Brush for Erlenmeyer flasks		4
Brush for glass dishes		4
Brush for glass dishes		4

Brush for sedimentation vessels		4
Balloon with plastic tap	10 l	2
Narrow neck bottles PE	250 ml	30
Narrow neck bottles PE	500 ml	30
Narrow neck bottles PE	1000 ml	40
Large neck bottles PE	250 ml	20
Large neck bottles PE	500 ml	20
Measuring (graduated) cylinder, high form	50 ml	10
Measuring (graduated) cylinder	100 ml	10
Measuring (graduated) cylinder, high form	250 ml	10
Measuring (graduated) cylinder, high form	1000 ml	10
Felt pen - Black		6
Felt pen - Red		6
Felt pen - Blue		6
Manual Sampling		
Sampling stick 3.5 m long		3
Sampling ladle, one piece	1000 ml	3
Sampling ladle, two pieces	1000 ml	3
Basket, metal wire		3
Transport vessels, plastic	2000 ml	12
Bucket with handle and drain	10 l	10
Measuring dish, plastic	1000 ml	5

Item	Volume	No. Req.
Measuring dish, plastic	2000 ml	5
Temperature Measurement		
Water - Ladle Thermometer		1
Substitute Thermometer		2
Plastic rope 8 m long		2
Outside Thermometer		2
Max. Min. Outside Thermometer		2
Digital Thermometer		2
Visibility Depth Measurement		
Disc for measuring Transparency with handle		2
Disc for measuring Transparency with rope DIN conform		2
Visibility cylinder - small model		2
Visibility cylinder, large model		2
Settle-able Solids		
Sedimentation vessels, PVC	1000 ml	12
Sedimentation vessels, glass	1000 ml	6
Intake stand, PVC		3
Stop watch 120 min.		2
Viscose cleaning swam		3
Oil – Detection		
Oil test paper 320		2

pH Measurement		
Portable (Pocket) pH -meter, (pH 96A / Set)		2
pH – meter, (pH 196 with temperature control digital)		3
pH – Measuring Chain (E 50 - 1.5)		2
Measuring pen (TFK 150 - 1.5)		2
pH – Electrodes, pieces		4
Oxygen Measuring Instruments (DO-Measurement)		
Oxygen/Temperature Measuring Instrument (e.g. OXI* 92/Set)		3
Microprocessor-O ₂ -Measuring Instrument (e.g. OXI* 196)		3
Oxygen – Electrode (e.g. EO 196-1.5)		6
Microscopes		
Microscope Primus monocular, Stage 10 x, 40, 100 objectives		1
Cross - Table		1
Microscope binocular with phase contrast - equipment		1
Cupboard closeable		2
Covering glasses package /100 piece (Slides)		2
Covering glass tweezers (Slides)		3
Drip pipettes with rubber cap		4
Photometric Determinations		
Refrigerator 120 l lockable		3
Dispersing machine		3
NANOCOLOR* photometer 300 D		3
NANOCOLOR* thermoreactor R-2T		3
NANOCOLOR* security box		3
NANOCOLOR* test tubes Ammonia 50		4
NANOCOLOR* test tubes COD 160		4
NANOCOLOR* test tubes COD 40		4

Item	Volume	No. Req.
NANOCOLOR* test tubes COD 1500		4
Digital flask pipette 1.0-5.0 ml.		3
Digital flask pipette 0.2-1.0 ml.		3
Plastic cap for 1.0-5.0 ml. Pipette		3
Plastic cap for 0.2-1.0 ml. Pipette		3
Plastic stand for 3 flask pipettes		3
Reagent Vials for COD Tests to fit a.m. reactor		20
– Disposable (box with 25 vials)		
Forceps for crucibles (Length 50 cm)		2
Forceps for crucibles (Length 20 cm)		2
Markers for crucibles, Heat resistant		5
BOD Bottles with caps, with sealing water tip.	300 ml	60
Dessicators		4
– non - vacuum, D = 300 mm, H = 300 mm		
– with porcelain plates		
Burettes + Container (500 ml)		5

- Volume 5 ml, Subdivision 0.05		
- Automatic, Pyrex glass type zero, mark sets in		
- automatically, complete with rubber bulb.		
Beakers (glass)	1000 ml	24
Beakers (glass)	500 ml	24
Beakers (glass)	250 ml	24
Beakers (glass)	100 ml	24
Beakers (transparent plastic)	1000 ml	12
Beakers (transparent plastic)	500 ml	12
Beakers (transparent plastic)	250 ml	12
Beakers (transparent plastic)	100 ml	12
Reagent bottles (Amber glass)	1000 ml	12
Reagent bottles (Amber glass)	500 ml	12
Reagent bottles (Amber glass)	100 ml	12
Plastic bottles for washing	500 ml	6
Glass bottles for dropper	100 ml	12
Funnels (glass), D = 10 cm, stem = 10 cm.		12
Filter paper Watman 40/42, (100 filter/packet), Packets		30

Electrical Power Supply

Purpose: Feeding of electrical power from the public electricity network to the WWTP

Location: Electricity supply company

Drawings: WWTP

All works have to be supplied with electricity on a very high level of reliability. The actual design and the dimensions have to be determined by the Tenderer according to the requirements of his offered plant.

The offered price must include all costs, taxes and charges to be paid to the electricity supply company, for the construction of the supply line, the extension of existing transformer and switchgear stations and all required equipment outside the plants. The Contractor shall carry out all coordination's with the local electricity supply

company according to the best possibility to realise such supply of electricity at all points of the works. All costs necessary for the supply of electricity from the public network have to be included in the offer.

Electrical Power Supply for WWTP

There is an existing 100 kVA 11 kV / 415 V 50 Hz electrical supply and transformer at the existing WWTP. The Contractor should check if this is sufficient for their needs. If insufficient they shall renew the transformer in close liaison with the Employer and KENGEN.

Emergency Power Generation

In order to overcome possible power outages of long durations of the public network, which would interfere extremely with the operation of the wastewater treatment and pump stations an emergency power generator, shall be provided at those locations. Already in the first implementation stage of the works a very reliable diesel generating station for the emergency power supply with a sufficient capacity to supply each plant, and with the total emergency power that is required to supply all important consumers at the final implementation stage, shall be installed.

Each diesel generating station includes, but is not limited to, at least one Gensets with all equipment as specified hereinafter and as required.

General Specifications for Diesel Generating Sets

Each Diesel Generator Station must be able to start up and supply the respective plant automatically in the situation of power outage (black out) or power irregularities (brown out, phase loss, etc.) after maximum 1 (one) minute. Each Diesel Generating Set (Genset) must be suitable for parallel operation with other Gensets.

The size and electrical power of the emergency power system must be sufficient to operate all important consumers (like pumps, blowers, etc.) if mains power is failing. Taking the emergency power concept of the future extensions into consideration, the minimum power of each Genset must be approx. 150 kVA.

Current peaks e.g. by start-up of big drives or demagnetizing of transformers must be taken into account at the design of the generators.

The degree of noise reduction shall be provided so that noise emission is limited to 45 dB(A) at the nearest building next to the WWTP and PS or at 150 m distance, whatever is more stringent.

The values of the exhaust gas emission have to be less than stipulated by the relevant Standards (clean air legislation).

Only such Generating Sets will be accepted for which a local dealer/agent with well-known reputation is available.

The Contractor shall deliver and install the Diesel Generating Sets, including all additional equipment and accessories that are necessary to get a very reliable emergency power system, which meets the present state of the art.

The engineering for the Gensets shall take the requirements for overvoltage protection into consideration as well.

All equipment that may not be separately described in the tender documents, but is actually required shall be included in the offered service.

All equipment must be completely supplied, installed, aligned, adjusted, tested, commissioned, documented, etc., incl. all necessary materials. The work to be carried out shall be carefully coordinated with all parties involved.

Low Voltage Main Distributions

Purpose: In order to receive electrical power from the transformers and to distribute this power to the LV Process Distributions

Location: WWTP

Drawings:

LV Main Distribution to receive electrical power from the transformer and to distribute this power to the LV Process Distributions. Each LV Main Distribution is to be segmented into sections according to the number of connected transformers (minimum = 2). Each incoming feeder shall be equipped with a suitable motor driven circuit-breaker as specified and with an Electronic Line Monitor. All sections have to be connected via motor driven circuit-breakers. During normal operation all sections of a LV Main Distribution are switched together. During faults or maintenance each section can be isolated.

The front of each LV Main Distribution shall be equipped with all control switches, indicators, meters, instruments, etc. required to control the unit.

Each LV Main Distribution shall also be equipped with one automatic reactive current compensation unit for each busbar section and with raised floor, labelling, etc. The drives of important circuit-breakers must be supplied by the battery of the respectively HV station.

The Contractor shall produce the final design of his equipment after his own technical clarification and obtain written approval of the design from the Project Manager.

Automatic Power Factor Compensation

The power factor shall be limited according to the requirements of the local electricity supply company but at least to cost approx. 0.95 by automatic three-phase reactive current compensation units.

The necessary compensation units are to be located one for each power transformer. Each compensation unit shall be divided into approx. 10 steps. Several capacitors each have to be provided. Due to the harmonic distortions created by large frequency converters and soft starters, each capacitor shall be connected in series with a suitable reactive coil such forming individual

resonant circuits. The resonance frequencies of these draining circuits have to be adjusted to the 5th, 7th, 11th, and 13th harmonic (250 Hz, 350 Hz, 550 Hz, 650 Hz) in order to achieve a sinusoidal mains voltage.

Each unit agrees with VDE 0560-41 and VDE 0660-500, IEC 439 and provides the following characteristics:

- Rated voltage: 400 V
- Rated frequency: 50 Hz
- Control voltage: 230 V, 50 Hz
- Degree of protection: IP 20

It is to be mounted in cabinets according to the design criteria for low voltage distributions.

The service includes suitable power capacitors according to VDE 0560 part 4, IEC 70 and VDE 560 part 41, IEC 439 with the following characteristics:

- Low losses, dielectric loss $< 0.2 \text{ W/kvar}$
- Self-sealing capacitor elements
- Constructed in a way, that guarantees automatic disconnecting of capacitor elements in case of over temperature or faults
- Compressible granulated filling in a steel casing
- Dry insulation, free of PCB (Poly-Chlorinated-Biphenyls)
- Compact and stable design
- Mounting possible in any position

The compensation units have to be tested according to VDE 660 part 500, IEC 439, i.e. for the temperatures according to the local requirements.

Each var-controller is mounted to the respective cabinet door including $\cos\phi$ -indicator. Miniature circuit breakers, switches, discharge device, under-voltage tripping and remote control input have to be included in the service. All wiring, mounting materials and complete installation ready for operation are also included.

Low Voltage Process Distributions and Electrical Process Installations

Purpose: Distribute this power via motor control units to all electrical consumers

Location: Each section of the plant's process

The Contractor shall deliver a complete and functioning Low Voltage (LV) System for the WWTP, including all engineering and all accessories that are necessary to get a very reliable energy supply system which meets the present state of the art.

One common LV Process Distribution (also called MCC) shall be realized.

Each LV Process Distribution is to be segmented into sections according to the number of connected incoming feeders (minimum = 2). Each incoming feeder shall be equipped with a suitable motor driven circuit-breaker and with an Electronic Line Monitor. All sections have to be connected via motor driven circuit-breakers. During normal operation all sections of a LV Process Distribution are switched together. During faults or maintenance each section can be isolated.

The LV Process Distributions receive power from the respective LV Main Distribution and distribute this power via motor control units (switchgear assemblies, soft starters, frequency converters, etc...) to all electrical consumers. The front of the LV Process Distribution respectively MCC shall be equipped with all control switches, indicators, meters, instruments, operator panels, etc. required to control all consumers additionally to the central control. All electrical consumers are to be supplied with electrical power on a very reliable level. For each electrical consumer an appropriate switchgear assembly with current transformer, ammeter, measuring transmitter, operation hour meter, etc. shall be provided as specified hereinafter.

The operating levels (control levels) for each drive are to be realized according to the specifications.

The service shall include a field control unit for each drive, raised floor for each LV-Room, complete labelling, internal wiring, etc.

Design Criteria for Low Voltage Distributions

Regulations: VDE 0660 part 500 air- and creeping paths, VDE 0110, VDE 0106.

For electrical plants within hazardous locations, the regulations of VDE 0165 are to be regarded.

LV panel rooms must be kept dry under any operating conditions. They may not be located below the surrounding ground level.

Switchgear-Assemblies and Components

Switchgear assemblies are complete combinations of electrical components to supply and control electrical motors and electrical consumers (i.e. Motor Control Centres / MCC).

LV switching devices must always fulfil VDE 0660. Power contactors shall be suitable for utilization category AC 3. All switchgear assemblies must be at least type tested according to VDE 0660, part 500. DIN VDE 0110 shall be observed concerning insulation and creeping paths.

Each tripping of protective units shall cause an optical and acoustic alarm given at the panel and at the Central Control Room. The alarm is accepted by operating an alarm switch that is mounted at the switchgear panel. Unaccepted alarms have to be indicated by flashing indicator lights and an alarm horn, accepted alarms shall be indicated by steady lights without alarm horn.

Circuits for lighting and socket outlets must be equipped with automatic fuses. Socket outlets shall be connected to surge-proof, peak-current-sensitive and universal-current-sensitive current operated earth-leakage circuit breakers, providing a tripping current of 30 mA.

Circuits for heating units with a poor accessibility shall be equipped with current operated earth-leakage circuit-breakers with a tripping current of 300 mA.

Frequency Converter

If required, for pumps, blowers, etc. suitable switchgear assemblies including frequency converters have to be installed.

These switchgear assemblies have to be arranged in a way that provides following operating capabilities:

- Start of the drive with initial higher start-up (break loose) torque
- Starting with limited motor current, so that during the supply by Diesel-Generator all necessary drives can start and run without overload problems
- Manual operation of each drive including setting of variable speed
- Software for automatic operation via the separately specified PLC (e.g. in order to keep a constant level in the tank, fully automatic operation of the necessary number of drives, automatic changeover between the drives to keep equal running hours for all pumps, etc.)
- Soft stop of the drives to prevent pressure peaks in the pipes
- Automatic restart of the drives after power failure in the same mode as before power loss
- Sequential start in all modes
- Save emergency stop with complete isolation of the mains

The frequency converters have to be completely delivered, installed, carefully programmed according to the connected machines, tested etc. The contactors, fuses, circuit breakers required to complete the circuitry of the switchgear assembly have to be included in the service.

Electronic Motor Soft Starter

These units perform the soft starting, reduction of starting current, soft stopping, breaking, energy saving and motor protection functions. By use of thyristors the built-in microprocessor unit of a soft starter controls the voltage of the connected motor in a way, that during the starting phase the voltage is continuously increased while the motor current and the motor torque is monitored and limited to a preset value. To make sure that motors start in a reliable manner, the units can be programmed to send an initial pulse of a higher voltage to the motors. For soft

Stopping, the soft starters reduce the voltage so that the torque of the motor reduces gradually without sudden steps. Included are among others the power supplies for the electronic units, mains filter, motor filter, high power fuses suitable for semiconductor-equipped sets, circuit breakers with signaling contact for the control voltages, a set of spare control fuses, etc.. Included in the soft starter is also a temperature limit switch to protect the unit in case of excess temperature, a number of control inputs and outputs to control the associated motor starter circuitry, five LED indicators to display the operating condition and a covered control panel with following elements: adjusters for ramp time (0.180 sec), start voltage (20..100%), current limit (0.5...6x nominal motor current) and stop time. DIP switches to programme the operating modes.

Electronic Line Monitor

All Low Voltage Distribution Switchboards need to have Electronic Line Monitors. These devices must constantly monitor the three phase voltages and currents at the feeding point. The ratios of the connected current and potential transformers have to be field adjustable at the monitor unit. The units shall be mounted in the doors of the switchgear cabinets. All programmed and recorded data shall be kept in non-volatile memory. No batteries required. Data and limit values can be easily selected and keyed in by the user at buttons at the front panel.

Electronic Motor Monitor

For all electrical motors with a power of 30 kW and above electronic protection relays have to be installed together with the electric starter circuits of the motors to protect the motors against overcurrent and excess temperature. The motor monitors shall continuously measure the motor currents of the three phases and the temperatures of the windings and determine on the basis of true RMS calculations and on the basis of the user-programmable motor characteristics and limit values if there is normal operation, or if there is a trip or an alarm condition. The programmable motor characteristics must include: Full Load Amps, Locked Rotor Current, Locked Rotor Time, Ultimate Trip current. All programmed and recorded data shall be kept in non-volatile memory. No batteries required. For door mounting. Data and limit values can be easily selected and keyed in by the user by buttons at the front panel.

Field Control Units

For each valve, pump, aerator, etc. a field control switch box shall be mounted at a location where the function of the equipment can be observed. For this encapsulated switchgear assemblies according to VDE 0660 with the degree of protection IP 65 are required. They must be suitable for use in wastewater treatment plants and outdoor mounting. The casings for surface mounting are installed vertically, with cables fitted from below to a screwed watertight gland according to the cables. Labels, white with black inscription, have to be fixed with screws.

The switchgear assembly consists of:

- • Suitable number of pushbuttons with flat button and a cover plate resistant to abrasion, with inscription (e.g. "Open", "Close", "Stop", "On", "Off", "Slow", "Fast", etc.)
- • 1 keylock switch according to plant's locking system, for electrical blocking of the pushbuttons, with abrasion-proof label "Local control - Off - Central control", key removable in all switch positions
- • 1 mushroom-head emergency pushbutton (red), latching, including keylock according to plant's locking system and surrounding circular yellow label with black inscription "Emergency Stop".

The emergency-stop-button shall be equipped with three NC contacts. One emergency pushbutton may be sufficient for a group of drives that must be stopped together in case of an emergency.

The whole assembly is surface-mounted into a weather-proof casing made of high-grade steel (W 1.4301/ANSI 304) installed on a suitable pole with protective sun and weather roof, made of high-grade steel (W 1.4301/ANSI 304), each keylock provides a protective cap to protect the cylinder from being affected by dirt. The installation ready for operation and all mounting and installation material have to be included. Field control units must be readily accessible.

Automatic Control Systems

Purpose : Automatic operation of the WWTP

Location : WWTP and PS

Drawing :

The automatic control shall be realised with Programmable Logic Controllers (PLC), also called Stored Program Controllers (SPC). Each LV main- and process distribution shall be equipped with a separate PLC unit, further PLC shall be supplied for control and data acquisition at the control centre (mimic diagram), HV stations and other important parts of the plant, that may require a separate control unit.

The Contractor shall deliver a complete and functioning Automation System, including all engineering and all accessories that are necessary to get a very reliable system which meets the present state of the art.

All PLC units shall be of the same design and type, whereby the design and type shall be chosen according to the highest requirements of any task within the complete works.

Each PLC unit shall be equipped with marshalling cabinets and must be supplied by an UPS. The service also shall include the required PLC software, a programming unit, etc.

The Contractor shall carry out the realisation of the automation systems according to the following work programme, regarding the whole electrical systems:

- Creation of description of functions, lists of consumers and measurements, circuit diagrams, workshop- and installation drawings for the whole electrical equipment
- Creation of the plant identification system
- Design of mimic diagram and control computers
- Creation of program descriptions for PLC units and the bus system
- Creation, installation and implementation of the software, start-up
- Submittal of draft of the final documentation
- Training of operational staff
- Test-run for 6 months
- Multiple optimisation of the system according to the experience, gained by the operating personnel
- Creation and submittal of the final documentation, firmware and software

Each step includes the respective technical clarification, production of the required documents, multiple revision of documentation until approval by the Project Manager.

PLC System

Automation devices have to be installed within separate switchgear cabinets in the respective LV-Room. Switchgear cabinets have to be designed according to the specifications concerning the low voltage distributions. They must conform to other switchgear cabinets at the location of installation.

The electrical specifications are:

- Operational voltage: 400 / 230 V, 50 Hz
- Control voltage: 230 V, 50 Hz
- Scanning voltage: 60 V, DC
- PLC and light indicators: 24 V, DC

Following materials have to be included:

- Cable ducts
- Mounting material
- Connecting material
- Fitting material
- Connecting terminals
- Automatic fuses with signalling contact for 24 VDC, 60 VDC and 230 VAC in adequate number for each panel
- Operator panel with LCD-display in order to show the operational status of the PLC, the controlled plant and to input control variables

The PLC shall be delivered uniform with front connections respectively front plug connectors, including connection wiring, interface element and build-in hardware-clock.

All PLC have to be equipped with identical CPU-modules. The type shall be determined according to the highest requirements of all PLC stations of the whole plant.

There have to be self-diagnostic routines within the CPU to check all systems constantly. The program memory and all status registers have to be buffered with a long lasting battery (minimum 3 years).

The service includes the technical project planning, generation and submission of all documentations and their careful storage within the switchgear cabinet.

The PLC shall be delivered and mounted completely functional with mounting racks, power supply units, overvoltage protection devices, circuit breakers, monitoring devices, interfaces, bus connections, connecting cables with plugs, coupling relays, isolating amplifiers, terminals, fitting material, etc. including the wiring of the switchgear cabinets.

The programs are to be stored on a flash card.

The in- and outputs of the PLC provide the following specifications:

- Digital inputs (DI) isolated, 24 VDC
- Digital outputs (DO) potential-free via coupling relays, 24 VDC, 2 A
- Analog inputs (AI) isolated, 0/4...20 mA, converter resolution 11 bit
- Analog outputs (AO) isolated, 0/4...20 mA, converter resolution 11 bit
- System interfaces, transmission speed min. 187.5 kbit/s

Each PLC unit shall be supplied by an uninterruptible power supply unit. A switch "UPS / Main" to select the power source shall be installed at the front of each PLC unit cabinet.

For important signals and signals for safety purposes the bus system may not be used. These signals must be transmitted directly by means of control cable with a transmission voltage of 60 VDC.

At least the following signals have to be processed and transmitted to the Central Control Room either via direct cable lines or via the bus system:

- For motors, drives and valves:
 - ☐ commands (on, off, faster, slower, high speed, low speed, open, closed, right, left, etc.)
 - ☐ status signals (fault, on, off, faster, slower, high speed, low speed, open, closed, right, left, active starting delay, etc.)
 - ☐ analog values (motor current, rotation speed, measurements, etc.)
 - ☐ further signals as required
- For measuring devices:
 - ☐ Status signals (fault, maintenance, limit alarms, etc.)
 - ☐ analog measuring values
- Electric switchgear:
 - ☐ commands (open, close, etc.)
 - ☐ status signals (open, close, fault, tripped, etc.)
 - ☐ analog values (current, etc.)
 - ☐ further signals as required
- Other signals from or to the plant:
 - ☐ electricity supply (voltages, frequencies, all signals from the generating sets, etc.)
 - ☐ from the process (calculated values, etc.)
 - ☐ all signals provided from machinery units with separate control devices
- All further signals that can be gathered from any device installed at the plant

Each PLC unit shall be equipped with a marshalling and instrumentation cabinet of identical design as the PLC cabinet and of sufficient size, installed as a switchgear cabinet according to the specifications for LV equipment. The marshalling and instrumentation cabinets shall provide a sufficient number of terminal blocks for the marshalling of all incoming signal cables to the I/O units of the PLC.

All signals must be connected potential-free by means of suitable coupling relays and isolating amplifiers.

PLC Software

The PLC software consists of the programs for the automatic control of the plants' devices and for the connection to the process control system, including in- and output via communication modules with the necessary communication software. It must be possible to process all in- and outputs and transfer respectively receive them to respectively from the process control system. The service includes the generation and implementation of the software according to the required amount of data. For further software extension a memory reserve of at least 30% is required.

The correct function of the programs shall be tested and optimised in all parts of the process while the machinery is working.

The price and the service includes all clarification necessary to define the exact functional requirements of the various parts of the plant and the necessary flow of manual and automatic control, written description incl. flow-charts of all details and functions of the control system and submittal for approval (4-fold), the complete software, project planning, programming and generation of the complete documentation, start-up, test run and optimisation. The software is delivered on and test run on the PLC is also included.

Laptop PC as Programming Unit

For programming the PLC, a programming unit based on a Laptop PC is required. The laptop shall be from latest technical development and shall provide the following characteristics:

- Standard operating system
- Office software package
- Anti virus software
- Software for parameterization, programming, on-line system maintenance, operation via menus
- Software for programming, diagnosis of the PLC via statement list, ladder diagram and flowchart, providing standard blocks, control blocks, etc., the software can be operated in on-line mode
- Programming module for the memory sub module of the PLC
- Connection and all necessary connecting cables
- Interface and cable for connection to the process control system, the star coupler and the PLC
- Power supply unit and battery
- Protective case

Uninterrupted Power Supply (UPS)

In order to supply emergency power 230 VAC, 50 Hz, sinewave to the different consumers during mains power failure some UPS-Systems, suitable for permanent power supply to all critical consumers are required. They shall supply all critical consumers for minimum 120 min. with electrical energy. The specifications of all well known computer producers must be fulfilled. At least the UPS must supply the following consumers:

- Central Control equipment
- All PLC-units and PLC bus-system
- Computers and printers of office rooms
- Telephone system
- Further critical consumers as required

Each UPS consists of a rectifier with a constant voltage / constant current curve according to DIN 41 773, a Battery-System (life-span at least 10 years) and an inverter with electronic power switch (EPS). The batteries have to be installed in separate battery cabinets.

Process Control Computer

State-of-the-art process-control computer system at the WWTP. This system shall comprise all hardware- and software-components and shall be from latest technical development and shall provide the following characteristics:

- Standard operating system
- Office software package
- Anti virus software
- Connection and all necessary connecting cables
- Power supply unit and battery
- The main process control computer makes all process-data and archive-data available at an inner-office data-bus-system (Ethernet-bus) and allows all connected computers to access the data and to inspect, utilise, input, modify and store the data and perform all process-control-functions.

Each computer shall be equipped with keyboard, pointing device (mouse), high-resolution colour screen, and printer.

Software for the Process Control Computers

The software consists of the operating software and the application software including all the engineering and programming. All services of the Contractor have to be performed in complete coordination and agreement with the Project Manager.

The Contractors engineering services, the software and the system's capabilities include additionally to the above mentioned general functions all the following features:

- All plants data processing and data presentation in English and Kenyan.
- Installation of the software in all computers and delivery of the complete software on 2 different sets of media (diskettes, CD)
- System suitable for and operating in a network environment
- Fully graphical man-machine interface
- Operation via menus

- Password system for special functions
- Clearly defined and completely documented interfacing of all software modules
- Hardware-independent software on the basis of standardised operating systems with multi-user and multitasking function
- Data-exchange for external data-processing on third-party systems via Ethernet
- All data have to be stored in a data bank
- Display of all process data as dynamical graphic plant images, trend curves, etc.
- Software for the process control
- Maintenance, additions or modifications of the software and the archived process data also via menu-operated software without interruption of the process control or other software tasks
- Operating hours counters for all motors of the WWTP, giving a warning if maintenance intervals are exceeded
- Input of laboratory data at a later point in time into the existing archive
- All process-data have to be pre-processed, stored, and archived in a way, that standard third-party software can be directly applied for further data-processing like: word-processing, data-base applications, spreadsheet applications, graphical applications
- Reports have to be generated, displayed at the monitor screens and printed automatically. The data to be subject to printing have to be software selectable
- Hardcopy of all monitor displays on the colour printer
- Maintenance software to create, modify, delete and install all data to control the flow of process data and their handling and presentation including creation etc. of the dynamically graphic plant images

The operation of the complete software system must be easy to learn and to handle for the personnel. All functions have to be menu-selectable, error-safe, self-explanatory.

The data are to be treated and stored as per DWA/ATV M 260 or equivalent harmonized International Standards.

1002 General Requirements

The Contractor shall design, manufacture, deliver to Site, erect, test and commission the Plant and its associated support and shall ensure that the completed Plant meets the performance requirements and objectives.

The Plant, material and equipment shall be finished complete in all respects to provide a complete installation. Any items necessary for the completion and operation of the Works as particularly specified in the Scope of Works shall be provided under the Contract. Any clause in the General Specification which relates to the work or materials not required by the Scope of Works shall be deemed not to apply.

The Contractor shall provide competent engineers and installation personnel to carry out the erection of the plant and the tests on completion, and to give instruction on the operation and maintenance of the Plant to the Employer's staff.

Where existing equipment is to be removed, the Contractor shall transport the equipment to a regional storage compound, or to an approved disposal area as directed by the Engineer.

xl) Levels, Dimensions and Equipment Duties

Levels and dimensions shown on the Tender Drawings or stated within the Particular Specifications are preliminary, for the tender purposes, and shall be subject to confirmation by the Contractor who shall verify the levels and dimensions and obtain the Engineer's approval before any item of Plant for that installation is ordered.

Drawings for new installation show indicative building designs and layouts. These shall be adhered to as closely as possible, minor variations to the arrangement of the buildings and plant may be made to suit the Contractor's design for the particular Plant to be supplied or to suit particular Site requirements, and shall allow, where necessary, the work to be carried out whilst maintaining the operation of the installation.

xli) Information to be Supplied by the Contractor

Within the times stated in this Contract the Contractor shall submit to the Engineer for his approval a detailed manufacturing and delivery programme.

In accordance with the requirements of the Conditions of Contract the Contractor shall submit to the Engineer for approval detailed Construction Documents giving information for all items of Plant. The information shall

include, but not limited to, pipework details and layouts, manufacturer's drawings, fixing details and the like. Where appropriate, performance curves shall be submitted. Electrical single line diagrams shall include make, type and ratings of all equipment, a systematic wiring identification system and a clear legend. The information submitted for approval shall be sufficient to enable the Engineer to check that the materials of construction and performance of the Plant are in accordance with the

Specifications and suitable for the purpose intended. The Contractor shall furnish additional information and calculations if requested by the Engineer. The Contractor shall allow 21 days for the Engineer to check the details, from the receipt by the Engineer of complete information. No Plant shall be manufactured or ordered from suppliers for a particular installation until the Engineer has given approval of the information.

At least 6 weeks prior to delivery of the Plant to Site, the Contractor shall submit to the Engineer for approval full and detailed designs and a programme for the erection and commissioning of the Plant.

All Drawings and Documents shall be submitted for approval in triplicate and subsequent to approval being given the Contractor shall supply a further five copies to the Engineer. Drawings and Documents which have been approved by the Engineer shall be adhered to strictly and not to be departed from without the approval of the Engineer.

1003 Spares Parts and Tools

Spare parts shall be interchangeable with the corresponding parts of the Plant. The quality of spare parts shall not be inferior to that of the original Plant. Spare parts shall be adequately protected and packed in suitable containers to withstand storage under site conditions and shall be handed over with four copies of a detailed and itemized list of the spare parts prior to issue of the Taking Over Certificate. Any parts needed within the Defects Liability Period shall be provided by the Contractor.

Complete sets of maintenance tools including spanners and special tools necessary for the servicing, maintenance and dismantling of the Plant shall be supplied by the Contractor and shall be contained in suitably fitted painted steel boxes marked with the contents and fitted with good quality locks and keys.

Tools shall be handed over to the Employer upon satisfactory passing the Tests on Completion. Instruments such as ammeters, voltmeters and vibration meters shall remain the property of the Contractor unless specified otherwise.

The Contractor shall supply sufficient spare parts and tools for five years operation in accordance with the requirements listed.

1004 Inspection and Testing During Manufacture

The Plant shall be subject to inspection, examination and testing during manufacture in accordance with the Conditions of Contract, to demonstrate that it complies with the Specification and that the performance is suitable for the intended purpose.

The Engineer shall be given three weeks' notice in writing before such tests are to take place.

The performance of each item of Plant shall be tested in accordance with the Specification, appropriate standard or regulations, and to the requirements of the Engineer.

Pumpsets shall be witness tested in accordance with ISO 3555. Each pump shall be tested with its motor as an integral pumpset, and with similar starting equipment and electricity supply conditions to those pertaining in the permanent installation, unless otherwise directed by the Engineer. Pumpsets shall be tested with suction conditions and water temperatures corresponding to those under which the pumpsets will operate on site.

The works test results shall be evaluated and the guaranteed duty point verified in accordance with Clause 9.4 of ISO 3555. The following tolerance values shall be used:

$$\begin{array}{rcl} X^{QV} & = & \pm 0.04 \\ X^H & = & \pm 0.02 \end{array}$$

The evaluated combined motor and pump efficiency shall be at least 0.975 of the guaranteed value stated

Technical Proposals.

All parts of a pump subject to pressure shall be submitted to a hydraulic test pressure not less than 1.5 times the maximum pressure which can occur within the pump under any site operating condition.

Pipework, valves and fittings shall be submitted to a hydraulic pressure test in accordance with the applicable Standard.

Valves shall be tested for operation against the maximum operational unbalanced pressure.

Electric motors shall be tested in accordance with IEC 34. In addition to routine tests, one electric motor of each type and size above 45 kW shall be subject to a full performance test including a temperature rise test.

All rotating machinery shall be tested for vibration in accordance with the principles of ISO 2372. The maximum vibration velocity acceptable for factory testing shall not exceed the limits set out in ISO 2372 for the particular class of equipment.

Switchboards shall be tested to the respective standards. All functions shall be tested by means of wiring auxiliary switches to the outgoing terminals. Protective relays and instruments shall be tested with their respective instrument transformers by injection of the operating current and voltage.

Tests shall include the following:

- a) Visual inspection;
- b) Inspection of provision for cable entries;
- c) Checking access, type of cable gland etc.;
- d) High voltage pressure test (2000V) for 1 minute followed by insulation test;
- e) Test relays with varied controlled supply to ensure relays close at 85% of nominal voltage and hold close down to 65% nominal voltage;
- f) Test tripping of relays occurs at 60% nominal voltage;
- g) Any special tests applicable to the installation;
- h) Injection testing of current transformer for correct polarity and ratio, and protection relays for correct operation;
- i) Functional testing including simulation of operation of sequence controls (e.g. level controls, etc);
- j) Checking of time delay settings and protection relay settings;
- k) Checking of fuses for correct type and rating;
- l) Any other tests required by the Engineer.

Test certificates in triplicate shall be submitted by the Contractor to the Engineer within two weeks of the date of the tests. Type tests are not acceptable. Test certificates shall be supplied for test carried out on the actual equipment being supplied.

Packing shall be subject to inspection.

Plant shall not be dispatched from the manufacturer's works until approval has been received.

1005 Tests on Completion

The Contractor shall submit to the Project Manager a detailed description and schedule of the tests to be carried out on completion. These descriptions shall be submitted not less than 21 days prior to the Contractor giving notice of the date for carrying out the Tests on Completion. As part of the Tests on Completion, each individual item of Plant shall be operated to demonstrate its correct functioning, and instruments shall be checked and zeroed. Copies of all test certificates shall be submitted to the Engineer.

Each item of Plant which is designed for continuous operation shall be operated for a period of not less than 24 hours. Items of Plant not designed for continuous operation shall be demonstrated to the satisfaction of the Engineer.

Plant Tests

Test on completion shall include the following:

- a) The Plant protective devices shall be demonstrated to operate satisfactorily;
- b) All rotating machinery shall be tested for vibration in accordance with the principles of ISO 10826-1; 1995. Vibration shall not exceed the limits set out in ISO 10826-1; 1995 for the particular class of equipment;
- c) All Plant shall be tested mechanically and electrically to show that each item functions safely as designed;
- d) The sequence of operation and control systems of all Plant shall be tested;
- e) The rotation of all pumps shall be checked. The performance of all pumps shall be tested and compared with the specified duties and characteristic curves prepared from tests at the manufacturer's works;
- f) All pipe work, valves and fittings shall be pressure tested to 1.5 times the working pressure unless specified elsewhere;
- g) All Valves must be pressure tested as per the manufacturer's recommendations. However, the valves (as a minimum), must have a perfect shut-off in all directions (no visible leakage to the naked eye).
- h) All meters will be removed from the pipework during pipework testing. Meters will be tested separately as per this general specification.
- i) Load tests shall be carried out on all lifting equipment. The lifting equipment shall be tested over the full range of travel in all directions;
- j) Calibration tests shall be carried out in all instrumentation;
- k) Greasing and lubricating systems shall be tested on all plant;
- l) Test of all alarm systems, overloads and safety equipment;
- m) Any other test requested by the Engineer.

Electrical Tests

The Contractor shall also carry out tests of all electrical equipment. The tests shall include insulation resistance and earth continuity for all cabling, polarity of switches and resistance of main earths. Tests, as applicable, shall be carried out on electrical installations and electrical panels prior to their use; such tests shall include:

- a) Visual inspection

- b) Test relays with Varia controlled supply to ensure relays close at 85% nominal voltage and hold closed down to 65% nominal voltage
- c) Test tripping of relays occurs at 60% nominal voltage
- d) Insulation resistance
- e) Injection testing of current transformers for correct polarity and ratio and protection relays for correct operation
- f) Functional testing including simulation of sequence and automatic controls
- g) Checking of time delay and protection relay settings
- h) Checking of fuses for correct type and rating
- i) Any other tests required by the Project Manager.

The Employer's operational staff will normally be in attendance during the Tests on Completion. The operation of the plant from start up procedures to closing down shall simulate fault conditions.

As well as affording the Employer's staff every opportunity to participate in the tests, the Contractor with reference to the Operation and Maintenance Manuals shall demonstrate the adjustment of timers and relays. The operation of the plant from startup procedures to closing down shall simulate fault conditions. The Contractor shall ensure that the Employer's staff is familiar with the manuals and aware of the appropriate diagnosis and rectification action to be taken in the event of a fault. The Contractor shall ensure that the Employer's staff is familiar with the manuals and aware of the appropriate diagnosis and rectification action to be taken in the event of a fault.

Tests – Cable Insulation and Earthing

On completion of the separate parts of the electrical installations the Contractor shall carry out, as and when required by the Engineer tests for the insulation of cables and continuity of conduits and earth connections, together with the ability to withdraw conductors from any and re-draw in conductors, and shall submit signed copies of the results of the tests in triplicate to the Engineer.

The following tests results shall be submitted:

- a) Insulation resistance tests to earth and between phases on sections of the installation as completed and also on the whole of the installations when completed;
- b) Earth continuity tests on each main, sub-main circuit and sub-circuit installed;
- c) Polarity of switches and socket outlets and continuity of ring main circuits;
- d) Resistance of earth main.

In addition to these tests the Contractor shall provide readings of potential drop at various points in the installation and current balance over the phases on all mains.

The Contractor shall provide all instruments necessary for carrying out such tests and shall provide attendance on the Engineer when tests are being carried out. The Contractor will receive notice in advance of the timing of such tests.

1006 Tools

Complete sets of maintenance tools including spanners and special tools necessary for the servicing, maintenance and dismantling of the Plant shall be supplied by the Contractor and shall be contained in suitably fitted painted steel boxes marked with the contents and fitted with good quality locks and keys.

Tools shall be handed over to the Employer upon satisfactory passing the Tests on Completion.

Instruments such as ammeters, voltmeters and vibration meters used during testing shall remain the property of the Contractor unless specified otherwise.

1007 Operation and Maintenance Manuals

At least two weeks before commencement of the Tests on Completion the Contractor shall submit to the Project Manager two draft copies of the Operation and Maintenance (O&M) Manuals for approval, and shall take account of any amendments or additions required by the Project Manager in the production of the final manuals.

Upon completion of commissioning of the works or section of the works the Contractor shall supply six sets of final operating and maintenance manuals for the respective section or part of the works. Each volume shall be bound in a stout plastic or other approved cover and shall be suitably labelled.

The manuals shall be compiled in accordance with BS4884-1 and -2 and shall include the following:

- a) Full and detailed instructions for operating the works. Such instructions shall be specifically written for the Plant provided under the Contract, manufacturer's standard instructions relating generally to the type of plant being provided will not normally be acceptable;
- b) Full detailed instructions, diagrams, etc. for maintaining the Plant, including dismantling and stripping down for repairs, and maintenance schedules for daily, weekly, monthly and annual servicing;
- c) Manufacturer's instruction leaflets for component parts of the plant, including instruments, switchboard components, and other specialist equipment;
- d) General arrangement, schematics and PI/Ds as appropriate including all pipework, equipment etc.;
- e) Comprehensive parts list for all Plant;
- f) Copies of approved 'As Built Drawings' of the Works, as completed. Amendments to the drawings required as a result of changes during erection shall be made by the Contractor;
- g) Records of factory and site test figures and all settings for timers, relays etc.;
- h) Operation and maintenance manuals shall be written in English language. All parts and equipment listing shall be in English.

1008 Guarding of Moving Machinery

All moving machinery shall be adequately guarded to prevent injury through accidental contact. In particular, exposed shafting and couplings shall be protected with suitable guards except where they are in normally inaccessible positions.

1009 Rating Plates, Name Plates and Labels

Each item of Plant shall have permanently attached to it, in a conspicuous position, a rating plate of durable material engraved with the manufacturer's name, type and serial number, together with relevant details such as the duty or output, speed, pressure or loading.

Each item of Plant shall be provided with a name plate or label designating the service of the particular item. The inscription shall be to the approval of the Engineer.

All switchboard cubicles shall be clearly labeled with their function and the function of each instrument, indicator or control. Each cable shall be fitted with identification labels. The type of labels and the inscription shall be to the approval of the Engineer.

All rating plates, name plates and labels shall be in English.

Labels shall be engraved onto durable material, metal or plastic and shall be securely fixed by screws on or alongside the item to which it applies. Sticking is not acceptable.

1010 Packing

The Contractor shall be responsible for the proper packing, storage and crating and clear identification of all Plant prior to dispatch and shipment from its place of manufacture.

All items of Plant shall be packed and marked in accordance with international standards for exports from the country of manufacture. The Plant shall be packed and protected against deterioration during shipment and for at least 12 months storage on site. Straw or similar organic materials shall not be used for packing.

Materials liable to deteriorate from water or moisture shall be packed in cases with waterproofing lining. Switchboards, control panels and similar items of plant liable to deterioration from moisture shall be specially packed to prevent ingress of moisture. Unless otherwise agreed by the Engineer the protection shall include placing in a sealed 0.13 mm thick polythene bag and silica gel or other approved air dryer shall be placed within the unit and sufficient air drawn out to cause the polythene bag to adhere to the outline of the unit.

Electric motors (and similar equipment) shall, where applicable, be dispatched with rotors locked to prevent damage to the bearings from vibration during transit.

All packages shall be clearly and conspicuously marked with the Contractor's identification mark and the Employer's reference mark.

All separate component part of the Plant shall be identified by metal tags tied by wire and reference to drawings, installation instructions, packing list etc. Details of the referencing system shall be submitted to the Engineer for approval.

10011 Corrosion Protection

Where dissimilar materials are in contact or close proximity and corrosion may occur through electrolytic action or differences in electrical potential, protection shall be afforded by electroplating, suitable gaskets, cathodic, protection or other means approved by the Engineer.

Chromium plated parts shall not be used on sewage works or in any other damp or corrosive atmosphere.

After cleaning and inspection but before the plant leaves the manufacturer's works, the machined surfaces of steel and ironwork shall be covered with a preserving fluid of an approved type, or otherwise protected to the Engineer's satisfaction.

All surfaces shall be adequately protected in transit, and any damage shall be renovated immediately on off-loading and on completion of erection.

All external screw fixings shall be supplied in the galvanised condition, stainless steel, or sheradised to comply with BS 4921, Class 1 or Class 2 passivation treatment.

1012 Pumps

Pumps shall be constructed from standard production parts and shall be well proven in design, quality of manufacture and operational reliability. Pump design shall give stable characteristics extending well beyond the specified operating range, and adequate net positive suction head when operating under minimum suction conditions. The head discharge curve of each pump shall have a suitable rising head characteristic with decreasing capacity over a range of 15% of the specified flow.

Pump casings shall be of robust construction cast in close grained cast iron or materials of a grade

suitable for withstanding the pressures, stresses and corrosive effects of the fluids likely to be experienced. Guide vanes integrally cast in pump casings shall be suitably contoured to guide flow from the impellers with high efficiency.

Pump impellers shall be cast from high grade non corrodible materials with flow passages hand finished to achieve a smooth surface with minimum efficiency loss. Where applicable balance holes shall be provided in the impeller hub to reduce imposed axial thrust.

Renewable wear rings of non-corrodible material shall be fitted to the pump casing to maintain close running clearances with the impeller and minimum efficiency loss.

Pump shafts shall be machined from high tensile stainless steel of a diameter sufficient to prevent distortion from stresses imposed on them. Critical shaft speed shall be well above maximum running speed.

Renewable shaft sleeves of non-corrodible material shall be provided to protect the shaft from wear at the pump glands.

Pump shaft sealing arrangements shall be suitable for the fluid pressures involved and for the shaft speed. Shaft seals shall be of the repackable type with stuffing boxes designed to facilitate adjustment or replacement of the packing materials.

Shaft bearings shall be grease lubricated ball and roller type adequately sealed in housings designed to afford protection against ingress of moisture and dust, and leakage of grease.

Air vents shall be provided on pump casings to permit the manual release of air during pump priming.

Stainless steel or copper drain piping shall be provided from pump Air cocks and sealing glands to discharge into the station drainage system. Drain piping shall be arranged for easy dismantling.

A strainer of suitable corrosion and abrasion resistant material, designed to prevent entry of foreign matter but permitting unrestricted flow of water into the pump, shall be provided on the pump suction pipework. The strainer shall be removed following the Tests on Completion of the pump.

1013 Bedplates and Motor Stools

Bedplates and motor stools shall be rigid cast iron or fabricated steel. All welding shall be stress-relieved. Mounting surfaces shall be machined for correct alignment of shafts.

The design of the bedplates shall make allowance for all stresses and vibrations from the plant. No reliance shall be made on the connections to the foundation structure to absorb such stresses. Bedplates will be bolted to plane concrete surfaces and shall not be required to be filled with concrete.

1014 Flexible Couplings

Flexible couplings shall be of the non-rigid rubber bushed steel pin type with easily removable coupling guards where necessary.

1015 Lifting Equipment

The lifting hoists and cranes shall be manufactured and tested in accordance with the relevant British Standard or equivalent approved. Load tests shall be conducted both in the manufacturer's works and after erection on site. Test Certificates in triplicate shall be provided and sent to the Project Manager before the crane is commissioned. All necessary test weights and slings shall be provided by the Contractor.

The crane/hoist manufacturer shall be responsible for and include in his extent of supply the following, unless particularly specified otherwise.

- (a) All hoist runway beams including trolley end stops complete with fixings.
- (b) All crane rails and gantry beams including all necessary fixings to secure the gantry beams to the concrete corbels and carriage end stops for fixing to the crane rails.
- (c) Where lifting and travel chains are specified they shall not be electro-galvanised.

The hoist shall be built into a geared travelling trolley designed to run on the lower flange of the runway beam and shall have a minimum possible depth between the hook seat and the lower flange of the beam. The hoist shall be fitted with lifting and travel chains. Alternatively the hoist shall be fitted to a geared trolley provided lifting clearances are suitable for the particular application. The trolley shall be provided with a travel chain.

Cranes shall be designed to fit and work within the existing clearances.

Cranes shall consist essentially of a crane bridge, end carriages, travelling hoist assembly, hoisting gear, chains, block and hook.

Cranes shall be of the single beam type securely attached to the end carriages which shall be carried by rails fully supported on steel gantry beams. Rails and gantry beams shall, unless shown otherwise on the Drawings, run the full length of the building.

End carriages shall be fabricated from rolled steel plates and sections and shall be of ample stiffness. Each end carriage shall be provided with two double flanged cast steel wheels of large diameter accurately turned on the tread to suit the track rails.

The lifting hook shall be of the swivelling type to BS 2903 with a displacement sling guard provided. Testing

where applicable shall be in accordance with BS 466, section 6.43 & 44.

1016 Foundation Bolts

All necessary foundation bolts required for the Plant shall be provided by the Contractor, and shall be complete with plates or hooks manufactured from suitable material and treated to prevent corrosion. All nuts and washers used with foundation bolts shall be either stainless or cadmium plated steel.

The use of 'Rawbolts' or other approved foundation bolt with an expanding shell, or bolts utilising epoxy resin cement grout in sockets cast into the foundation concrete is to be preferred and the Contractor shall only use rag-bolts where, in the opinion of the Project Manager, their use is absolutely necessary.

1017 Motors

Electric motors shall be manufactured to the requirements of BS 4999 and BS 5000.

Motors shall be continuously rated at least 10% above the maximum power absorbed by the pump within the specified operating range.

The starting (locked rotor) current of any motor shall not exceed 6 times the full load operating current. Motor starting torque shall be at least 120% of the pump torque requirements throughout the starting sequence.

Motors shall be insulated to Class F with Class F temperature rise. Materials shall be based on a resin

bonded system being inherently water repellent. The complete motor interior including rotor and stator windings and core, shall be finished with 2 coats of suitable anti-tracking oil and water repelling paint.

Motors for both indoor and external use shall be constructed with Class IP.54 enclosure, Class IC.41 method of cooling, and shall be fitted with grease lubricated ball and/or roller bearings incorporating effective seals to prevent grease leakage.

Motors shall be rated to allow continuous running and a starting/stopping sequence of not less than six consecutive starts in any one hour.

Motor terminals shall be protected with corrosion resistant grease after installation.

Each motor above 5 kW rating shall be fitted with an anti-condensation heater of sufficient rating to maintain the motor at 5 °C above ambient when the motor is at rest. The heaters shall be connected into the motor starter circuit such that they are switched off when the motor is running.

1018 Motor Starting Arrangement

Motor starting arrangements and limitations shall be as follows:

- i. Motors above 100 kW: Auto-transformer or stator rotor as specified elsewhere, starting arranged to limit starting current to 2.5 times motor full load current;
- ii. Motors 18.5 to 100 kW: Star-delta starting;
- iii. Motors 18.5 kW and below: Direct-on-line starting.

1019 Power Factor

The overall power factor of the plant under any load or operating condition shall not be lower than 0.90 lagging. Power factor correction capacitors rated at 85% of the no-load kVA of the motor shall be provided for each motor of above 5 kW rated output. In addition capacitors shall be fitted to smaller motors as necessary to maintain the minimum power factor specified above.

1020 LV Switchboards and Control Panels

LV switchboards and panels shall comply with BS 5486, and be rated and ASTA certified to the levels specified in the particular part of this specification for operation on a 415 Volt 3 phase 4 wire 50 Hertz supply and a minimum prospective short circuit fault rating of 43 kA.

The panels shall be modular cubicle pattern and shall be floor mounted free standing unless specified otherwise. They shall be manufactured from fabricated mild steel not less than 2mm thick and shall be of uniform height, rigid construction and neat appearance, providing an enclosure to IP.54.

They shall be constructed so that normal maintenance may be carried out from the front, but removable covers at the rear shall be provided for cabling, etc, where rear access is possible when the panel is installed. Separate cabling compartments shall be provided.

For ease of handling on site, the panels shall be delivered in sections with removable eyebolts provided for lifting.

Bolted doors shall be of rigid folded construction retained with hexagonal headed captive bolts.

Hinged doors shall be fitted with neoprene or similar approved gaskets to provide effective dust and amp exclusion. Catches shall be designed so as not to damage the paint work if the door is shut with the

catch in the closed position. Hinges shall be designed so that there is no inherent tendency to displace gaskets.

Busbars shall be of copper fully complying with BS 5486 Part 2, enclosed in a separate chamber and shall be continuous over reach shipping section. Busbars shall not be drilled for outgoing connections, which shall be made with clamps.

The riser dropper bars shall be either air insulated tinned copper or an approved solid insulation phase segregated type, fault rated to the same level as the main busbars.

Live connections to and from busbars shall be either fully insulated or suitably screened and any covers screening the busbars and connections shall be provided with adequate warning labels.

A high conductivity copper earth bar shall be bolted and efficiently bonded to the main frame to run the full length of each panel.

Flexible earth continuity bonds shall be provided for all hinged doors and swing panels. Circuit

breakers shall be of the air break pattern fully complying with BS 4752.

Contactors shall be triple pole, air break, electromagnetically operated, of unit block construction with inherent no volt feature, rated in accordance with BS 5424 Part 1, 1977. Each contactor shall have a minimum of two spare auxiliary contacts.

Unless otherwise specified, all contactors and relay control circuits shall be connected to an a.c. supply of a maximum of 240 volts.

Isolation of a control circuit supply to one or a group of starters shall not interrupt supplies to other starters.

All fuses shall be of the HRC type to BS 88. Fuses rated 30A and below shall be mounted in approved withdrawable fuse carriers. Carriers containing links shall be coloured white, whilst carriers containing fuses shall be coloured black.

Time delay relays shall have a good repeat accuracy and the direction of adjustment for increasing and decreasing the timing period shall be clearly marked.

The fuse switch associated with each starter shall be a full shrouded, triple pole unit rated for stalled motor duty and shall comply fully with BS 5419. A padlocking facility shall be provided for locking in the OFF position.

The fuse switch shall be housed within the same compartment as the starter with which it is associated and shall be mechanically interlocked with the compartment door.

The control supply shall be broken by auxiliary contacts on the fuse switch in the open position.

Anti-condensation heaters of the 'black heat' type shall be provided at the bottom of each cubicle to maintain an internal temperature of 5°C above ambient. An adjustable thermostat with clear scale shall be installed at the top of each cubicle to limit the maximum temperature. Each heater shall be individually fused and provided with an isolation switch.

1021 Safety Devices

In addition to the electrical protection specified elsewhere herein, safety cut-outs shall be provided to protect equipment against any operating conditions which could arise and which would be liable to cause

damage to the equipment: for example, lack of water at pump suction.

1022 Motor Protection

Motor protection relays for electric motors above 11 kW shall be of the electronic composite type. The relay shall incorporate wide range adjustable over-current, IDMT and earth fault together with single phasing and successive start protection.

1023 Indicators and Alarms

The operating push buttons, switches or handles or all circuit breakers, motor starters, isolators, etc shall be located on the front of cubicles, or for cubicles of the desk type on the face of the desk. There shall be visual indications of the 'ON' and 'OFF' positions.

All operations of fault and alarm circuits shall be clearly individually indicated on the fascia of the switchboard, by lamps.

Fault and alarm lights shall remain on until the associated fault or alarm condition has been cleared and the system reset.

An audible alarm shall also be provided to indicate operation of any major fault or alarm function. Alarm lamp acknowledgement shall also cancel the audible alarm.

Push buttons fitted on the panel shall be of the shrouded type, unless otherwise specified, and shall have a label indicating their function.

Indicating lamps on panels shall be rated to withstand not less than 20% continuous over voltage and shall be so designed that the heat from the bulb does not discolour the panel.

Indication lamps and push buttons shall be coloured in accordance with IEC 73 and in particular as follows:

xlii)	Indicating Lamps Colour
On	White
Off	Green
Fault	Red
Alarms	Yellow
Heaters	Blue

xliii)	Push Buttons	Colour
Start	Green	
Stop	Red	
Alarm Accept	Black	
Emergency Stop	Red	

All electrical indicating instruments shall comply with BS 3693, Part 1, be moving iron type and to Class 1.5 or better. Instrument mounting height shall not exceed 1.80 metres above floor level. Unless otherwise specified instrument full scale deflection shall be at least 120% of the normal operating point (i.e. nominal voltage or full load current).

Ammeters in motor circuits shall be capable of withstanding the starting current of the motors and shall have a compressed overload scale for this purpose. The full load current shall be defined with a red line. Voltmeters scales shall have a red line indicating normal volts.

All voltage circuits of instruments shall be protected by a fuse in each unearthed phase, situated as close as practicable to the point of connection.

Current transformers shall have short circuit ratings not less than those of the circuits with which they are concerned, and shall fully comply with BS 3939.

The secondary winding of all current transformers shall be earthed. The rated burden of each CT shall be a minimum of 150% of the designed load burden.

Where specified, capacitors for correcting power factor shall be incorporated in the panel. Such capacitors shall comply fully with BS 1650.

All motors shall be provided with emergency stop push button mounted adjacent to the motors which shall lock out the control circuit and shall require a key to reset the circuit.

1024 Instruments - General

Instrumentation including transmitters shall be of the solid-state electronic type, unless otherwise particularly specified elsewhere herein.

1025 Pressure Gauges

Pressure gauges on pump delivery and suction pipes shall be 150mm diameter and of an approved type and pattern, calibrated in metres water column generally in accordance with the requirements of BS 1780. Gauges shall be connected through a three way isolating cock so that air can be released to the atmosphere. All necessary connections piping and fixing clips shall be provided.

1026 Cables and Wiring

Cables shall be of approved design from a BASEC approved manufacturer having a certificate of Assessed Quality Management. They shall be manufactured within the 12 months prior to delivery and be delivered to site on cable drums or with protective wrappings.

The overall sheath of the cables shall be coloured as follows:

240/415 Volts	-	Black
Earth continuity conductor	-	Green/Yellow
Instrument	-	Grey
Intrinsically safe	-	Blue

Cables shall be of the voltage grade, conductor size and type detailed in the specific requirements. General specification of the cable type to be used are detailed hereunder.

xliv) Cross-linked polyethylene cables shall have stranded, copper conductors with cross-linked polyethylene insulation. Multi-core cables shall be laid up in an extruded bedding, single wire armoured and sheathed overall with PVC, to BS 5467 (XLPE/SWA/PVC type).

Single core cables shall have aluminium wire armour. Cables rated over 6350V shall incorporate graded semi-conducting tapes and core screens in accordance with IEC 502.

Low smoke and fume emission cables shall be as above except that the bedding and sheathing shall be of low smoke and fume emission material, all in accordance with BS 6724 (XLPE/SWA/LSF type).

xlvi) PVC armoured cables shall have stranded copper conductors with extruded PVC insulation, PVC sheathed, single wire armoured and sheathed overall with PVC (PVC/SWA/PVC type). Cables shall be in

accordance with BS 6346. Conductors of 1.5mm² and 2.5mm² shall have stranded conductors (7/0.50 and 7/0.67 respectively).

xlvi) PVC insulated wiring cables shall be 450/750 volt grade single core stranded copper conductors PVC insulated to BS 6004 (PVC wiring type).

xlvii) Telephone cables shall be thermoplastic insulated multipair cables having twisted pairs of copper conductors (telephone type).

xlvi) Instrumentation cables shall be polyethylene insulated copper conductors with twisted individual pairs screened, polyethylene bedded, steel wire armoured and PVC sheathed overall, all in accordance with BS 5308 Part 1 Type 2. Conductors shall be 0.5mm² stranded 16/0.2mm (PE/IS/SWA/PVC type).

xlvi) Earth and bonding cables shall have stranded copper conductors PVC insulated and sheathed (PVC/PVC type).

i) Flexible cables shall have stranded, tinned copper, flexible conductors, EP rubber insulated and CSP sheathed all in accordance with BS 6007 (flexible type).

ii) Flame retardant cables shall be EP rubber insulated, tinned copper conductors in a CSP sheath, braided with galvanised steel wire (single cores having phosphor bronze wire) and protected with a CSP sheath overall, generally in accordance with BS 6883.

Generally cables shall be installed on uPVC tray.

Where cables are buried the Contractor shall provide and install the cables, plastic marker strip and sand above and below the cables. Cables shall be laid directly in trenches and a plastic marker strip shall be positioned 300mm below the ground surface in all cases.

Where cables pass through walls, floors, etc. the Contractor shall provide a suitable sleeve through which the cable may pass. Under roads or hard surface uPVC ducts shall be provided and after the cables have been installed the sleeve and ducts shall be made watertight and vermin proof in a manner to suit site conditions.

Cable route markers shall be supplied at every 30m along cable runs and at changes of direction. All non-armoured cables shall be protected by conduit.

Where cables are run on open surfaces and exposed to the sun a metal shield shall be fitted over them. Similarly where cables are run up walls they shall be protected to a height of 2m above ground or floor level.

1027 Lighting and Small Power

Lighting and small power distribution boards shall comply with the relevant parts of BS 5486. They shall be complete with incoming isolating switches and fuse as required. The distribution boards shall generally be three phase type.

Light fittings shall comply with all relevant British Standards. Fluorescent fittings shall be of the switch start type with all control gear, and be complete with a capacitor to ensure that the power factor is a minimum of 0.85. The fittings shall have a high grade paint finish suitable for installation in a tropical climate.

Bulkhead fittings, where specified, shall be suitable for industrial installations and have a minimum degree of protection of IP 55.

The cable for this section shall be PVC insulated with PVC sheaths, complying with BS 6007.

Fused spur units shall be double pole 13A switched type with neon indicator in a surface mounted metal- clad box suitable for industrial installation and complying fully with BS 1362.

Socket outlets shall be twin 13A or single 13A switched type in surface mounted metal-clad boxes suitable for industrial installation and complying fully with BS 1363.

All switches shall be water and dust sealed suitable to provide a reliable installation in the environment of a water treatment works. The switches shall be of heavy duty design to match the switched sockets specified above.

Light switches shall be 5A rated with required number of gangs and ways in a surface mounted metal- clad box suitable for industrial installation and complying fully with BS 3676.

Weatherproof light switches are to have a minimum degree of protection of IP 55.

All equipment shall be securely fixed to the walls of buildings. Such fixings shall be of threaded stud type allowing removal of the equipment without removal of the wall fixings.

Site lighting standards shall be constructed from tubular steel and shall provide a lantern mounting height of 5m above finished ground level. All steelwork shall be galvanised after fabrication.

Each standard shall have a base compartment suitable to house fused service cut-outs, control gear, etc., with a lockable compartment door. An earthing stud shall be provided at compartment level within the standard.

As a minimum the site luminaires shall be side entry 70W SON-T with a metal/GRP canopy and a polycarbonate bowl protected to IP 55.

The wiring between the fused service cut-out and lamp-holder shall be carried out in 2.5mm² PVC insulation colour green.

The Contractor shall provide and install for each standard, one fused lighting cut-out and fitted with a fuse, the whole being suitable for looping in and out PVC SWA PVC cables. The cabling for the site lighting shall be run in the ground.

The lighting standards shall be set in concrete blocks below ground level, the base of the lighting standard root resting on the concrete slab. The Contractor shall be responsible for excavation of the foundations, positioning the lighting standards and placing of the concrete to form the foundation block. When forming the foundation block the Contractor shall ensure that the cable entry in the lighting standard root is kept clear of all concrete in such a manner as to permit entry of the supply cables.

1028 Earthing and Bonding

All metalwork forming part of the electrical installation and services other than the current carrying part of the electrical circuits, shall be efficiently connected to the main earthing system in accordance with IEE Wiring Regulations. All connections shall be by means of an approved mechanical joint or adjustable clamp which shall be accessible and made secure with brass nuts and bolts; only washers of non ferrous material shall be used.

Protective conductors shall provide earth continuity either through the conduit, armouring, lead sheathing, copper sheathing, steel trunking or by independent earth tapes or PVC sheathed wires, according to the system of wiring employed. Where PVC conduits or trunking systems are employed the protective

conductor shall be routed within the conduit or trunking.

Wherever cable armouring is used as a protective conductor, care must be taken to ensure an adequate earth bond and additional bonds to the metalwork shall be provided as required.

1029 Main Earth Connections

Where a main earth bar is to be installed it shall be connected in a ring with the earth bar provided on the switchgear and any existing main earth ring in the building. The glands and wire armour of cables shall be connected to the switchgear earth bar or directly to the earth ring.

The main earth bar shall be 31.5mm x 6.3mm and where necessary shall be increased to 50mm x 6.3mm. Connections to metalwork shall be made in copper bars or using flexible copper conductors having a green and yellow PVC sheath.

Reinforced concrete or sheet steel piling shall be connected to the earthing system. The steel structural frame of the building shall be bonded to the main earth bars.

Earth rods are to be 16mm diameter driven to a depth of approximately four metres. Spacing between rods shall not be less than the depth of a rod. Inspection pits shall be provided for each electrode to allow subsequent access for testing. Disconnecting links for testing purposes shall be provided at the main earth bar.

Where copper earth tape is buried below ground level it is to be served with PVC or double half lap wrapped with an approved grease impregnated tape.

The routing, dimensioning and arrangement of all main earth bars and connections shall be detailed on schedules and drawings.

1030 Lightning Protection - Structures

The lightning protection system shall be of the Faraday cage type with horizontal conductors on the roof structure and down conductors on the outside walls of the structure.

The horizontal conductors shall be installed along the outer perimeter of the roof ensuring that no part of the roof is more than 9m from the nearest horizontal conductor.

All metallic projections on or above the main surface should be bonded to and from part of the conductor network.

The number of down conductors should be decided as follows:

A structure having a base area not exceeding 100m² may have only one down conductor. Areas exceeding 100m² shall have one plus one for every 300m² or part thereof in excess of the first 100m² or one for every 30 metres of perimeter.

Down conductors should be distributed around the outside walls of the structure.

Earth electrodes of hard-drawn copper rods with minimum dimensions of 12mm diameter shall be driven into the ground as close as practicable to the structure and end of the down type conductor.

The horizontal and down conductor shall be copper strip 25mm x 3mm.

The rods shall be installed in sections coupled by screwed connectors where necessary to penetrate the

substrata of low resistivity.

Each of these earth terminations should have a resistance to earth not exceeding the product given by 10 ohms times the number of earth terminations to be provided.

The whole of the lighting protective system should have a combined resistance to earth not exceeding 10 ohms.

Each down conductor shall be provided with a testing joint in convenient position for testing.

The fixing clamps shall be leaded gunmetal type and fixing bolts and screws shall be phosphor-bronze.

1031 Platforms and Walkways

General

All necessary platforms, ladders, stanchions, handrails, chains and all associated fittings, support structures and curbing shall be supplied to provide a safe and efficient installation.

Steelwork

All mild steel items shall be protected to BS 5493 Section II by hot dip galvanizing after fabrication to BS 729 with a minimum thickness of 85 microns (0.0034") unless otherwise specified.

No cutting, drilling, bending, riveting, threading or similar operation will be permitted after galvanizing, and due care shall be exercised in transporting, handling and fixing galvanised metalwork to prevent damage to zinc coating. Under no circumstances shall damage to zinc coating be repaired with rust inhibiting paint.

Platforms

Platforms as indicated on the Specification drawings shall be provided. All platform panels shall be individually secured to the supporting structure and be of suitable size and weight for ease of handling. They shall be cut and fixed to maintain a continuity of pattern.

Platforms, walkways and floor covers shall be adequately supported to prevent undue flexing and have supporting rebates with a minimum landing width of 30mm. Where the supporting structure is concrete, galvanised mild steel angle curbs shall be provided and securely grouted into rebates left in the concrete such that the tops of the panels are flush with the top of the concrete.

Normal access ways shall be suitable for a minimum uniformly distributed load of 5 kN/m² (105 lbf/ft²). Where platforms and floor covers are specified for concentrated loads or machinery support, the uniformly distributed loading shall be not less than 15 kN/m² (315 lbf/ft²).

Plated flooring shall be aluminium chequer plate having a minimum base thickness of 8mm with a non-slip tread pattern, secured to the supporting steelwork with countersunk screws, which shall be cadmium plated when used with aluminium plate. For manoeuvring small-wheeled items e.g. switchboards trucks, plain floor sheeting 8mm thickness shall be provided over specified areas.

Open mesh platforms shall be open type, galvanised mild steel flooring.

Hinged Covers

Hinged covers provided in platforms shall have a galvanised, fabricated steel framework, covered to match the surrounding floor strength and pattern.

Covers provided for permanent man access shall be located as indicated on the specified drawings. They shall have a locking stay fitted, arranged so that in the fully open position, the stay will hold the

cover open until released. Provision for padlocking the cover in the open or closed position shall be provided.

Covers for valve keys or other small openings shall be sized to suit the application and not include either stays or padlocking facilities.

Ladders

Ladders shall be of mild steel construction except where they are subject to prolonged immersion in water where they shall be of stainless steel.

Permanently fixed ladders of the step type shall have flat section, non-slip, open type treads not less than 450mm wide between stringers, with handrails fitted to each side extended to meet the platform handrails at the upper end. Tread width shall be not less than 120mm with a pyramid pattern nosing.

Vertical or near vertical fixed ladders for emergency use shall be in accordance with BS 4211 with equally spaced rungs between 230mm and 260mm apart with a width between stringers not exceeding 400mm. Safety hoops shall be provided where ladders rise more than 2.3m from the ground or platform. The stringers shall be extended at least 1100mm above the upper platform, and suitably opened out for access, or where ladders are below manhole covers, a separate hand hold shall be fixed to the upper platform.

Railings

Guardrails shall be provided for all platforms elevated greater than 500mm and the upper rail shall form the handrail. A knee rail shall be included and located approximately at mid-height.

Stanchions and rails shall be of mild steel or aluminium alloy tubing as specified, not less than 31mm overall diameter and tube thickness 10 SWG set in a twin-rail arrangement with the upper rail not less than 1.1m above the platform level or 900mm above the stringer pitch line for stair flight. Ball type tubular standards are to support the rails at not more than 1.5m centres and arranged so that there is a standard not more than 300mm away from any bend and 150mm from any rail joint. Rails are to be secured to prevent movement within the standards. Standards and rails shall be attached to the platform/walkway and not to any non-structural floor or toe plates.

Any roughness on the external surfaces shall be removed in an approved manner to produce a safe surface to the satisfaction of the Project Manager.

A plastic coated finish shall be applied where specified and care should be taken to preserve from damage the plastic coating which may, if desired, be applied at a later date. The Contractor is to include all cleaning and derusting operations necessary.

Whenever possible, runs of guardrail shall be continuous and sharp vertical changes of direction shall be avoided. Handrails shall terminate in swept ends either to the wall or return to the knee rail by means of a U bend which shall not extend greater than 350mm beyond the centre line of the last standard.

Safety Chains

Access openings in guardrailing to ladders and platforms having a direct drop of more than 300mm shall be protected by a double row of safety chains of galvanised or electro-plated zinc mild steel 3 SWG x 3 links per 100mm complete with 'S' hook attachments at one end and permanently fixed at the other.

Trench Covers

Trench covers shall be of minimum or galvanised mild steel chequer plate (min 3mm thick) supported to prevent undue flexing and having suitable holes to allow removal by standard lifting keys. Support shall be by means of steel curbing rebates cast into the trench top edges, such that the top of the covers are

flush with the top of the finished floor level and providing a landing width of at least 30mm.

Additional or alternative support for switchboards etc. shall be from at least 75 x 35 mm channel section cross bearers and transverse trimmers, fixed or cast into the floor and located to suit equipment fixings, access requirements and floor cover spans.

To prevent differential deflection, butt straps shall be fitted to the underside of floor plates which have no other support.

Edging curbs suitable for mild steel chequer plate shall be painted in red oxide primer, the curbing may be tapped to accept cover securing screws. Where aluminium plates are used in contact with any mild steel supports, a bitumen coating on the points of contact shall be used.

1032 Mechanical Flow Meters

Mechanical flow meter shall be volumetric, jet or in-line helical vane (Woltman) type to Standards ISO4064/BS 5728 EEC Specification with integral strainer and matching Flanges. Meters shall be designed for minimum maintenance and shall incorporate best quality rotor bearings to ensure long working life.

Meter bodies shall be cast in spheroidal graphite iron to BS EN 1563. All internal parts shall be manufactured from non-corrodible materials.

Meters are for the measurement of potable water flow with a normal working temperature up to 30°C and a maximum working pressure of 16 bar.

Meters shall be generally in accordance with the following table.

Meter Size (mm)	Q _{max} : PEAK Instantaneous Flow (minutes only) (m ³ /h)	Q _n : MAXIMUM Continuous Flow At ±2% measuring Error (m ³ /h)	Q _{min} : MINIMUM Flow at ±5% Measuring error (m ³ /h)
80	200	120	0.70
100	250	180	1.20
150	600	400	3.00
200	700	550	5.00
250	1200	750	10.00
300	1500	1000	12.00

Measurement mechanisms shall be removable from the meter body without the necessity to remove the meter from the main. Meters shall be equipped with a register indicating flow in metric units a sweep hand and six figure counter. Dummy cover plates to seal the meter after the mechanism removal shall be provided.

Tapers shall be provided, or non-standard bearings and propellers, if required, to obtain the specified degree of accuracy at the specified flow rates.

The meters shall be suitable for working pressures up to 16 bar unless otherwise stated.

An extension drive and extended head shall be fitted to meters as required. The drive shaft bearings and gears shall be designed for long life under continuous operation, and normal wear shall not significantly affect the accuracy of the meter.

Meters shall have a circular dial and rate of flow indicator registering flow in litres/sec. A flow totaliser

having at least six digits shall be incorporated in the head. The totaliser shall have a capacity of at least one years flow at maximum flow rate. A multiplying factor in multiples of 10 may be used in conjunction with the totaliser; the factor shall be clearly marked alongside the register.

Meters shall be individually flow calibrated at the manufacturer's works and shall be guaranteed to within 2% of true flow within the rated range of the meter. Each meter shall be supplied with a calibration certificate.

The spare parts shall include as a minimum spare gearing and bearings for each size of flow meter used.

Meters shall be installed with at least 10 diameters of straight pipe upstream and 5 downstream to minimise turbulent effects.

1033 Stoplogs

Standard mounting fixing arrangements are channel fixing into prepared rebates in channel walls and floor. Frames shall be supplied in three sections for ease of handling and installation and shall be manufactured from stainless steel to BS EN 10088:1995 grade 1.4301 (304) or 1.4401 (316). Frame seals shall be resilient EPDM (Ethylene Propylene Di Methyl) wiper type seals having an angled lip seal. Seals shall be fitted to the seating and unseating sides of the frame. The seals shall be fixed with corrosion resistant retaining strips and stainless steel fasteners.

Logs shall be manufactured as a composite sandwich construction comprising a lightweight rigid, cellular core with a fully welded steel box section matrix between two other skins of rigid, compressed composite plastic which shall be asbestos free, ultra violet stabilised, rigid and non toxic. All materials shall be chemically bonded and sealed. Inter Log Seals shall be twin seals fitted to the bottom edge of each log to permit on or off-seating pressures.

Each log shall be provided with 2 stainless steel lifting pins, located on the log faces to permit manual lifting.

1034 Cranes and Hoists

General

Cranes and hoists shall be of standard proven design in accordance with BS 466, rated for lifting the specified working loads, utilization and service conditions and shall be suitable for operation from the runway beams provided. Motions shall be motorized as specified with dual speed hoisting facility and controlled from a pendant push button unit via a crane control panel mounted on the gantry.

All operations, whether manual or electric, shall be controlled or performed from motor room floor level unless otherwise specified.

The lifting assembly shall be rated for the highest lift that could occur during installation and maintenance operations, including allowance for stiction.

The crane shall consist of a gantry or jib, crab and hoist assembly, ropes, block and hook together with the necessary running rails and all electrical supply requirements.

Chains used for lifting or travel shall be alloy steel and corrosion protected by an electro-deposited, zinc coated finish after manufacture. They shall not be hot dip galvanised.

Jibs or gantries shall be of plate or box girder design and securely attached to end mountings or carriages.

Hoist

The hoist unit on travelling beams shall be mounted to provide the highest possible lifting facility whilst maintaining adequate clearance between the crab/hoist assembly and the building structure and fittings. Hoist units fitted to single runway beams, fixed or jib mounted, shall be of the self-suspension type mounted on a single rigid trolley suitable for manual geared travel along the runway beam. Two end

stops shall be provided on the beam suitable for the trolley provided. The trolley shall have ball or roller bearings grease packed for life.

The hook shall be fitted with a swivel and a safety catch and be capable of touching the floor and providing a minimum lifting height as specified.

In the case of electrically operated hoist the normal hoist speed shall be approximately 4 metres/min and the creep speed shall be approximately 600mm/min or nearest standards. An overload device and overwind limit shall be included to prevent dangerous overloads. Raise and lower limit switches shall be provided at the maximum and minimum lift positions. Instantaneous fail safe braking in the event of power failure shall be provided.

Where operation is by electric motor a power supply shall be provided under the contract. Power shall be taken from a feed in the main distribution panel forming a part of the works and a wall mounted fused isolator shall be provided at a suitable location approximately 1.5 m above floor level alongside the lifting installation.

Power transmission to the moving installation shall be by pick up shoe running along the underside of shrouded rails, suspended concertina cable running on slides or a rail or a cable from a self winding cable reeling drum. In the latter case the tension in the cable shall be controlled and supported provided to prevent the cable dropping more than one metre below the crane rails(s).

Testing

All lifting equipment shall be tested at the manufacturer's works and on site. Tests on site shall comprise a full load test, including, where applicable, deflection checks on beams. Where the contractor wishes to use lifting equipment forming part of the permanent works for installation purposes he shall have the equipment tested and be in possession of a valid test certificate before using the equipment. All equipment must be tested or retested within one month of handing over to the Employer. Test certificates shall be provided in triplicate. The Contractor shall be responsible at his own cost for the provision of all weights, slings and other equipment required for testing.

Rating Plates

The SWL shall be clearly marked on the rating plate and shall be legible from the plant working level.

Paint Finish

The finish colour shall be full gloss Yellow Colour No. 356 to BS 381C or equivalent reference 08 E 52 to BS 4800.

Clearance Access

Where clearance permit, provision for safe maintenance shall be provided in accordance with BS 466 and shall include a walkway across the span having a height clearance of 2m and be fitted with double-tiered handrails and toe boards.

1035 Air Compressors and Blowers

Air Compressor/Blower

The compressor shall be an air cooled type capable of oil and dust free air delivery at the volume and pressures specified when directly or indirectly driven by an electric motor or diesel engine.

The compressor performance shall be in accordance with BS 1571 for the site condition and duty cycle specified and shall include the following components:

- Suction air filter/silencer;
- Solenoid operated unloader valve;
- Pressure relief valve;

- Non-return valve;
- Isolating valve;
- Low oil pressure switch (or pressure lubricated).

Where necessary, depending on load factor, the compressor shall include cylinder jacket and after cooler facilities for cooling the delivered air, the aftercooler having a suitable pressure relief valve and automatic drain valve.

Air Receiver

The compressor shall deliver air into an air receiver manufactured in accordance with BS 5169 Class III Grade E or F, to accommodate the specified design pressure and internal volume.

The receiver shall incorporate the following items:-

- One safety relief valve;
- One automatic drain valve;
- One pressure gauge (0 – bar);
- Pressure and temperature switched to suit the control;
- Inspection access to permit internal examination of the receiver;
- Lifting facilities as determined by the receiver weight.

The receivers shall preferably be located in low ambient temperature areas to minimize condensation and the inlet outlet pipe connections shall be arranged to promote air circulation.

Separators

The air distribution main shall include a separator to remove suspended moisture in the air main.

Compressed Air Filters

The air supply shall incorporate filters of the disposable element type as near as possible to the point of use.

Filtration shall be carried out using two filters in series, the first filter graded for coarse filtration and the second for fine filtration as defined in the Specific Requirements.

Drain Traps/Strainers

Automatic drain traps shall be provided for air receivers, filters and separators. Strainers shall be provided for protection of the drain traps. Ball traps shall have cast iron bodies with stainless steel internal parts (Spirax Sarco or equal).

Air Pressure Control

The compressor shall be arranged to maintain the air pressure in the system within the specified limits by means of pressure switches in conjunction with unloader valves and timers to prevent prolonged off-load running.

The frequency of starting and stopping shall be within the limitations of the drive arrangement.

Where two compressors are operated on a duty/standby basis, the duty compressor shall operate whenever the low pressure switch closes and shall cease operation when the high pressure switch opens. Should the pressure fall to the standby low pressure, the standby compressor shall operate in conjunction with the duty compressor and shall similarly cease operation when the high pressure switch opens.

The circuits for the compressor motor starters shall be completely separate. Either unit shall be capable of duty or standby operation and periodically their modes will be reversed.

The blower shall discharge continuously the specified free air delivery at specified suction and delivery pressures.

The blower shall be of the centrifugal or positive displacement rotary type with cast iron casings capable of delivering oil-free air. The blower shall be fitted with mechanical seals and incorporate a mechanical oil lubrication system, including an oil flow indicator, level indicator, pressure gauge, filling and drain plugs.

The design of the blowers is to be such that the noise level is kept to a minimum. The impellers shall each be equipped with heavy duty spherical roller bearing at each end. Gear end bearings shall be axially located on the inner and outer races to control thrust and maintain factory set clearances at all times.

The two timing gears shall be accurately machined to position the impellers in the impeller case and shall be secured to the shafts by locking kits. Gears shall be enclosed in an oil-tight housing.

The shaft sealing arrangement shall comprise a garter spring viton lip seal and a piston ring seal with an intermediate space vented to atmosphere.

Gears and gear end bearings shall be lubricated by a splash oiling system from oil maintained in the gear housing. Drive end bearings shall be grease lubricated or lubricated by a splash oiling system from oil maintained in the drive cover, depending upon gear size.

Each blower is to be direct driven through a flexible coupling, or indirectly via 'V' belts, by means of an electric motor, the complete assembly being mounted on a cast iron combination base plat. Both driver and driven units are to be dowelled or otherwise positively located to the base plate and substantial guards provided over all moving parts.

All covers and flanges associated with spigotted joints should be provided with easing screws if possible.

Blower Accessories

Each blower shall include a tachometer, an adjustable weight operated lever type air relief valve, delivery pressure and suction gauges each with isolating cocks mounted on a panel secured to a blower. An automatic unloader vented to outside atmosphere or an approved by-pass system is also to be included if this will assist starting.

The air relief valve is to be of double flanged cast iron construction with gunmetal trim. The adjustable weight shall have provision for locking to prevent any unauthorized interference.

Bosses shall be provided on each blower discharge pipe, upstream of the non-return valves, suitably tapped for connection by capillary tubing to pressure switches.

Blower Filters

The filters shall be capable of handling the designed throughput of air with the minimum of pressure drop whilst excluding 99.7% of all particles down to 2 microns.

The filters shall be of the two stage type comprising a hand operated roller mounted first stage roll type element and a disposable cartridge type second stage having access from one side only. The first stage unit is to be mounted in a galvanized sheet steel case with easily removable covers, the roller handle being conveniently positioned for easy adjustment of the roll.

The second stage unit is to be mounted in a galvanized sheet steel case and the units connected by a transition piece, a further transition piece being arranged between the second stage and the silencer.

Connections with isolation taps are to be provided on both sides of each stage and suitable manometers fitted to allow for measurement of the differential pressure.

Each unit shall be supported from the floor on substantial steel frames with welded plate feet.

Air Silencers

Single inlet and outlet silencers shall be included for the blowers and manufactured of sheet steel, comprising a perforated inner tube and an outer galvanized casing, the space between being filled with a sound absorbing material. A flange is to be provided at each end, and all necessary supports extending to floor level are to be included. The silencers are to be designed for the minimum pressure drop.

Noise Attenuating Enclosure

The enclosure shall be removable pre-fabricated type designed to reduce the noise level by approximately 20 dB (A).

The enclosure shall incorporate access doors or panels such that routine maintenance can be carried out without removing the entire closure. It shall be possible to remove the enclosure without disconnection of the silencer mounted outside the enclosure. The operating sound pressure level of the set, measured in accordance with BS 4196 at a distance of 3 metres, with the exhaust silencer and the noise attenuating enclosure in position, shall be a maximum of 80 dB (A).

1036 Miscellaneous Equipment

Submersible Mixers

The mixer shall be of the propeller type where the motor, gear unit, shaft, and propeller comprise a compact unit which is completely submerged.

The complete unit shall be of materials suitable for the particular application.

The junction box shall be completely sealed from the surrounding liquid and from the motor unit to prevent ingress of liquids.

The gear unit shall be fitted with spur gears with helical teeth to provide the desired speed reduction to suit the particular application.

The motor shall be of submersible type in accordance with Section 6 – Electrical Specification. The mechanical shaft seal shall have working faces of material to suit the particular application.

Bearings shall be of the deep groove ball or roller type designed for an L10 life in excess of 25,000 hours of continuous operation.

The whole mixer unit shall be mounted on guide rails and shall be complete with all necessary chains and shackles for safe and effective removal.

A lifting davit suitable for removal of the mixer unit shall be provided which shall be tested in accordance with the relevant British Standards. Test certificates shall be provided and the safe working load shall be clearly marked. The lifting capacity of the davit shall exceed the maximum weight of the unit by 100% minimum to overcome binding of the mixer unit on the guide rail.

Tank Covers

Tanks shall conform to the following:

- Tank covers are to be provided where specified in order to retain odours. They shall be purpose designed and manufactured for the particular application from ultraviolet resistant Glass Reinforced Plastic (GRP) or glass-coated steel, and shall be provided with all necessary ribs and stiffeners on the underside to provide a rigid and robust structure;
- They shall rise from the tank walls to the centre of the tank, shall be self-draining and shall not sag or form hollows;

- They shall be suitable for use with sewage sludge and sludge gases, including those dissolved in water;

GRP covers shall comply with the relevant provision of BS 4994 as appropriate. Glass coated steel covers shall comply with the specification requirements for glass coated steel tanks, as appropriate;

Loading shall be in accordance with the provisions of BS 6399 (Roofs with no access) except where permanent access is specifically provided, in which case loadings shall be to BS 6399 (Roofs with access). In the case of GRP roofs, the maximum strain shall be limited to 0.3%. Calculations shall be provided for all roofs and covers;

The corners and edges of cover panel shall be smooth and uniform. All joints (viz. panels to wall, panels to bridge or panel to panel) shall be sealed with a flexible strip and pliant sealant to produce a close seal. The joints around openings, such as hatch covers, shall be sealed with a flexible strip firmly attached to the fixed portion of the covers;

Each cover shall incorporate 2 No. hinged, locking manholes at positions to be agreed, not less than 0.8m square. The lids shall be strengthened to prevent twisting on opening and shall be designed to fold back flat on opening with securely fixed handles;

The manhole and tank covers shall be provided a separate 200mm diameter stiffened opening with a sealing plate for instrumentation use. Where the covers are to be fitted to a tank at a roof height of more than 2m above ground level, suitable safety harness fixing points shall be provided adjacent to each manhole opening;

Each cover shall be provided with 2 No. 500mm square openings, one near the centre, one at the edge, in positions to be agreed, with stiffened edges, for fitting of ventilation equipment, and shall be sealed with removable plates; In case where the covers are to be supplied together with new tanks or new scraper bridges, then they shall be designed in co-operation with the relevant manufacturers to ensure compatibility;

Where specified and where necessary for machinery access, special sealed access openings shall be provided shaped to suit the machinery concerned;

The method of fixing and sealing to the tank walls shall be for the supplier to decide, and shall be stated in the Tender. All supports, fixings etc. shall be manufactured from corrosion resistant material. Galvanized or plated mild steel is not acceptable.

Section 11 Instrumentation and Control

1101 General

Design and Electromagnetic Compatibility

All circuits and equipment shall be designed in accordance with good engineering practices and particular care should be taken to ensure that no component shall exceed its maximum voltage/current/power ratings at any time, including during transient surges.

All instrumentation equipment shall be protected from interference emanating from radio frequency transmissions, either radiated or cable borne, such that it shall not cause malfunction of the system or damage to the components.

All equipment supplied shall not radiate any form of electromagnetic energy in amounts that might interfere with external equipment or instrumentation.

The latest standards on interference shall be followed and the principles of electromagnetic compatibility (EMC) applied to the design and application of the plant.

Interrelation with Other Sections

Requirements given in other sections shall be applicable whether relevant to equipment or materials specified in this Section.

Thus indicator gauges, metres, enclosures, panel construction, finish, components, wiring, terminations, cabling requirements and environmental operating conditions shall be in accordance with the relevant clauses of the Mechanical and Electrical Sections unless specifically amended in this Section.

Interrelation with other Contracts

Where the location, installation or connection of any components of instrumentation are arranged by the Engineer under other contracts, it shall be the responsibility of the Instrumentation Contractor to advise and provide all relevant information on such matters to the Engineer in order that the correct and proper performance of the Contractors instrumentation is not prevented or impaired.

Temperature and Humidity

All supplied equipment shall function without error and shall be constructed of such materials or so treated as to prevent the formation of mould, fungus or any corrosion over the ranges of temperature and relative humidity specified in the specific clauses for this site.

Enclosure Protection

Instrumentation and hardware mounted in the field shall be contained in suitable enclosures to provide ingress protection to BS EN 60529 rating IP54 indoors and IP65 outdoors as a minimum. Sensors installed below water level or liable to submersion shall be rated IP 68. Where items are fitted in a panel or other enclosure, they shall preserve the design IP rating of that enclosure.

Voltage and Frequency Tolerance

Equipment shall be capable of working from a supply whose voltage may vary $\pm 15\%$ and tolerate any transients that could be experienced in such an environment without programme corruption or system failure.

Instruments

Each instrument and sensor shall be selected considering all the relevant performance parameters for the principle of measurement adopted, its intended use and the particular process in question.

All instrument output signals shall be volt-free, clean contacts rated at 220V AC 2A for digital and 4-20mA continuous proportional linear signal for analogue. Pulsed outputs suitable for integration counter drives shall be 24V DC.

Inputs, Outputs and Signal Loops

Opto-isolation shall be provided on all input interfaces to card.

Digital signals shall be 24V DC with the power supply from either the associated power pack or the external instrument. Relays shall be used where more than one instrument including I/O are fed from a single signal.

Analogue signal shall be continuous linear scaled signals with a 4-20 mA operating range. Loops with instruments wired in series (e.g. panel mounted indicator and RTU input) shall have zener fitted across each subsequent instrument leg to ensure loop integrity.

Terminals

Signal terminals shall be the disconnect type. Power supply terminals shall be shrouded and clearly marked with the appropriate warning tags. LED's shall be provided for fault tracing, if not supplied on the I/O cards. LED's in either case must be clearly visible from the front, with only the enclosure door open.

For each incoming screened cable, a separate earth terminal shall be provided for screen termination to earth.

All equipment, isolators, terminals and cables shall be clearly marked. 20% spare terminals shall be provided.

Programming and Monitoring Unit

Hand-held portable devices shall be provided for the system allowing user configurable operation to enable the downloading or uploading of data or software and the local running of diagnostic software. For RTU plc's the device shall be fully compatible with the RTU and shall be supplied with:

- Software to enable the development of programmes and the subsequent downloading to the RTU.
- Software to enable full communications with the RTU and to:
 - upload data or alter data in the RTU;
 - access communications ports and I/O.
 - Full page process mimic display capability.

Discrete Components

All discrete resistors, capacitors, switches, relays, diodes, transistors and other electronic devices shall comply with the BS 9000 series specification for components of assessed quality.

The Engineer's agreement must be sought before using components that are not certified, but it will remain the Contractor's responsibility to ensure that all components are suitable for the application.

Similar types of components shall be of the same manufacture and design wherever possible.

Integrated Circuits

All integrated circuits shall be of a proven design and shall be clearly marked with the original manufacturer's identity and device number.

Sub-Miniature Switches

Where DIL or other sub-miniature switches are used they shall be provided with a cover, or other means of protection, to prevent accidental switching during handling.

Printed Circuit Boards

Printed circuit boards shall be made of glass fibre with copper trackwork, all exposed copper being tinned prior to assembly, and the board and components cleared of flux before a thin layer of clear varnish is applied for environmental protection.

The board and its components shall be identified by references relating to the corresponding circuit diagram which shall be printed on the component side of each board. Where a number of boards are mounted in a rack system, the rack and boards shall be clearly marked to identify each board to its particular position.

Sockets and Connectors

The use of plug-in connectors for electronic equipment shall be kept to a minimum, and all circuit components including integrated circuit chips shall have soldered connections where this is permitted by the chip manufacturer.

Where sockets and connectors are incorporated in the design, they shall have self-cleaning, hard gold alloy plated, wiping action contact faces, and incorporate polarizing keys or similar means to prevent incorrect mating. Insulation displacement type connectors shall not be used.

All light current wiring having a cross-section of 1.0mm² or less shall have tinned copper conductors.

Test Facilities

The electronic equipment is to include built-in test facilities to permit the detection and replacement of faulty modules without the use of oscilloscopes, signal generators, or other sophisticated test equipment.

Surge Protection

All telecommunication lines, data and signal cables and other items of equipment external to the building environment prone to damage resulting from induced surges due to lightning discharges, shall be fitted with lightning surge protection barrier devices at each end of the line to suppress and divert any transients likely to cause damage to the connected equipment.

All surge diverters/lightning arrestors fitted to telecommunication lines shall be of a design approved by the telecommunications authority.

Surge protection units shall be un-fused, solid state devices, designed to limit the transient over-voltages to not more than twice the normal working voltage of the line. They shall have low in-line resistance and automatically return to normal operation after diverting a surge.

The units shall have provision for either DIN rail or individual panel mounting or direct bolted connection to a suitable copper earth bar.

The location of the units shall be arranged such that the earth connection shall be routed clear of the protected signal cables and have short, straight connections without sharp bends to the main earth

points, using copper conductors not less than 16mm² csa and not greater than 5 metres in length to provide a low impedance path.

Surge suppression devices to provide protection from mains switching or other supply network disturbances shall be incorporated or fitted to all sensitive monitoring or control devices. They shall be designed to filter unwanted transients and limit the 'let-through' voltage to less than twice the working mains voltage, between all conductors and each conductor and earth. Protection monitoring status indication shall be fitted

High Pressure protection

It shall be possible to program a "high-pressure" safety cut-out, set 1.5 bar above the duty pressure. The pumps set shall automatically shut down in the event of the above pressure being identified. Following a shut-down the controller shall (a) re-start the pump set automatically once the high condition has disappeared, or (b) will remain shut down until manually re-started by an authorised person. (The preferred option shall be agreed with the end user prior to hand over and the controller programmed accordingly).

Low Pressure/pipe burst protection

It shall be possible to program a "Low-pressure" safety cut-out, set 1 bar below the duty pressure. The pumps set shall automatically shut down in the event of the above pressure being identified. Following a shut-down the controller shall (a) re-start the pump set automatically once the high condition has disappeared, or (b) will remain shut down until manually re-started by an authorised person. (The preferred option shall be agreed with the end user prior to hand over and the controller programmed accordingly).

Soft pressure build-up

The panel shall incorporate a slow-speed/one-pump-only start up, following a power outage or maintenance shutdown to gradually fill up the pipeline and reduce risk of airlocks and water hammer.

Redundant sensor

The controller shall have a feature that gives an alarm if there is incoherency between the two discharge sensor signals.

Testing and Commissioning:

Once installed on site, with all necessary permanent water services, power supplies, control and alarm systems completed and tested. The panel manufacturer shall be invited to site to commission, test and demonstrate the operation of the panel to the full satisfaction of the Engineer and End User.

1102 Instrumentation General

Indicating instruments shall show the specified measured values in either electro-mechanical or electronic and analogue or digital form, as defined in the Specific Requirements.

Wherever possible, panel mounting indicating instruments shall be of matching size, appearance and orientation and suitably scaled, all in accordance with the general requirements for electrical panels.

Strip Indicators

Strip indicators shall be provided for the specified functions and arranged as shown on the proposed panel layout.

The indicators shall be solid state electronic type employing a column of neon gas plasma bars, illuminated consecutively in proportion to the input signal. The scale length shall be at least 100mm and allow on-line span and zero adjustment.

All indications shall be driven from transducers or inputs giving analogue signals of 4-20 mA.

Indicator/Recorders

Electro-mechanical indicator/recorder shall be a flush, panel, mounting, single/multi pen indicator/recorder, scaled and labeled as specified herein. The initiating signals for each pen and the trace colour(s) together with any event markers and/or alarm settings, shall be as specified.

Continuously running recorders shall run at a speed of 20mm/hour with date and time annotation at 4 hourly intervals. For intermittent running, as in storm pumping applications, the recorder chart speed shall be 60mm/hour and shall only be initiated when the level approaches the first pump start level and be stopped 30 minutes after the final pump cuts out. Starting and stopping times and dates shall be printed on the chart and each pump operation shall be individually annotated by means of a single trace for each pump showing its running time.

To provide minimum time lags between other channels on the recorder, dot print outs may be used where required.

The Z folded chart paper shall be 250/100mm wide, linearly scaled in half hourly divisions and the width shall be calibrated 0-50 divisions linearly or logarithmically scaled as specified to adequately show the normal range of operation and include the maximum possible signal. The chart shall run for a minimum period of 30 days and 24 spare charts shall be provided. Circular charts shall be 105mm wide, 7 day graduated.

Each channel shall provide a continuous ribbon strip visible indication over a calibrated scale (left hand zero) and an individually different coloured trace on the chart by means of either fibre tipped pens fed from disposable ink cartridges or electrical writing or sensitized paper.

Each input shall be separate and isolated from the conditioning amplifiers and all necessary computing modules shall be included in the unit to provide the required indications.

The following features shall be provided for the operator control, accessible from the front without withdrawing the unit during operation:

- Pen renewal (if relevant);
- Power on/off switch;
- Chart drive on/off switch;
- Chart replacement and adjustment.

Adjustable high and low, volt free alarm contacts shall be provided on each channel and incorporated into the control scheme as required to initiate the alarms as specified.

Time Indicator

A mains driven synchronous type clock shall be suitable for front of panel mounting and resetting.

The display shall either be digital or analogue as specified and based on a 24 hour notation. The digital display shall be of white figures (not less than 55mm high), on a black background. The analogue display shall be dual scaled showing 0-12 hour black figures and 13-24 hour red figures on a white faced dial of not less than 220mm diameter.

The mains supply for the clock shall be via a suitable fused clock connector mounted in the panel, connected such that the clock is energized from the live side of the panel isolator.

Capacitive Devices

Level monitoring shall be by means of a capacitance electrode suitable for the medium and environmental conditions specified such that the electrode capacitance varies in proportion to the immersed electrode length and be arranged to provide a 4-20mA output proportional to the specified level range on a scaled indicator giving a continuous read out.

Auxiliary switches shall be provided for high level alarm, low level alarm and control of external equipment. The position of all switches being adjustable over the level range.

Any fault in the electrode connection and in the electronic circuits shall provide an electrically isolated alarm signal for remote monitoring.

The electrode housing shall be a heavy duty pattern to IP 68 suitable for 2" flange mounting and incorporate a 20mm ET cable entry. The head shall be removable for cabling and servicing without disturbing the electrode mounting.

Pressure Transducers

Pressure monitoring shall be by a transducer suitable for the medium and pressure/level range specified herein.

Each transducer shall be ranged to provide adequate sensitivity over the working range and be capable of sustaining a 400% overpressure without damage. They shall be of rugged and waterproof design, employing a pressure sensitive element within a stainless enclosure having an isolation diaphragm, suitable for either free wire suspension in the medium or fitted with a BSP thread for external connection to the relevant pipe tapping.

Suspended sensors shall be mounted in accordance with the manufacturer's instructions within a uPVC 'stilling tube' of sufficient nominal bore to enable easy withdrawal of the sensor.

Sensors shall be enclosed to IP 68, offer a long life and shall be supplied complete with a suitable signal cable to reach the approved point of termination transmitter-converter without intermediate joints.

The position of the equipment shall be such that withdrawal and installation can be achieved easily.

Cable entry shall be integral sealed assembly or by 20mm conduit entry into a sealed watertight terminal enclosure with provision for transducer venting.

A transmitter shall be provided either integral with the transducer or separately mounted as specified, suitable for operation from the mains or battery supply specified (not greater than 24V) and converting the signals received from the transducer to a 4 – 20 mA signal proportional to the ranged specified which shall be used as follows:

To drive an indicator/recorder to give a continuous readout; To operate separate on/off pre-set adjustable points.

The transmitter shall have provision for range and zero adjustment.

For use in hazardous areas as specified, the units shall be certified intrinsically safe Ex (1).

Ultrasonic Devices

Flow or level monitoring by non-contact ultrasonic measuring devices shall incorporate ambient temperature compensation and adjustable datum setting facilities. Where specified, the output shall be computed to give a flow reading for the given parameters and/or control of pumps.

Transducer

The sensor head shall be protected to IP68, mounted to provide an unhindered beam path, prevent unwanted reflections, within easy reach of maintenance personnel and, where possible, be clear of flood conditions. For sewer or foul pumping sumps, the units shall be certified intrinsically safe Ex (i) for use in hazardous areas.

Signal Converter

The converter shall be suitable for operation from the specified power supply and convert the signals received from the sensor head to a 4-20 mA signal proportional to the range specified, to be used as detailed in the Specific Requirements.

The converter shall comprise a base unit and a programming device, all in a polycarbonate enclosure to IP 65. Communication between the programmer and the signal converter shall be in such a manner that the IP rate is not prejudiced.

A minimum of 3½ digit liquid crystal display shall be used to indicate key programming features, settings and output conditions, including flow calculations to BS 3680 for flumes and weirs.

Accuracy of the signal converter shall be better than $\pm 1\%$ of reading and shall have the following programmable outputs:

- mA proportional to user definable engineering units.
- SPDT relay contact output closing upon failure of the signal converter,
- lost echo or multiple echoes.
- Off SPDT contact outputs with independently set trip points. These
- outputs shall be programmed to energise upon high/low levels, rate of change or to allow a number of pump sequencing operations. Contacts rated at 5A 240V ac, non-inductive.
- Serial ports RS 232 for down-loading data.

Electro-Magnetic Flow Meters

Electromagnetic Flow meters shall be sized and installed in accordance with the manufacturer's recommendations as approved by the Engineer, BS 5792 and BS 6739.

Flow meters shall be supplied with a calibration certificate. Electromagnetic flow meters shall be selected and sized to give a maximum velocity of between 1 and 7m/sec. The minimum velocity achieving the stated accuracy shall be not more than 0.1 m/sec.

The flow meters shall be of electromagnetic inductive type having a DC pulsed field with automatic zero error averaging and low power consumption. They shall have no moving or protruding parts nor cause any restriction in the flow path and be capable of setting adjustments without the need to stop the flow.

Each metering system shall comply with BS 5792 a

and comprise a flow sensor mounted in the pipework line and a signal converter, wither integrally mounted or remotely located preferably within the main control panel.

The system accuracy shall be a maximum at normal operating flow with an error not more than 1% of the reading. When operating in the lower 30% of the meter range, the accuracy shall be within $\pm 3\%$.

Flow sensors - these shall comprise electrodes located in ammeter tube which shall be of watertight construction, suitable for operation without loss of accuracy when totally submerged to a depth of 3 metres.

The meter tubes shall be made from a non-magnetic material lined with an inert material suitable for the medium and fitted with flanges to suit the pipework system, the lining material being applied such that it extends from the bore of the tube to fully cover the raised face of the tube flanges.

The measuring electrodes shall be continuously cleaned by means which do not interrupt the process flow or the measurement. A sensing electrode shall also be provided to detect when the flow meter is not fully charged with liquid.

The flow meter body shall be effectively bonded by non-corrodible, tinned copper braid links at each end, to the adjacent pipework to ensure a good connection between the body and the metered liquid, an earthing flange being inserted where non-conducting pipework is employed.

Signal Converter/Pulse Power Unit

These units shall be suitable for operation from the flow sensor into output signals having the following features: Single flow rate range adjuster suitable for the flow sensor.

Independent output signals shall be provided for each flow direction as follows:

- ☐ +5/0/-5 volts d.c. signal for telemetry purposes with magnitudes directly
 - proportional to flow.
 - 4-20 mA current signal, to be used for indication of flow, quantity, etc.
 - 24V impulse for integration counter drive.
 - Works presettable system response time.
 - Output driven downscale to zero on receipt of a 'flow meter empty' signal from the liquid sensing electrode.

The transmitter shall have the following programmable outputs:

- mA, proportional to use definable engineering units.
- off multifunctional SPDT relays. Individually programmed to allow a number of sequencing operations, rate of change or high/low flow indication. Contacts rated at 5A 240V ac, non-inductive.
- Serial port RS 232 for down-loading data.

Flow Meter Cabling

Where remote mounted converters are specified, cables shall be provided, installed and terminated between the sensor and converter/pulse power unit for the following purposes.:

- flow signal;
- reference signal;
- coil supply;

Such cables and sealing glands shall be suitable for submersible operation of the sensor to the depth specified. The length of each cable shall be as specified.

Spool Piece: A flanged steel spool piece shall be provided of the same diameter and length as the respective flow meter and flanged for insertion in the pipe should it be necessary to remove the flow meter.

Isolating valves shall be provided on either side of the flow meter. Differential

Pressure Flow meters and Differential Pressure Switches

Flow meters of the differential pressure type shall be designed and installed in compliance with ISO 5167- 1 or an Approved Standard. Primary devices shall be insertion probe type or carrier-ring type orifice

assemblies with stainless steel orifice plate, or venturi tubes shall include two sets of gaskets and fixing bolts for each primary device. Gasket materials shall be appropriate to the metered fluid and service conditions. Full details of orifice or venturi tube calculations shall be supplied.

Orifices shall be square-edged and concentric. The upstream edges of orifices shall be sufficiently sharp that the reflection of a beam of light from the edge cannot be seen without magnification. Drain holes shall be provided. The diameter ratio shall be between 0.20 and 0.70. Orifice assemblies shall have identification tags showing the direction of flow, orifice diameter and position of drain hole. The identification tag shall be welded to the plate before the orifice is machined.

Insertion probe type installations shall follow the equipment manufacturer's recommendations. The probe shall be mounted to a standard sized ferrule or flange plate and include appropriate 3-way valve block.

Differential pressure transmitters and switches shall have over-range protection up to 1.5 times the maximum line pressure.

Location of these devices should be such that no turbulence shall interfere with the measurement of pressure either side of the device.

Signal Converter

The sensor shall be of the inductive type giving an output of 4 -20 mA proportional to the flow rate and a totaliser. The sensor shall be protected to IP 66 and having the following characteristics:

- Accuracy: $\pm 0,25\%$ of FSD between 25 and 100% of the flow measured.
- Stability: 6 months period: $\pm 0,25\%$ of FSD
- Voltage supply: 200 Vac
- Sensitivity: 0,005%/V at 50% flow and more

Differential pressure switches shall have contacts with differing "cut-in" and "cut-out" values. The nominal values at which differential pressure switches operate shall be fully adjustable over the whole range of the instrument and the set value shall be clearly indicated by means of a scale and pointer. Contacts of differential pressure switches shall be hermetically sealed.

Mechanical Flow Meters

Mechanical flow meter shall be volumetric, jet or in-line helical vane (Woltman) type to Standards ISO4064/BS 5728 EEC Specification with integral strainer. Meters shall be designed for minimum maintenance and shall incorporate best quality rotor bearings to ensure long working life.

Meter bodies shall be cast in spheroidal graphite iron to BS EN 1563. All internal parts shall be manufactured from non-corrodible materials.

Meters are for the measurement of potable water flow with a normal working temperature up to 30°C and a maximum working pressure of 16 bar.

Meters shall be generally in accordance with the following Table:

Meter Size (mm)	Q _{max} : PEAK Instantaneous Flow (minutes only) (m ³ /h)	Q _n : MAXIMUM Continuous Flow At $\pm 2\%$ measuring Error (m ³ /h)	Q _{min} : MINIMUM Flow at $\pm 5\%$ Measuring error (m ³ /h)
15	3.0	1.5	0.036
20	5.0	2.5	0.050
25	7.0	3.5	0.082
32	10.0	4.5	0.127
40	20.0	6.5	0.182
50	80	40	0.55
80	200	120	0.70
100	250	180	1.20
150	600	400	3.00
200	700	550	5.00
250	1200	750	10.00
300	1500	1000	12.00
400	3000	2000	25.00

Measurement mechanisms shall be removable from the meter body without the necessity to remove the meter from the main. Meters shall be equipped with a register indicating flow in metric units a sweep hand and six figure counter. Dummy cover plates to seal the meter after the mechanism removal shall be provided.

Tapers shall be provided, or non-standard bearings and propellers, if required, to obtain the specified degree of accuracy at the specified flow rates.

The meters shall be suitable for working pressures up to 16 bar unless otherwise stated.

An extension drive and extended head shall be fitted to meters as required. The drive shaft bearings and gears shall be designed for long life under continuous operation, and normal wear shall not significantly affect the accuracy of the meter.

Meters shall have a circular dial and rate of flow indicator registering flow in litres/sec. A flow totaliser having at least six digits shall be incorporated in the head. The totaliser shall have a capacity of at least one years flow at maximum flow rate. A multiplying factor in multiples of 10 may be used in conjunction with the totaliser if required, however, if this is the case, the factor shall be clearly marked alongside the register.

Meters shall be individually flow calibrated at the manufacturer's works and shall be guaranteed to within 2% of true flow within the rated range of the meter. Each meter shall be supplied with a calibration certificate.

The spare parts shall include as a minimum spare gearing and bearings for each size of flow meter used.

1103 Electrical Works

Functional Precepts

Plant Operation

The plant will be unattended and all constituent units shall be arranged to be fully automatic and maintained ready for service at all times.

In order to simplify operation and maintenance, all control schemes shall, as far as possible, follow the same operating pattern, have similar control cubicle layouts, and employ similar items to minimize spares holdings.

Electrical system design shall reflect the hydraulic system design as far as possible and shall be directed to making each major item of plant capable of running substantially independent of others. Where common equipment is employed, then every effort shall be made to ensure that no single fault can affect the entire plant and particular care must be taken to protect the overall integrity of the system.

Provided that the principle of segregation is not infringed, solid state or microprocessor based equipment may be incorporated within the various control panels in lieu of electromagnetic relays, timers, etc., in order to perform the necessary control functions. In this event, full details of the proposal to achieve segregation shall be submitted for approval with the Tender. All costs for programming, setting-up, providing and training of purchasers staff in the operation and maintenance of such equipment shall be separately identified in the Bill of Quantities.

Power Supplies

The Supply Authority will be requested by the Employer to provide a reliable, secure and adequate power supply to each site. This supply may not be made during the period of the Contract and the availability of electrical power supplied cannot be guaranteed. The Contractor shall provide all necessary temporary power supplies, by use of mobile generators or otherwise, for purpose of construction, connection, installation, testing and commissioning of the Works. The Contractor shall be responsible for assessing the requirements, availability and reliability of all power supplies at each site and shall be deemed to have included in his tender for the provision of all necessary temporary electrical power supplies.

The electricity supply is a nominal 415 V, 3 ph, 50 Hz. The voltage may vary $\pm 15\%$ and equipment shall be rated to withstand this variation.

Power will be brought to the site by the client either at 11 kV or 415 V. Where the supply is at 11 kV, a stepdown transformer will be installed by the client. The Contractor shall provide all cabling and wiring from the transformer or from the client cut outs at the metering location. Buried cables within the station compounds shall be in duct.

The Contractor is responsible for ascertaining the exact details of the supply, including the type of earthing, the earth fault loop impedance external to the installation, and the prospective short circuit current.

The Contractor shall provide a certificate of completion from the Government Electrical Inspectorate (GEI) prior to the client installing the meter and cut-outs, and making the final connections.

The Contractor shall size all cables in accordance with the IEE Regulations or NEC. The Contractor shall submit all calculations for comment and approval prior to the installation being carried out. The Contractor shall also provide a single line distribution diagram showing equipment and cable ratings, earth loop and prospective short circuit values.

Pump Units

All pump units shall have means of isolation from their associated pipe work system.

In dry well installations, the suction valve will normally be left open, unless used for isolation when the pump is out of service.

The delivery side of the pump set shall include a non-return device to prevent back circulation when the set is not running. This shall be a fail-safe device such that in the event of pump failure or loss of external services, the device shall independently close. A gate valve will normally also be installed on the pump delivery side, downstream of the non-return device, for pump isolation.

Pump Unit Control

The pump unit control panel shall include all control and indication elements for the pump motor, together with any associated valve actuators, lubricating systems and valves, cooling fans, flushing pumps and other ancillary control equipment required by a pump drive, all arranged to operate in a safe and proper sequence.

Where external services are fitted to open the delivery valve, the control system shall initiate the valve opening procedure as soon as the pump is up to a speed sufficient to overcome any existing delivery pressure.

Failure of the valve to open within the time allowed or closure occurring whilst running, shall initiate an alarm and shut down the pump set.

Pump Duty Control (4 or more Pumps)

Each of the pump units shall be capable of operating in any combination of duty sequence. The Contractor should apply a clear and reliable method of pump duty allocation and duty rotation, to evenly distribute running times for each pump unit.

Any starting sequence, including those following restoration after a supply failure shall be time sequenced to prevent excessive load on the supply system. Each duty circuit shall include its own timer, arranged to be initiated in the selected duty sequence by the preceding duty, the delay periods between each restart being adjustable up to 20 seconds.

Where a microprocessor based pump control system is employed using common modules, two modules shall be provided, each capable of controlling at least 50% of the pumps available, the duty set points being interleaved between each module to limit the effect of failure of one module.

Level Control

The water level shall be monitored by a system providing the necessary duty set points, each being adjustable over the full range of control specified.

To achieve performance stability under all environmental conditions and variations, all necessary signal compensation devices shall be included.

The monitoring system shall be damped to prevent spurious switching due to transient wave motion but shall respond sufficiently to allow adequate time for plant reaction to stabilize in order to prevent hunting.

The system shall include a duplicate back-up monitoring device or have a built-in self-monitoring circuitry with alarm facilities.

Any high settings which may be provided as part of a level control system may be linked with the independent high level alarm sensors specified.

Alarms and Indicators

Separate indication of the following conditions shall be provided by means of annunciators grouped as indicated on the front of the panel. All indications shall have a lamp test facility.

Alarm annunciators shall be provided with accept and reset facilities together with an audible alarm and an audible/mute selector switch.

Each of the alarm conditions specified shall initiate its individual annunciator with a flashing indication which shall become steady when "Accept" button is pressed and be extinguished by the "Reset" button once the alarm condition is removed.

In specified unattended locations, self-reset facilities shall be provided to enable the system to restore itself to normal operation after the fault has passed.

With audible/mute switch set to "Audible", the audible alarm shall sound when the indication is flashing and be silenced when "Accept" button is pressed. In the "Mute" position the audible alarm shall be muted and any alarm initiation shall give a steady lamp indication only.

To prevent false alarms occurring during mains failures or on restoration of mains supply, the common alarms specified shall be supported by a battery backed supply, either directly or via an inverter.

Control Selector

A three position Hand/Off/Auto selector switch shall be mounted on the front of the panel to give the following control facilities; the switch shall be lockable in each position by means of a barrel locking device incorporated in the handle and the switch handle shall clearly indicate the switch setting.

In the "Hand" position operation shall be by means of the "Start" and "Stop" push buttons mounted on the front to the panel with all plant protective devices retained in circuit.

In the "Auto" position the plant shall be operated automatically under the control system specified together with the plant protective devices.

Emergency Stops

Where means of stopping are required adjacent to a motor of the driven plant to prevent danger, emergency stop push buttons, trip switched, or interlocks shall be provided, arranged to immediately isolate the supply, as long as a greater risk is not thereby introduced.

Emergency stop buttons shall have a stay-put lock off feature, with "twist to release" manually operated reset facility. Such a button shall be located on the motor starter panel. A key operated reset facility shall be provided where specified.

Where plant is normally enclosed or has fixed guards to prevent accidental contact from moving parts, stop buttons are not normally required adjacent to such parts.

Stop buttons shall be hard wired direct to all motor control circuits and not by way of any semi-conductor logic control circuitry.

Means of equipment isolation for maintenance purposes shall be provided. This may either be by use of key operated emergency stop buttons or lockable isolators, which may be at the control panel or local to the plant.

Mains/Standby Supply Changeover

If the site is supplied from two alternative mains supplies, the changeover section shall monitor the three phase voltages of each of the two incoming supplies and automatically close the contactor to the healthy supply. The two incoming supply contactors shall be mechanically and electrically interlocked to prevent paralleling two healthy supplies.

Where a bus section switch is provided for manual switching arrangements to allow both supplies to be utilized without paralleling, the contactors must be electrically interlocked between each other and the bus-section switch. Voltage monitoring settings shall be adjustable and nominally set to operate on a rising voltage of 90% nominal, with low/high voltage settings at $\pm 15\%$ nominal on each of the three phases.

Automatic Operation

Mains/Supply – Closing the incoming isolator or restoring a healthy supply will initiate the closing of the Mains contactor via the monitoring relays, subject to the generator operating condition.

Momentary supply drop-outs up to 5 secs. shall allow the plant to resume without further action. Breaks of supply greater than 5 seconds shall initiate the generator supply. Delayed start timer setting to be adjustable 0-3 min.

After any changeover of supplies, automatic or manual, the pump motor loads may be restored automatically or manually (remotely or locally) as specified but with sequential 20 seconds re-start delay timers incorporated in each pump starter circuit to prevent co-incidental starting surges.

Voltage Drop

The volt drop within the installation shall not exceed a value suitable for the safe functioning of any fixed current-using equipment.

Equipment and Cable Ratings

All busbars, cable, switchgear, fuses, motor starter,, relay, instruments, panel wiring, etc. shall be sized and rated in accordance with normal operational requirements of the associated plant and equipment, taking into account maximum load currents, volt drop, frequency or motor starting, maximum ambient temperature etc.

Where specific voltage or current ratings have been included on the drawings and in the description of individual items of equipment in the Specification and/or Bill of Quantities the values stated shall be deemed to be minimum values. It shall however be the responsibility of the Contractor to ensure that all equipment supplied is properly insulated and adequately rated to handle operational loads and, in the case of fuse gear and circuit breakers, to deal with prospective fault currents.

m) Switchboard Components

Panel Construction

Panels shall be constructed of sheet steel having a minimum thickness of 2.0mm (14 SWG) or other approved material, and similar equipment shall be of the same manufacture and units of the same type and rating are to be interchangeable. The use of toxic, hygroscopic or flammable materials shall be avoided.

LV Panels shall be damp and dust protected (IP52) for indoor situations and hoseproof (IP65) for outdoor or wet situations, or as otherwise specified under the specific requirements.

HV Panels shall have covers and partitions affording a degree of protection IP53 to BS 5447 or equivalent for drawout sections. Internal partitioning, instrument and control sections etc. shall be to IP52.

Switchboards shall incorporate a rigid steel frame and be suitable for ready extension at each end without further cutting or drilling. Composite switchboards shall be assembled by the principal electrical manufacturer and shall be sectionalized as necessary to facilitate handling.

Switchboards shall include barriers between each of their units to ensure safe maintenance on any circuit during normal operation with the remainder of the board live. When a functional unit is isolated and open, the degree of protection to any remaining live part shall be at least IP20. Barriers or covers to live components shall have warning labels attached.

If any compartments are provided within a section of outgoing units which are not fully equipped, they shall be arranged so that they can be fully equipped without de-energizing that section of the switchboard.

Cubicle type switchboards shall be totally enclosed, flush front and rear patten, arranged in a multi-tiered formation if practicable, with at least 300mm clearance between floor level and any operational item of fuse gear or control gear. Kicking strip protection shall be provided by a 100mm high plinth forming the base of the switchboard.

The overall height of control panels, including plinths, shall not exceed 2300mm. Isolator handles, control switches, push buttons indicator lamps and instruments shall be centred not more than 1900mm above finished floor level.

All components mounted on the front of the panel shall be of matching uniform appearance, orientation and colour, with all bezels and escutcheons finished black. The layout and grouping of components shall be as approved or specified.

Within each control cubicle a reduced size schematic diagram of the control circuit, printed on durable material, shall be permanently fixed.

Doors and Covers

Each section or compartment shall be provided with full width access doors or covers, with individual doors or covers not exceeding 750mm width.

All doors and covers shall have returned edges for rigidity and incorporate dust seals of flexible material secured in channel rebates. Covers exceeding 0.5m² in area shall be provided with a supporting lip within the lower edge or have lift-off hinges. All doors shall be supported on strong hinges of non-corrodible material and shall be secured by adjustable quarter turn cams, operated by small TEE handles incorporating key operated barrel locking facilities or flush locks with drive key inserts. Covers shall be secured by similar fastenings or captive bolts.

All additional fittings such as handles, hinge brackets and locks shall be a black finish, polyamide moulding or epoxy coated metal.

Doors shall open at least 90° with the opening positively limited such that doors and their appurtenances are prevented from fouling adjacent panels when opened.

Switchboard Rating and Busbars

Switchboard busbars, droppers, switchgear and its associated cable boxes shall be mechanically and electrically designed to withstand the fault level and duration specified herein and (except for LV switchboards rated less than 900A) shall be an ASTA certificated design rated at not less than 80kA RMS for 1 sec. or 50 kA for 3 sec. LV switchgear and motor control gear shall comply with BS 5486 Form 4 segregation of busbars, functional units and terminal chambers, unless otherwise specified.

Busbars and droppers shall each be air insulated and formed from solid drawn high conductivity copper bars, having a constant current rating with a uniform cross sectional area throughout their length. Each shall be clearly marked with the appropriate colours to indicate each phase, neutral and earth. Droppers shall be as short and as straight as possible. Busbar compartments shall be fully segregated and shrouded from all other sections of the switchboard.

All busbar connections shall have at least two bolt fixings, and due considerations shall be given to high stresses at bolted connections on high voltage equipment. Where flexible busbar connections are used these shall be secured by high tensile steel and nuts with anti-vibration locking devices.

Earthing

All metal cases of meters, relays, instruments, starters, and control switches shall be connected to the switchgear frame earth terminal by means of green and yellow PVC insulated cable, not less than 2.5mm² cross section.

An earthing terminal or group of terminals shall be provided in the panel for termination of panel earthing connections and incoming cable earth or connection to a main earth bar.

A main earth bar of copper shall be provided to run the length of each board so that all cable sheaths and armouring may be bonded to it. Where the fault level at the switchgear is 33kA or less the minimum size shall be 31.5mm x 6.3mm x 6.3mm.

Panel Preparation and Finishing

The whole preparation and paint system shall be suitable for the operating environment specified and a painting schedule giving details of preparatory treatments, types of paint, number of coats and method of application shall be submitted with the Tender. Proprietary items may be used in their standard finish subject to the approval of the Engineer.

The system proposed shall conform to the following minimum requirements.

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- After all machining and forming has been completed all steelwork surfaces shall be thoroughly cleaned of rust, welding slag or spatter and other contaminations prior to any painting.
 - Panels for indoor location shall, immediately after cleaning, have all surfaces protected by an approved zinc-based corrosion resistant primer, followed immediately by one intermediate and two finishing coats of paint to give a minimum total dry film thickness of 560 microns (0.002").
 - Panels for damp situations or outdoors shall have the surfaces grit blasted and zinc sprayed within 4 hours to BS 2569 Part 1 to a thickness of 125 microns (0.005") at the works. The final paint finish shall be one of two pack epoxy primer and two coats of epoxy paint to give a minimum total dry film thickness of 75 microns (0.003").
 - Steel fixings and fastenings shall be treated to prevent corrosion by hot dip galvanizing to BS 729 or sheradized to BS 4921 Class 1 before painting. Chromed fittings shall not be used.
 - Any damage occurring to any part of a painting scheme shall be made good to the same standard of corrosion protection and appearance as originally employed. Any finish coat applied on site shall be considered for decorative purposes only.

Paint Colours

The colours of the primer, intermediate and finishing coats of a paint system shall be easily distinguishable from each other and the materials used shall be suitable for the application employed and preferably be supplied by one manufacturer who shall ensure that all coatings are compatible.

Electrical control panels shall be gloss finished in the following final colours:

DETAILS	COLOUR	BS 4800 Ref:	BS 381C Ref:
Panel Exterior	as advised by the Engineer		
Interior Equipment	White	10 B 15	-
Trays	White	10 B 15	-
Bushbar Shutters	Signal Red	04 E 53	537
Circuit Shutters	Lemon Yellow	10 E 53	309

Labels

Each switchboard shall be provided with a title label and have circuit designation labels fixed to the front and rear cover of each circuit compartment. Rear covers for more than one sub-section shall have labels for each sub-section. In all cases, the label shall be positioned so as to leave no doubt as to which item it refers.

All indicators, instruments, relays, control switches, push-buttons, fuses and other ancillary apparatus shall be provided with labels clearly stating their function.

Character sizes for mains title and circuit designation labels shall be at least twice those for ancillary items.

All label inscriptions shall be to the front of the switchboards/control panels/starters shall be of transparent Perspex with radiussed or chamfered front edges, reverse engraved with white infill then sprayed on the rear to match the colour of the board. Other labels shall be sandwich type white/black/white, or yellow/black/yellow for Danger labels, or as approved by the Engineer.

All labels shall be fixed square to the equipment by means of screws or rivets of nylon or non-corrodible material. Labels affixed with adhesive will not be accepted.

Cabling Facilities

Cable boxes and glands shall be accommodated within cubicles except where otherwise approved and all removable access, sealing and gland plates are to be provided with gaskets to form an adequate seal against the external atmosphere.

Adequate space within each compartment shall be allowed for external cable tails to be connected without stress on the terminations, bearing in mind the type and size of such conductors. Where multi-cores in excess of 95mm² or any single core cables are to be terminated, a minimum distance of 450 mm free space shall be allowed between the gland plate and the terminal connection point.

In multi-tier compartments, individual terminal covers and gland plates shall be provided for each circuit such that additional circuits may be terminated safely whilst the switchboard is energized.

For paper insulated cables, a suitable cable end sealing box shall be provided for each circuit as specified. Where the cable enters from beneath the panel, the bottom of the wiping gland shall be at least 150 mm above the panel floor level. Removable split ends sealing plates are to be provided for subsequent fitting around such cables.

Undrilled removable gland plates shall be provided for cables requiring compression glands entering from beneath the panel. The plate shall be located at least 300 mm above the panel floor level and shall form part of a compartment constructed within the panel to seal the interior of the panel. Access for glanding-off shall be provided by removable covers fitted to the available vertical sides which may extend the full width of the panel as necessary.

Where single core cables are to be accommodated, a non-magnetic or slotted gland plate shall be provided.

Terminals, studs or drilled holes shall be provided to accommodate all necessary cable terminal lugs and, prior to manufacture, The Contractor shall confirm cabling termination requirements with the Engineer.

Panel Wiring

Panel wiring should be run neatly within the cubicle in suitable cable looms or panel trunking, and in the case of instrument, intrinsically safe or safety extra-low voltage circuits, run in separate groups accommodated within the cubicles. The looms or trunking shall be adequately secured without the use of adhesive material. Wiring carried across door hinges shall be neatly loomed and rolled in torsion in the plane of the hinges to minimize flexing of the wiring, thus wiring shall enter and leave at different levels as widely spaced as practicable. Bushings or grommets shall be used where wiring passes through sheet metal or plastic.

All components and auxiliaries in repetitive units shall be wired in an identical pattern to match the arrangement of each component.

Wiring cables shall be adequately rated, tinned copper stranded conductors or not less than 1.0mm² (32/0.2) PVC insulated 600V grade, except wiring to PLC or other light current equipment which shall be not less than 0.5mm² (16/0.20).

Wiring insulation shall be coloured as follows:

AC Circuits

Mains supply (LV)	- Black
Uninterruptible power supply (LV)	- White
ELV supplies (up to 50V AC)	- Yellow
Intrinsically safe circuits	- Blue

DC Circuits

Battery supply (ELV, not exceeding 120V DC) - Grey

Where various voltages exist within the above definitions, the colour coding shall be subject to agreement with the Engineer.

Each wire shall be terminated with suitable ring or spade crimps or bootlace ferrules and identified at both ends by means of white or resistor colour-coded ferrules imprinted to correspond with the diagram connections.

Wires linking common points in the circuit shall bear the same reference at each termination. Alternative identification methods require prior approval of the Engineer.

Terminals

All terminal blocks for the connection of small wiring shall comprise shrouded anti-tracking mouldings or melamine phenolic or comparable material with provision for securing conductors either by high tensile screws and clamps or be solder tag connection.

Terminal blocks shall be arranged so that both terminals and wiring ends are readily accessible and have separate terminals provided for incoming and outgoing wire, together with insulated barriers between adjacent connections and transparent insulated covers. Blocks accommodated on common mounting rails shall have a foot designed to ensure a secure fit to the rail. Foot springs shall be of stainless steel and have a locking device fitted to prevent accidental release of the block.

Each terminal shall be labeled to correspond with the diagram of connections and terminal identification labels shall be attached to the fixed portion of the terminal blocks only. Terminals for intrinsically safe circuits shall be clearly segregated and coloured blue.

Terminal which may be 'live' when the equipment is isolated from the main supply shall be adequately shielded from accidental contact and be clearly identified and inscribed accordingly.

Current Transformers

Each current transformer shall bear a label showing the ratio, class, short time factor and accuracy limit factor. The inscription must be reasonable when the transformers are installed within the gear without the necessity of dismantling any equipment other than removing cover panels.

Bar type current transformers shall be supplied in preference to those with wound primaries. Short time current factors shall relate to the full fault level specified. For over-current protection, the product of VA rated burden and rated accuracy limit factor shall be 150 unless otherwise agreed with the Engineer.

One secondary terminal of each current transformer shall be earthed at the switchgear.

Voltage Transformers

Voltage transformers shall be vacuum impregnated or encapsulated resin insulated type. Each transformer being fully isolatable and accessible for maintenance purposes and fitted with primary and secondary fuses.

Indicating Instruments

All indicating instruments shall be of a similar flush vertical mounting, rectangular pattern, enclosed in black coloured, dust and damp-proof cases, one side being not less than 90mm (3.5") long or as specified. Scaling shall be in approved metric units normally ranged from zero to 20% - 40% above the system designed operating value,

except where finite limits exist (e.g. p.f. indicators, synchroscopes) or where restricted ranges are specified. Instruments having a mechanical movement shall provide at least 90° scaled arc. 240° arc scales shall be employed on principal specified indicators.

Ammeters for motor circuits shall have an extended scale to cater for the starting current. These shall be adjustable red pointers or red markings on the scale to indicate the normal circuit current for the associated plant and shall be connected to each of the three phases of a three phase motor circuit.

Indication Lights

Indication lights shall be flush panel-mounted types with bodies fastened and keyed to that the lamps shall be capable of replacement from the front of the apparatus without disturbance to the lamp-holder or panel wiring. Lens colours shall be specified in the Specific Requirements. Bezels shall be coloured black.

All light sources shall be operated at Extra Low Voltage. Single units shall be dotted with MES caps and be illuminated by LED clusters where colours permit otherwise filament lamps shall be used.

To extend lamp life, filament lamps shall be arranged to operate approximately 20% below their rated voltage and details of voltage and type of indication lamp shall be submitted for the Engineer's approval. Particular consideration shall be given to circuits operated from a battery supply permanently floating across a charging circuit, where terminal voltage may be higher than the nominal voltage.

When annunciator style indicators are used they shall incorporate two lamps wired in parallel for each fascia which shall have a window area of not less than 48mm x 24mm. the engraved characters shall be not less than 3mm in height and shall be filled black on a translucent background coloured as specified.

Alternatively where specified (particular for unattended situations) self-contained LED annunciator display modules shall be used and configured for panel mounting. Legend plates shall be provided adjacent to each indicator. Where message display indicators are used, they shall have programmable legends and adjustable pulse rates.

Push Buttons

Push buttons shall be heavy duty, double break pattern with fully shrouded moulded buttons having a spring return action through a flexible oil-tight seal. Each button shall be coloured in relation to its function accordance with Appendix 2 or as otherwise specified herein and bezels shall be coloured black.

Emergency stop buttons shall be arranged to de-energise without delay the drive motors for the whole of the associated plant whatever control mode of operation may be selected. They shall be of the 'stay put' type having a large red mushroom head with twist-to-release manual reset, suitably labeled and have at least two poles, 1 N/O and 1 N/C with contacts suitable for the circuit operation.

Where key reset heads are required, the key shall be common for all buttons.

Control Relays

Control circuit relays for switching 5A/250V or less shall be of the multi-pin plug-in type having the following features:

- Neon or LED indication of relay energisation;
- mechanical ON/OFF indication;
- manual test button with provision for retention of the button in the operated condition for test purposes;
- legend plates on relays and base;
- relay retaining clip;
- be mounted on moulded bases having recessed screw terminals.

If sufficient contacts are not available in one relay, not more than two relays may be connected in parallel.

Any relay used to switch an external alarm circuit shall have a volt-free contact for the purpose.

Protection Relays

Electro-mechanical protection relays and associated devices shall be provided as specified, suitable flush mounting in dust proof cases; withdrawable types being provided where they are fitted in fixed panels.

Where not mounted on a battery sourced alarm monitoring display, the relays shall have hand-reset flag indicators unless a self reset or electrically-reset facility is specifically called for. Hand-set indicators shall be capable of being reset without opening the relay case. Flag indicator relays shall be de-energised once the flag has fallen.

Where two or more elements are included in each case, separate indicators shall be provided for each element.

Fuse Links and Holders

Suitable rated fuses shall be provided at all points necessary for circuit protection and isolation, separate fuses being provided for instruments, indication, alarm, heater and coil circuits. Fuse ratings shall be rationalized as far as possible to limit spares.

LV Fuses in circuits exceeding 50V shall, where practicable, be housed in all insulated carriers with fully shrouded bases of matching colour, which shall not be interchangeable with carrier and bases provided for removable solid links which shall be coloured white.

LV fuse links shall be HRC cartridge type to BS 88, Class Q1, having provision for screw fixings for attachment to the carrier.

Control and Instrument Fuses may be accommodated in moulded terminal blocks suitable for DIN rail mounting. Fuses rated up to 6.3A 250V shall be 20 x 5 mm (G type DIN 41660) having a hinged fuse carrier housing.

Fuses rated up to 13A 250V shall be 25 x 6.3 mm cartridge type to BS 1362, secured by a screw cap. The live connection being made to the lower terminal.

Locks and Keys

Lockable selector switches or panel doors in a multi-unit installation shall employ a common interchangeable operating key but keys for each function may be non-interchangeable, subject to the approval of the Engineer.

For each key pattern employed, three keys shall be provided; each having a permanently attached brass identification label, embossed with the following:

- key number
- location of lock/item of equipment reference.

Lose padlocks and keys for security locking switchgear, isolators, shutters etc. shall not be included but will be provided by the Client to suit their master key suite to permit locking. Hasps shall not have less than 9mm diameter holes suitable for 6mm diameter shackles.

Key Cabinets

Key cabinets shall be provided to accommodate, on suitably numbered/coloured, adjustable hook bars, one set of all the above keys and padlocks. The keys shall be fitted with corresponding number/colour coded tabs.

The cabinets shall be of stove enameled sheet material, suitable for surface wall mounting and be fitted with lockable hinged cover doors.

Insulating Mats

Black rubber matting shall be supplied complying with BS 921 and shall be supplied for all indoor control or switch gear panel. It shall extend the complete length of the control panel and the minimum width shall be one metre.

n) HV Breakers and Disconnectors

Circuit Breakers

For AC circuits, circuit breakers shall be triple pole of the vacuum interrupter, SF6 or air break type as specified, suitable for short circuit fault duty specified herein. Low voltage breakers shall incorporate a neutral link, unless in special cases a neutral pole is called for on the breaker under the specified requirements. Air or oil break circuit breakers shall be 'trip free' and the whole of the operating mechanism shall be suitable for such conditions of operation.

The whole equipment shall be robust and capable of withstanding repeated closing and opening impacts satisfactorily.

Each breaker shall be provided with the following:

- Mechanical 'Flag' indicator giving reliable indication that it is either "Off" (open) or "On" (closed);
- Means of isolation so that the breaker may be maintained with busbars alive;
- An operating handle that can be concealed when not required, ensuring a flush fronted appearance;
- An adequate number of auxiliary switches with the addition of one normally open and one normally closed spare switches, all to be wired to a terminal board of approved design in the fixed portion of the switchgear and arranged in the same sequence on all equipment;
- Protection relays and tripping devices as specified;
- Facilities for connection of appropriate auxiliary circuits when the circuit breaker is in the isolated position to permit operation of the breaker for test and indication purposes;
- Key operated interlocks between breakers as specified.

H V Disconnectors

HV disconnectors shall be triple pole, oil free switch-disconnectors rated for fault making/load breaking duty to IC 265, mounted on a non withdrawable chassis and enclosed in a metal clad enclosure in accordance with BS 5527 or equivalent.

The contact breaking mechanism shall incorporate expulsion quenching techniques to ensure positive arc extinction and high closing speeds to enable the switches to close onto existing short circuits without harming the equipment or the operator.

The switches shall be either manually or electrically closed and manually or electrically tripped as detailed in the Specification Requirements. All operations shall be effected with the panel door closed and include an ON/OFF indicator. Contact separation shall be clearly visible through a viewing window on the cover.

Safety Shutters

Where withdrawable circuit breaker units are used, the housing shall be arranged to accurately locate the movable portion prior to engagement and accommodate automatic safety shutters.

Each group of busbar and circuit spout orifices shall be fitted with an individual automatically operated safety shutter, the appropriate shutters being positively opened or closed when the circuit breaker is racked in or out.

When closed, the shutters shall effectively prevent any contact with either the busbar or circuit connections and seal the spouts against the ingress of dust. The shutters shall be painted in bold characters 'CIRCUITS' as appropriate, the busbar shutter being coloured red and the circuit shutter being coloured yellow (see Appendix 8).

For testing and inspection, each shutter shall be separately hand operated from the front of the unit and latched in the open position. Any movement of the circuit breakers either in or out of the housing shall automatically restore the automatic feature.

Provision shall be made for each shutter to be locked only in the closed position.

Non-withdrawable HV switchgear shall have a three phase test access point incorporated in the design such that cable tests may be carried out on each circuit. The test access point shall be fitted with a lockable cover and interlocked to prevent access to live circuits.

Provisions for Earthing

Provision shall be made for earthing the busbars and each circuit outlet through the circuit breaker, either integrally or by means of a portable device as specified; such an arrangement being suitable to withstand the full short circuit rating of the switchgear.

Where integral earthing facilities are included, selection of the locating mechanism shall prevent the breaker being engaged into any position other than that selected. Visual indication of such circuit breaker locations shall be clearly marked, e.g. "CIRCUIT EARTH", "BUSBAR EARTH", "SERVICE/ON" and "ISOLATED/OFF".

Facilities shall be provided so that padlocks can be fitted to prevent the selection of either "EARTH" positions.

Facilities shall be provided for padlocking the circuit breaker while it is closed on to an earth circuit to prevent unauthorized tripping electrically or mechanically.

The circuit breaker truck (or carriage) and oil tank if applicable, shall be effectively earthed when in the "SERVICE/ON" position.

HV switched shall have facilities for earthing the circuit by means of a selector at the ON, OFF and EARTH positions shall be visibly indicated, appropriately labeled and provided with locking facilities in each position. Inspection windows shall be provided so that the position and condition of the selector contacts and insulators can be observed.

Interlocks

Each circuit breaker unit shall be provided with mechanical interlocks to prevent incorrect operation or accidental contact with live metal, and to protect the equipment and operator from the dangers of mal-operation and designed to prevent the following where relevant:

The circuit breaker being closed unless it is in the fully-engaged or fully-withdrawn position.

The circuit breaker being engaged and plugged into the busbar and circuit spouts unless the tank is bolted to the top-plate.

The circuit breaker being engaged or withdrawn unless the main contacts are open.

The circuit breaker unit being withdrawn from or pushed into the unit housing unless the breaker is in fully-withdrawn position.

The circuit breaker being positioned in the unit in any position other than that indicated on the locator. Access to voltage transformers unless they are in the isolated position.

Handling Track

For each switch board and different type of breaker supplied, on purpose designed, manually operated lifting and handling track shall be provided to enable safe removal of a circuit breaker from its compartment.

Switch Oil

The first change of switch oil shall be provided for each oil circuit breaker or switch. An oil level indicator shall be provided on each tank with maximum and minimum limits marked.

o) LV Distribution Switchgear

Switches

Switches shall be of the air break pattern, enclosed zinc sprayed heavy duty, cast metal or sheet steel cases providing enclosure protection to at least IP55 unless otherwise specified, suitable for industrial surface mounting or flush cubicle mounting as specified.

They shall be rated in accordance with BS 5419 or equivalent and be fitted with solid or HRC fuse links as appropriate in each phase and a neutral line, all contained within the switch case, with the terminals accessible from the front of the switch. Phase barriers and contact shrouds shall be provided with an interlock to prevent withdrawal or access when the fuse switch is in the 'ON' position.

Each switch shall have a free handle control mechanism to prevent inching and damage to contacts, be fitted with 'ON' and 'OFF' position indicators and have provision for locking in the 'OFF' position. When padlocked in the 'OFF' position, interlocks shall prevent the unit door being opened.

The moving contacts of fuse switches shall be readily withdrawable as a complete unit for maintenance when the remainder of the board is live.

Distribution Fuseboards

Fuseboards shall be of the rust proofed, zinc sprayed, heavy gauge sheet steel, having a flush fronted door with concealed hinges and a resilient gasket, providing enclosure protection to at least IP 55 unless otherwise specified.

The interior shall be assembled from all-insulated shrouded fuse carriers and bases of the 380V pattern, fitted with phase dividing barriers and all live parts being fully shrouded, all in accordance with BS 5486 or equivalent.

Circuit identification charts shall be fitted to the inside of all fuseboard doors.

All fuse carriers shall be fitted with fuse-links rated to suit the circuit duty. Spare ways shall have fuse links of the same current rating as the carrier, unless different current ratings are called for under the specific requirements. The Contractor shall however confirm fuse ratings with the Engineer before fitting fuses to the carriers. Fuse-links shall be of the HRC cartridge type to BS 88, Class Q1, having screw fittings to the carriers.

Molded Case Circuit Breakers

Molded case circuit breakers shall be of the quick make, quick break, and trip-free type complying with BS 4752 and shall be complete with thermal/magnetic releases, except for those units serving as isolators only. Multiple breakers shall have a common trip bar and trip elements on each pole to ensure that any abnormal condition on any one pole will cause all poles to open simultaneously.

Visual indication of open, close trip conditions shall be provided. Facilities for padlocking in the 'OFF' position shall also be provided.

Miniature Circuit Breakers

Miniature circuit breakers shall be of the quick make, quick break, trip-free type complying with BS 3781 Part 1. Circuit breakers shall be complete with thermal/magnetic or magnetic/hydraulic releases.

Multiple breakers shall have a

common trip bar and trip elements for each pole to ensure that any abnormal condition on any one pole will cause all poles to open simultaneously.

Visual indication of open, close trip conditions shall be provided. Facilities for padlocking in the 'OFF' position shall also be provided.

MCB Distribution Boards

Miniature circuit breaker distribution boards shall be totally enclosed, metal clad, flush fronted units, with a hinged front door, all in accordance with BS 5486 Pt 12. The interior shall be assembled from all- insulated miniature circuit breakers with bolted connections and with switch dollies arranged for vertical operation. Phase dividing barriers shall be provided and all live parts shall be screened from the front. Circuit identification charts shall be fitted to the inside of all distribution boards.

Terminals

All terminal boards and terminal blocks shall provide a positive mechanical clamp type connection. Pinch screw type terminals shall not be used. Terminals for the connection of all external cabling shall be situated at least 100mm from their respective gland plate or further if the cable size requires a greater distance for dressing.

All main phase terminals shall be suitably marked to ensure correct phase identification.

Labels and Circuit Lists

All electrical equipment enclosures shall be clearly labeled to indicate the plant designation.

Individual items not subject to switchboard requirements shall have labels of non-corrodible, Traffolyte sandwich type white/black/white, or yellow/black/yellow for danger labels or as approved by the Engineer. They shall be fixed square to the equipment by means of screws or rivets of nylon or non- corrodible material. Labels affixed with adhesive will not be accepted.

Inscriptions on labels and circuit lists shall be in English and Arabic and be submitted for the approval of The Engineer. Abbreviation 'No.' shall not be used.

A list of circuits in approval form shall be supplied and fixed behind a "Perspex" sheet on the inside of the all distribution boards which are provided or rewired under this Contract.

Residual Current Circuit Breakers

The circuit breaker shall be arranged to isolate each live conductor simultaneously within 30ms if the residual leakage current through the device exceeds 30mA.

It shall be housed separately or incorporated into other composite enclosures, include provision for testing the tripping operation under earth leakage conditions by means of a built-in resistor and push button, and require manual resetting.

p) Motor Starters

General

Each starter shall contain all the necessary equipments to control the circuit load and isolate it from the supply in the event of a fault and shall be equipped to comply with the following general requirements unless otherwise specified under the relevant starter duties.

For starting LV Motors direct on line, the starter shall be rated for intermittent duty class 0.3 (up to 30 operating cycles/hour) and utilization category AC-3 in accordance with BS EN 60947, or as otherwise specified.

Unless otherwise specified for particular cases, pump starting shall be by autotransformer. Small motors may be direct-on-line or star-delta started as applicable.

The ratio of the starting intensity and the nominal intensity shall be inversely proportional to the power of the motor; the following values shall be used for determination of starting requirements:

For plant which is not supplied by a standby generator set:

$$\frac{I_s}{I_N} = 6 \quad \text{when the nominal current of the motor is between 15 and 40 A;} \\ \text{and if the starting current lasts less than 1 second;}$$

$I_s = 3$ when nominal current if the motor is between 40 and I_N 125 A;

$I_s = 2.5$ when the nominal current of the motor exceed 125 A. I_N

Where plant is supplied by a generating set, the above mentioned values are respectively the following: 4-2.5-2.

Unless stated otherwise, power factor correction shall be provided at all sites to give a power factor of not less than 0.9 lagging at duty point load. Except for smaller installations where the capacitors may be located within the starter sections(s), power factor correction capacitors shall be generally housed in their own separate section, complete with a switch fuse isolator. Panel sections that are fitted with capacitors shall have a prominent warning label in English and Arabic stating that the capacitors may remain charged.

Power factor correction circuitry shall be arranged such that the capacitors are not in circuit whenever the panel is being supplied from a standby generator.

Isolation

Each unit shall be housed in a separate compartment or enclosure and be completely isolated by means of an isolating switch interlocked with the door or cover to allow access only when the switch is open. The isolating switch shall be operated by means of an external handle and shall have provision for padlocking in the "OFF" position.

When in the "ON" position, interlocks shall prevent the unit door being opened. Any components still live after this switch has been opened shall be adequately shrouded and have warning labels attached thereto.

The switch shall be rated for making and breaking stalled motor current duty as specified in BS 5419. Off-load isolators shall be suitably interlocked to ensure that they do not make or break load currents and be provided with locking facilities in the "OFF" position.

Additional physical isolation by means of withdrawable units for ease of maintenance may be offered but is not a specific requirement. For such an arrangement the live poles shall be automatically shuttered when the unit is withdrawn and the shutters have provision for padlocking in the closed position.

Contactors

All contactors shall be of the air-break electromagnetically held-on type. All contact pieces shall be readily replaceable and the necessary auxiliary contacts for control, indication and alarm shall be mounted in accessible positions and arranged in the same sequence on each contactor.

Vacuum interrupters shall be used for high voltage circuits. They shall be solenoid operated and designed to fail-safe, so that in the event of failure of any part of the closing mechanism the contacts will open.

Protection

Each starter shall be provided with an adjustable motor over-load and single phase protection device suitable for the motor load and have adjustable trip and rest delays provided, together with manual resetting facilities. Ambient temperature compensation shall be provided where relevant. Other protection features shall be as specified relevant to the particular drive.

Protection devices shall be arranged to trip the load and initiate the fault indications as specified and accept normal switching of load.

Where starters are fed directly from busbars or other systems having a high prospective fault level, suitably rated fuses or other means shall be provided within the starter to limit the fault let through to a value within the rating of the starter components.

Protective overload devices shall be arranged to ensure that any such fault is cleared by such fuses and provide Type '2' co-ordinated protection to BS EN 60947.

Control Circuit

All control circuits shall operate at not more than 110V and be derived from a double wound, screen earthed isolation transformer with one side of the secondary winding connected to neutral/earth. The primary supply shall normally be from one phase to neutral if available.

Individual transformers shall be provided for each starter but sequence groups of starters having a common isolator shall use a common control transformer.

Fuses shall be provided on each primary and secondary supply and be clearly labeled and segregated. A link shall be fitted in the neutral/earth connection.

The control circuit in the main supply must be isolated before opening the cubicle door but provision shall be made to re-energise the control circuit when the main supply to the cubicle is isolated, so that the operation of the control gear may be inspected without de-energizing the motor. The necessary control circuit Normal/Test switch shall be mounted within the cubicle and so arranged that it is not possible to close the door with this switch in the 'Test' position.

Control and Monitoring

The method of control and operation shall be as called for under the specific requirements for the starter.

Control selector switches fitted to the front of starters shall have matching operating handles which are clearly shaped to show the selected position. Specified function switched shall have a key operated barrel locking device in the handle, or be key operated alone, with the key removable in each lockable position.

All fault conditions relevant to each mode of operation shall stop the drive and prevent it re-starting until the particular fault is cleared and individually reset; lock-out relays and a reset button being provided for any self-resetting devices such as excess torque switches etc.

Specified fault conditions shall be identified by separate indications on the starter. Volt-free contacts shall be provided and wired to terminals in each starter unit for remote signaling of all status indications specified. Minimum status indications shall be Auto Available/Un-available and Running/Fault.

Where the starter is to be remotely controlled by a remote terminal unit (RTU), interposing relays with 24 volt DC coils complete with back EMF suppression diodes shall be provided in each starter unit to facilitate remote control and watchdog capability (See Instrumentation and Control Specification).

"Hours-run" meters shall be of the non-resettable cyclometer type indicator having a flush fascia and driven by a synchronous motor controlled to show the hours (up to 99,999.9) run by the main motor. They shall incorporate visible indication of operation but need not necessarily be of the same bezel size as the instruments.

All starters of motors of 3 kW and above shall have ammeters, local 'running' indicator lamps being provided for loads less than 3 kW.

Heaters

Anti-condensation heater shall be fitted in each starter (and motor, where specified), fed from a separate fuse through the starter isolating switch and an auxiliary contact on the motor contactor, arranged so that the heaters are disconnected when the motor is running.

In multi-tiered starter panels, the heater shall be located at low level within each tier and fed from a clearly identified common distribution supply with local isolating links in each tier.

Star/Delta Starters

Star/Delta starters shall be of the closed transition "Wauchope" type, having starting resistors, mechanically and electrically interlocked Star and Delta contactors plus a timing relay in addition to DOL starter requirements, all rated for up to 10 starts per hour.

Protection

The thyristors shall be protected by high speed semi-conductor fuses and heat sink thermal cut-outs.

The device shall be shut down in the event of single phase loss or open circuited thyristors.

In the event of short circuited thyristors, the drive shall continue to run at full voltage by automatically transferring to an override condition.

Indicators

Alarm indicators shall be provided for each of the above faults.

An auxiliary relay shall be used to control the function of the main contractor.

Energy Saving Facility

For continuous running devices, an energy saving control shall be provided where the voltage applied to the motor is automatically matched to the actual power demand. The control shall be effective after run-up and a dwell time at full voltage has been allowed to enable the motor load to stabilize.

The device shall respond immediately to any sudden load changes to prevent a potential stall condition.

Frequency Converters

The motor speed control shall be a frequency converter of an approved type and manufacture, providing a variable frequency of adequate capacity to drive the specified motor over the specified speed range and suitably matched to the starting torque and the speed torque characteristics of the driven plant. (Details to be determined by the Contractor from the driven plant/motor manufacturer during the Contract).

The converter unit with the associated control electronics shall be housed in a steel, free standing, drip protected (IP21) panel, mounted in the position specified. The unit shall be suitably air-cooled by means of an integral fan and all the components within the unit shall be readily accessible for easy servicing and removal without disturbing other components. Chassis units shall be suitable for rack mounting.

The incoming supply shall be via an isolator interlocked with the panel door and have suitable fuse protection.

The drive unit shall be capable of operating with the motor disconnected for test purposes. A current limiting circuit shall be incorporated to give short circuit and over-current protection in the output circuit, and under-voltage detection shall be incorporated

to protect the drive against fan failure. A thermostat shall be fitted for protection against fan failure and overheating.

Harmonics

The unit shall be protected from any harmonic distortion or switching surges in the power supply system and incorporate contractors to automatically isolate the input and output and to protect the unit from component damage arising from a power supply interruption which shall, if necessary, include automatic shutdown. If the converter will not perform correctly when running from a specified standby generator an interlock shall be provided to prevent such operation.

To prevent disruption of the supply system, wave from (and dependent instrumentation), harmonic voltage and current distortion introduced into the mains supply by the drive unit shall be within the limits specified in Electricity Council Engineering Recommendation G5/3. The point of common coupling shall be regarded as the output connection of the first upstream transformer.

The supplier shall list with the offer the expected harmonics generated by the drive under running conditions (worst case).

Where an input filter is used to limit the harmonic currents, the design shall minimize the possibility of resonance with any power factor correction capacitors fitted.

The supplier shall include any shielding necessary in accordance with BS 800, to prevent any interference that may affect other surrounding instruments.

Monitoring and Control

The control of each of the variable drive unit shall normally be from a PLC outstation which will provide a start/stop facility and a 4-2mA speed control signal. Where the distance between the drive unit and PLC exceeds 20m, special care shall be taken to ensure radio frequency interference and distortion is kept to a minimum.

The following signals will be required from the drive unit and wired to clearly marked terminals:

- Common fault (motor overload, emergency stop operated etc.)
- Control status indicating Hand/Off/Auto
- Control 'on'
- Motor available
- Motor running
- RS 232 Serial Interface (where required by the specification).

The following items shall be included along with other control devices and instrumentation:

- Control potentiometer for speed setting on hand control, (scaled with liner graduations over the range and arrows indicating clockwise rotation to 'INCREASE SPEED' and anti-clockwise rotation to 'DECREASE SPEED');
- Output ammeter;
- Frequency/speed meter;
- Test and fault diagnostic card for circuit checking, having a front panel display and facility for serial link remote indication.
- Isolated inputs for 0-20/4-20mA auto control, stop/start, external reset, etc.
- Adjustments for ramp up/down, duration, frequency range, base/maximum speed, current limiting facility and economy made.

The following items shall be monitored for fault conditions:

- Phase failure;
- Earth fault;
- Over current;
- Over voltage;
- High temperature/fan failure;
- DC link fuse failure.

q) Rotating Electrical Machines

General

Machine type and starting or driving arrangements together with type of enclosure protection shall be as specified herein. Vertically mounted machines shall be fitted with a drip-proof top end cowl and those fitted with skirts shall have a skirt depth in excess of the shaft extension.

Each machine shall comply with the current BS 4999 and the relevant parts of BS 5000 and shall be designed to run at a high power factor and efficiency at the prescribed plant duty.

Rating

The output of each machine shall be a continuous maximum rating (Duty type S1) determined by the Tenderer in relation to the power requirements and the normal environmental conditions for the plant offered in accordance with this Specification.

The maximum temperature rise of any machine winding shall not exceed 90°C above a 40°C ambient when operating at the above rating. Where the insulation is rated up to 120°C only, the maximum plant loading shall not exceed 95% of the rated output of the machine.

Generators

Alternators shall be star connected machines producing a 3 phase 4 wire 50Hz supply at the specified rated voltage within a standard waveform deviation, when being driven at the rated speed and connected to the plant load specified herein.

Regulation

The generator automatic voltage regulation system for single set running shall be capable of maintaining the voltage for all loads between no load and rated load at rated power factor.

Due allowance shall be made for the current peaks associated with starting the motor loads connected to the alternator, and the regulation system shall be designed such that the transient voltage reduction following the load application does not exceed 15% of the rated voltage and shall be restored to within 97% of rated voltage in less than 1.5 seconds. The transient voltage rise when the rated load is thrown off shall not exceed 25%.

Where voltage regulation equipment is mounted on the alternators, the components shall be readily accessible and detachable for servicing, having terminations separate from the main terminals.

Excitation

The alternator shall be the brushless self-excitation type with rotating armature and verifier assembly mounted on the alternator shaft, electrically interconnected with field winding. Radio noise suppression shall be in accordance with BS 800 and the exciter field shall be safely discharged when the alternator is tripped.

Motors

Motors shall be suitable for operation from a 3 phase supply having the star point earthed and the phase sequence running R-Y-B anticlockwise. Motors rated less than 0.5kW may be arranged for single phase operation.

The torque available during starting of each motor shall be at least 10% in excess of the maximum required at any speed to satisfactorily start and accelerate the mechanical plant load under all service conditions.

Overspeed and Reverse Rotation

Each motor shall be capable of satisfactory performance during a period of 2 minutes whilst it is run at 1.2 times its rated speed and subsequently at normal speed continuously.

Where specified (to cater for backflow consequent upon delivery valve failure), pump motors shall be capable of reverse rotation up to these speeds without damage.

Electromagnetic Brakes

Where an electromagnetic brake is fitted to drive, the brake shall be continuously rated. It shall be suitable for direction connection across the associated motor terminals or for individual supply and interlinked control, depending on the method of operation and control specified herein.

The brake shall be arranged to fail-safe by holding on under spring return passage when the coil is de-energized and have provision for hand easing for maintenance purposes. All control circuits for brakes shall be arranged to fail-safe.

Coil and terminals shall be totally enclosed in a fully waterproof housing.

Power Factor Correction

Where specified, a power factor correction capacitor complying with BS 1650 and suitable for operation over the temperature range $-10^{\circ}\text{C}/+40^{\circ}\text{C}$ shall be supplied, connected, tested and commissioned to improve the overall power factor of each machine to not less than 0.9 when running at full load.

Each capacitor bank shall be fitted with HRC fuse protection enclosed within a sheet steel housing having a terminal box with separate bolted access over an external earthing terminal.

Means shall be provided for monitoring fuse failure visually. For HV applications, striker pin fuses shall be provided and arranged to operate a trip bar which shall initiate an alarm contact for remote indication.

Resistors shall be fitted to the capacitors and motor terminal boxes, inscribed as follows:

lii) **“WARNING - EQUIPMENT CONNECTED TO STORED ELECTRICAL CHARGE. ISOLATE AND EARTH ALL TERMINALS BEFORE HANDLING.”**

Submersible Pump Motor

The pump and its associated motor shall form a compact integral pumping unit suitable for installation within the area specified. The motor shall be of squirrel-cage construction suitable for starting method as called for in the particular specification, and rated for continuous submerged operation in water having a maximum temperature of 22°C . Where a sealed coolant motor is used, the coolant shall be distilled water.

The stator winding shall be insulated against heat and humidity to Class F and shall incorporate at least three thermal overload devices.

A length of butyl rubber insulated, CSP sheathed flexible cable shall be provided and connected to the motor. Unless otherwise specified, the cable length shall be at least 20 metres without joints. The cable cores shall be phase coloured and be suitable to carrying the motor full local current under the specified operating conditions. The cabling sealing gland shall be a water tight design and, where included within the pressurized pipework, shall be capable of withstanding a water pressure of 1.5 times the closed valve head generated by the pumping plant.

Terminal Boxes and Connections

Terminal boxes shall be provided, suitable for PVC/SWA/PVC cables for all external cabling connections.

All boxes shall be bonded to the main frame earth and the frame of each machine shall be provided with means of connecting an earth protective conductor.

Each machine rated 10kW or above shall have at the six ends of the stator winding extended to the terminal block with the necessary linking effected there, adequate clearance being provided between phase terminations to permit the use of cable sockets.

For high voltage machines the terminal assembly shall be capable of satisfactorily withstanding the full fault capacity specified herein for one second.

Heaters

Anti-condensation heaters shall be provided in all non-submersible machines as an integral part of the machines and wired with butyl rubber insulated tails to a terminal box adjacent to the main terminal box, the cover being clearly labeled 'Heater Supply – 220V'.

Heaters shall be of the embedded element type having a low surface temperature and be impervious to moisture. They shall be arranged to operate on a 220V supply from the associated control unit when the motor winding is de-energised.

Maintenance Facilities

Machines rated over 50kW shall have lifting ears or eyes forming part of the main frame of the machine lifting and pulling facilities with a single tapped hole in accordance with the tables given in BS 4999 (Part 10). Depth of tapped hole shall be 1.5 times the diameter.

Bearings

Bearings shall be of the heavy duty ball or roller type greased for life enclosed in a substantial housing designed so that lubricant cannot escape on to the windings and fitted with adequate seals to prevent contamination or escape of lubricant down the rotor shafts. Means of lubrication shall be made available from outside the machine carcase of enclosure. The shaft shall be suitably located to prevent the rotor from moving out of magnetic centre while starting or running.

The rotor of any vertical spindle machine shall be provided with a suitable thrust bearing to support the weight of the rotor and its half coupling only.

Slip Rings

All machines which incorporate slip rings shall be so designed that the slip rings and associated slip ring mountings shall form a single unit which can be readily detached from the shaft for repairs and replacements. The slip rings shall be continuously rated and of the totally enclosed type.

r) Cabling and Wiring

Electrical Installation

The electrical installation shall comply with the current edition of the Regulations for Electrical Installations published by the Institution of Electrical Engineers (IEE Wiring Regulations) and the requirements specified herein where these differ from the IEE Wiring Regulations.

The installation shall be arranged in a neat and orderly manner which may involve running out of direct lines in order to conform to building outlines etc. and to utilize any holes provided for a cabling purposes in the structure. Unnecessary crossing of cables will not be accepted and due care should be given to this when selecting runs. Each cable shall be in one continuous length and no straight through joints will be permitted except as agreed with the Engineer.

It should be the entire responsibility of the Contractor to programme the whole of his work and co-operate with other contractors to ensure that the various parts of the electrical installation are executed at the proper stages of the construction, special care being taken with concealed work.

Care should be taken that sleeveings and sheathings of cables are not damaged during installation. Should any part be damaged, the damage shall be made good to the entire satisfaction of the Engineer. Cables shall only be installed when the ambient and cable temperature is above 0°C and has been for the previous 24 hours.

Cables shall, wherever possible, be arranged to enter equipment from below, particularly equipment located externally or in damp situations. Cables entering cubicles provided with sealed covers of timber or sheet steel shall be accommodated by drilling or dividing the covers with clearance holes as

necessary to allow the cable to pass through and be terminated at glands or gland plates provided within such cubicles, so that the cover when replaced, prevent entry of dust and vermin.

Protection of Exposed Cables

Where cables emerge through steel platforms or concrete floors, the Contractor shall provide and position protective curbing or sleeves made from galvanized material extending 75mm above finished floor level.

Sleeves shall be finished flush with the underside of the floor. Final details shall be agreed with the Engineer on site in respect of all situations.

Cables rising into or against floor mounted equipment shall be secured to the equipment in a neat manner to ensure that the cables are properly supported and that no undue strain is put on the cable termination or the plant. Where vibration or expansion is a consideration, adequate precautions and vibration loops shall be made at the appropriate position.

Where cables emerge in an area exposed to vehicular traffic and no overhanging projection exists up to one metre above ground level, a galvanized steel pipe or protection cover fabricated from 3.00mm (10SWG) galvanized mild steel (or heavier as appropriate) shall be provided and fixed to the associated structure for a minimum height of 1.5 metres above the local finished ground level.

Selection of Cable Runs

The routes and arrangement of all cables and the position of equipment and wiring points shall be marked out on site by the Contractor and agreed by the Engineer before any work is put in hand. Where cable routes have been agreed, the Contractor shall be entirely responsible for measuring the lengths of cable to be ordered and ensuring that the cables are supplied in the correct length.

Cutting away and Making Good

The Contractor shall be responsible making out the agreed positions of all chases, holes and fixings required for the passage of cables and conduit, and shall arrange with the Main Contractor for making good with a week mix of concrete.

The Contractor shall carry out all the necessary drilling for fixing up to 25mm diameter in the building fabric for the support and fixings of all items supplied or specified herein. Such work shall be carried out in a neat and workmanlike manner without unduly defacing concrete or brick surfaces. The use of stud fixings employing cartridge guns will not normally be permitted.

Where indicated on the Specification drawings, holes have been incorporated in the structures for the passage of cables and any additional cutting away and making good necessary to such structures will be done by the Main Contractor with the agreement of the Engineer.

Cable Materials

Cables shall be of approved design from a BASEC approved manufacturer having a certificate of Assessed Quality Management. They shall be manufactured within the 12 months prior to delivery and be delivered to site on cable drums or with protective wrappings.

The overall sheath of the cables shall be coloured as follows:

- | | |
|------------------------------|----------------|
| • High Voltage | - Red |
| • Low Voltage | - Black |
| • Earth continuity conductor | - Green/Yellow |
| • Instrument | - Grey |
| • Intrinsically safe | - Blue |

Cables shall be of the voltage grade, conductor size and type detailed in the specific requirements. General specification of the cable type to be used are detailed hereunder:

Paper insulated mains cables shall be stranded plain annealed copper conductors, insulated with helically wound paper tape, mass impregnated with non-draining insulating compound.

Multi-core cables shall be laid upon in a belted construction having a lead sheathing applied overall, protected by a steel wire armouring and having an extruded PVC sheathing overall (PLSW/PVC type).

Single core cables shall have a lead alloy sheath without armouring but with extruded PVC sheathing overall (PLY/PVC type).

Cross-linked polyethylene cables shall have stranded, copper conductors with cross-linked polyethylene insulation. Multi-core cables shall be laid up in an extruded bedding, steel wire armored and sheathed overall PVC, to BS 5467 (XLPE/SWAP/PVC type).

Single core cables shall have aluminum wire armour. Cables rated over 6350V shall incorporate graded semi-conducting tapes and core screens in accordance with IEC 502.

Low smoke and fume emission cables shall be as above except that the bedding and sheathing shall be of low smoke and fume emission material, all in accordance with BS 6724 (XLPE/SWA/LSF type).

PVC armored cables shall have stranded copper conductors with extruded PVC insulation, PVC sheathed, steel wire armored and sheathed overall with PVC (PVC/SWAP/PVC type). Cables shall be in accordance with BS 6346. Conductors of 1.5mm² and 2.5mm² shall have stranded conductors (7/0.50 and 7/0.67 respectively).

PVC insulated wiring cables shall be 450/750 volt grade single core stranded copper conductors PVC insulated to BS 6004 (PVC wiring type).

Mineral insulated cables conductors and sheaths shall be solid annealed high conductivity copper separated by highly compressed mineral insulating powder. The cable shall be sheathed overall with PVC.

Light duty rated up to 600V, heavy duty up to 1000V, all as BS 6207 (MICS/PVC type).

Telephone cables shall be thermoplastic insulated multipair cables having twisted pairs of copper conductors (telephone type).

Instrumentation cables shall be polyethylene insulated copper conductors with twisted individual pairs screened, polyethylene bedded, steel wire armored and PVC sheathed overall, all in accordance with BS 5308 Part 1 Type 2. Conductors shall be 0.5mm² stranded 16/0.2mm (PE/IS/SWA/PVC type).

Earth and bonding cables shall have stranded copper conductors PVC insulated and sheathed (PVC/PVC type).

Flexible cables shall have stranded, tinned, copper, flexible conductors, EP rubber insulated and CSP sheathed all in accordance with BS 6007 (flexible type).

Flame retardant cables shall be EP rubber insulated, tinned copper conductors in a CSP sheath, braided with galvanized steel wire (single cores having phosphorous bronze wire) and protected with a CSP sheath overall, generally in accordance with BS 6883.

The sheathing shall have heat and oil resisting characteristics to BS 6899 with an oxygen index value not less than 35 (HOFR type).

Compression Glands for Cables

All the glands shall be supplied by the Contractor and shall be of the brass compression pattern, so designed that any strain on the cable is taken by the steel wire armouring. The glands shall incorporate watertight seals on both inner and outer sheaths and have a separate armour clamping ring to ensure a good mechanical connection for the earth continuity path. The glands shall be secured with heavy duty locknuts and the whole assembly is to be protected by an overall plastic sleeve, suitably sealed to prevent atmospheric attack.

Glands fitted to unthreaded gland or adaptor plates, non-metallic equipment, or where specified for circuits likely to pass high fault currents, shall include brass earthing tag and connections arranged to effectively bond the gland body via a protective conductor to an effective earth point. Where instrument

cable screen terminations need to be isolated, insulated gland adaptors or non-metallic plates shall be used.

Glands and earthing tags shall be compatible with the gland plate and cable armouring materials to prevent electrolyte corrosion, e.g. brass for steel wire armouring described above, but shall be classified EX (d) in accordance with BS 5501 Pt 5 and be suitable for use with Apparatus Groups IIA and IIB.

Where cables to BS 6346, BS 6116 or BS 5467 having extruded or taped bedding are used for direct entry into such apparatus Groups, a sealing stopper box or compound sealed barrier gland shall be used in accordance with BS 5345 Part 3.

Termination of Glanded Cables

All cable compression glands shall be fitted by the Contractor, with the insulated conductors and sheathing being carried through the gland. The sheathing shall be preserved where required within the equipment and the insulated conductors properly connected to the terminals of the equipment concerned.

The armouring shall not be cut off short of the gland but shall be properly laid up and secured under the clamping ring provided. The gland shall be fitted finally with an overall PVC sealing sleeve.

All cable tails shall be of sufficient length to connect up to the equipment terminal boards, and in addition to making off the gland the Contractor shall strip, insulate, ring through and identify the individual cores, fit suitable termination lugs, ring or spade crimps or bootlace ferrules as appropriate, and fit numbered reference ferrules, lace the tails in a workmanlike manner and finally connect up.

All spare conductors within multi-core cables shall be terminated as shown on the connection diagram or be folded back with sufficient surplus to allow them to be connected if required in the future.

Wiring Ferrules

These shall be of durable materials suitable for permanently affixing to the cable cores and be of the interlocking slide-on type, such that the interpretation of the reference is unambiguous.

All control circuits consisting of more than two wires shall be identified by means of wiring ferrules attached to the individual cores at each end of the conductor where it is connected to any apparatus or junction box.

Unless otherwise specified, it shall be the responsibility of the cabling contractor to obtain interconnection terminal data and references from the equipment manufacturer to enable proper connections to be made.

Cable Cleats

Cleats for fixing cables to walls, structures, etc. shall be of the non-corrodible hook and clamp type made of high impact plastic or cast aluminum comprising two halves fixed by means of galvanized rawlbolts or on to galvanized backstraps where the number of cleats makes this more economic.

All assemblies to be complete with necessary galvanized bolt, nut and washers. The spacings of supports or cleats for cables shall in any case be not greater than shown in the following table but, where circumstances merit, closer spacing arrangements may be required by the Engineer.

The vertical spacings shall be applied to runs sloping up to 30° from the vertical. For greater deviations, the spacing for horizontal runs shall apply.

For outdoor and damp situations, fixing bolts or studs for cleats shall not be less than 13mm overall diameter unless otherwise agreed by the Engineer.

Cable Support Spacing (mm)

Cable Type	XLPE/SWA/PVC OR PVC/SWA/PVC with stranded copper conductors	
Overall dia (mm)	Horizontal	Vertical
Up to 15	350	450
15 – 20	400	550
21 – 40	450	600
41 – 60	700	90
Over 60	110	1300

Segregation of Duties and Services

Cable of different circuit categories shall be segregated as defined in the IEE Regulations. Instrument control cabling shall as far as possible be routed separate from electrical power cables and long parallel runs to them or pipework should be avoided. Where parallel routes and crossovers are necessary, a minimum separation of 250mm shall be maintained. Power cables shall not occupy the same ducts as instrument cables.

Similarly, separation between the three categories of instrument cables shall also be maintained as scheduled below:

Categories to BS 6739	Cat 1	Cat 2	Cat 3
CATEGORY 1 Instrument power & Control (over 50V, under 10A, AC or DC)	-----	200 mm	300 mm
CATEGORY 2 High level signals (5V to 50V DC)	200 mm	-----	300 mm
CATEGORY 3 Low level signals (Less than 5V DC)	300 mm	300mm	-----

Only conductors carrying signals of the same category shall be contained within any one multicore cable. Similarly, conductors forming part of intrinsically safe circuits shall be contained within multicore cables reserved solely for such circuits.

All screens for instrument cables shall be earthed at one point only, preferably at the main control centre.

Cables in Concrete Trenches

Where cables are run in concrete troughs or trenches, they shall be run on the floor of trenches less than 300 mm deep. In trenches deeper than 300 mm, cables shall be supported along the side of the trench on galvanized mild steel hangers, racking, cleats or on a suitable tray run supported from the side of the trench, whichever is specified. The spacing cleats or hangers shall be as specified under 'Cable Cleats'.

Where use is made of existing trenches with existing cables installed, it may be necessary to reposition certain existing cables so that the new cables can be laid in a proper manner and the whole of the cables (new and old) left in an arrangement which is tidy and fulfils engineering requirements. Such repositioning work shall be carried out to the directions of the Engineer.

Galvanizing Fastenings

Where manufactured or purpose-made steelwork, ladder, racking tray supports and all fixings nuts, bolts and washers are specified as galvanized, this shall mean hot dipped galvanized finish to BS 729 as far as practicable. Bolts and nuts shall be in matched condition.

Fixings screws for boxes, saddles, clips and other accessories shall be of brass or other non-corrodible type e.g. cadmium plated steel.

Racking

Cable racks shall be robustly constructed of mild steel, not less than 2.5 mm (12 SWG) in thickness and galvanized after manufacture. Where cleats are not used, the rack shall be provided with a toe at the outer end. Racks of proprietary construction may be used subject to approval.

Main rack supports, where fixed to brickwork or concrete, shall be secured with bolts of not less than 13mm diameter. The fixing bolts shall be of the self-securing type with expanding sockets and shall not require grout to hold them in position.

Where fixed to walls in places subject to dampness and in cable subways, the racks shall be set off from the walls by 35mm x 18mm thick galvanized packers placed at the bolt fixing positions.

In cable basements, the lower tier of any row of racks etc. shall be not less than 100mm above finished floor level.

Cable Ladders

Cable ladder shall be heavy duty type, fabricated from mild steel not less than 2mm thick and galvanized after manufacture. The side rails shall be at least 120mm deep with rungs set towards one edge, spaced at regular intervals of approximately 300mm and having elongated slots to accommodate the cable fixings.

Lengths of ladder shall be coupled and changes in direction, level and width shall be achieved by means of standard accessories designed for the system, such as radiused risers and gusseted intersections. Cable tray shall be accommodated on the ladder system for cables less than 15mm overall diameter.

Cable Channels

Cables requiring mechanical support across voids may be accompanied in not less than 40mm square galvanized channel sections fitted with plastic closure strips and suitable end caps in preference to tray, and subject to the Engineer's approval.

Cable Tray

Cable tray shall be heavy duty pattern formed from galvanized sheet steel, perforated with elongated holes for cable fastenings. The tray shall have side flanges not less than 25mm deep with returned edges and be galvanized after fabrication. Material gauge shall be 1.5mm (16 SWG) minimum, except that for tray widths less than 400mm the gauge may be reduced subject to the flange depth and the approval of the Engineer. Factory made tee sections and bends shall be used where possible.

The cutting trays shall be kept to a minimum but where unavoidable, all cut edges shall be rounded or folded over and protected with zinc rich cold galvanizing paint, holes for cable shall be bushed with nylon/PVC strip edging material. Mushroom headed bolts and nuts shall be used to join sections of tray and accessories and arranged not to present any obstruction on the tray. Capacity amounting to 25% usable tray area shall be left spare.

Where specified herein for damp or corrosive conditions, the trays shall be of un-plasticized PVC with non-corrodible nuts and bolts.

Cables on Tray or Ladder

Cables shall be laid flat and straight, properly dressed into position and fastened by cable ties or straps of metal reinforced PVCC strip material, secured at intervals not greater than 1m for horizontal and vertical runs. Where the runs is horizontal but arranged in the vertical plane, support spacing shall be as specified under 'Cable Cleats'. Care shall be taken to space the cables to allow adequate cooling. Not more than seven cables shall be embraced by one group tie and not more than two layers of cables shall be run on one tray.

Cables in Ducts

Before drawing any cables in ducts, the Contractor shall ensure that they are clean and free from obstructions.

Adequately spaced temporary supports and cable rollers shall be provided for the drawing in of cables such that abnormal strains and damage to the cable is prevented; approved lubricants shall be used as necessary. Cable stockings shall be used for general drawing work, core pulling eyes being specially fitted for heavy hauls.

Stresses shall not exceed 10MN/m² (1500 lb/sq in) on the lead sheath and 70MN/m² (10,000 lb/sq in) on the core.

Maximum pulling tension shall not exceed 20 kN (4500 lb).

Duct Seals and Cable Transits

After the cables are drawing, the Contractor shall seal the ends of all ducts, pipes or trenches leading into buildings, passing through walls or floors within buildings or underground chambers containing equipment for cabling associated with this Contract, whether occupied or not.

All cables, conduits or pipes shall be sealed into the ducts by means of a secure and effective water, gas, vermin and fire-proof material which will accommodate settlement and vibration. This may be a self-supporting non-settling mastic packed into the annuls to a depth at least equal to the sleeve diameter, or approved multicable transit units with appropriate fillers and insert blocks. All steelwork on such transit assemblies and frames shall be hot dip galvanized.

Where shown in the Specification drawings, transit frames will be incorporated in the construction by the Civil works contractor.

Cable Laid in Ground

Where cables are laid direct in the ground, they shall be well bedded in fine soil or sand and shall be covered with protective tiles. A minimum of 60mm thickness of fine soil or sand shall be supplied around the cables. All cables running along any one portion of route shall be laid at the same time and no extra payment will be made do re-excavation should any cable be overlooked at the time of laying. The Contractor shall be responsible for all excavation, for the supply of fine soil or sand for bedding, and for the backfilling and reinstatement of cable trenches along previously agreed runs. Trenches shall not be backfilled until the installed cables have been inspected by the Engineer.

Clearance and Coverage for Buried Services

Trenches shall be excavated or ducts laid at such depth that where cables are laid in the ground the minimum coverage to the top of the duct of the cable shall comply with the following:

Minimum Coverage

Type of Service	Vehicular Roadways	Open Ground Footpaths
HV	1000mm	750mm
Others	750mm	500mm

Where possible, electric cables and their ducts shall be routed so that subsequent excavation to expose another service will not disturb cables and electrical ducts. Where separated routes are not practicable then the following clearance shall be ensured:

Minimum Clearances

Type of	To HC	To LV	To Other	To Gas/Water etc.
Cable	Cable	Cable	Cable	Pipes
HV	150mm	300mm	300mm	300mm
LV	300mm	150mm	240mm	300mm
Others	300mm	250mm	150mm	300mm

The spacing of cables installed at the same time shall be generally in accordance with the above table, but where circumstances permit a more economical arrangement may be specified by the Engineer.

As far as possible electric cables shall avoid the same route as other services except where otherwise directed. Where such segregation is not possible then 50mm thick concrete slabs may be used as separators with the Engineer's approval. Adequate slack shall be left at each bend for cables laid direct.

Protective Cover Tiles

These shall be of the concrete apex pattern engraved 'Danger – Electricity' or similar, of dimensions appropriate to protect the number of cables along a particular route.

Following the installation and compaction of the bedding soil or sand over the cable, covers shall be laid by the Contractor so that they overlap at approximately 30mm each side of the cable run. Where cables are displaced by no more than 300mm vertically, covers shall be installed only over the upper cable run.

Backfilling and Reinstatement

Reinstatement of soil following laying of cable shall be effected by backfilling in 100mm layers. Hand ramming shall be employed for the first two layers and power ramming for subsequent layers.

After hand ramming to a depth of 200mm, a yellow coloured plastic tape approximately 150mm wide with the words 'CAUTION CABLE BELOW' shall be provided and run over the centre of the route of each cable run by the Contractor.

Top soil is to be placed and the level of the finished reinstatement shall not protrude more than 50mm above normal ground level.

All surplus spoil is to be removed from the site and areas surrounding the excavation shall be restored to their original condition.

Where tarmac surfaces have been excavated, the final 200mm backfilling after allowing the settlement shall consist of 120mm of compacted, graded hardcore, followed by a 60mm concrete screed and a 20mm top dressing of tarmacadam.

Route Markers

These shall be of reinforced concrete with the words 'ELECTRIC CABLES' cast in one face. They shall either be of the flush block type approximately 300mm x 150mm or the pillar type approximately 600mm high erected with 300mm projecting above the ground, as directed by the Engineer.

As soon as site conditions allow, the location of each group of buried cables and every joint shall be accurately marked. Concrete marker posts or blocks shall be set at the origin, changes of direction, joints and otherwise at intervals of 20 metres or as directed by the Engineer.

Cable Identification

Identification labels of durable material shall be provided suitable for permanently affixing to the cable sheath by means of buckle type straps and shall carry the cable reference in PVC channel strip. The reference character sizes shall be not less than 4mm (5/32") high (Crtitchley Unilabel or similar).

Cable identification labels shall be fitted to each cable end below its respective gland, also where the cable passes through ducts or trenches and at each entry and exit to a room or building.

Trunking Materials

All trunking, bends, cover plates, tees, flanges, supports, fixings, etc. shall comprise an approved complete system capable of adaption and erection without size modification and with compatible manufactured bends and accessories being used as far as practicable. The trunking access covers shall comprise easily removable convenient sized lengths retained over the entire length by clip-on features or suitable fastenings which shall not obstruct cable entries. Overlapping covers and internal flanges or coupling sleeves shall be provided at all trunking junctions. All cable supports, edges, sharp internal angles etc. shall be protected with PVC or formed to present a smooth edge.

Metal trunkings and fittings shall be zinc coated or galvanized mild steel not

less than 1.2mm thick (18 SWG). Copper earth bonding straps shall be fitted at the junction of adjacent lengths of trunking and fittings.

PVC trunkings and fittings shall be of high impact heavy duty rigid PVC.

Trunking Installation

As far as possible, trunking shall be installed clear of other services and positioned so that future access is not restricted. Drawings detailing supports, terminations, sizes and centre lines of trunking shall be submitted to the Engineer for approval prior to commencement of the installation. Provision for expansion of the trunking materials shall be made in accordance with the manufacturer's instructions. Trunking shall include fire barriers of fiberglass wadding fitted at each point where the run passes through fire walls and floor levels. All cable and conduit exits shall be fitted with bushes without decreasing the effective cross-sectional area of the trunking.

When connecting adjacent sections of trunking or when fixing trunking to a wall or supports, round or mushroom headed bolts or screws shall be used such that no sharp edges project into the inside surface. When installed in damp situations the trunking shall be spaced from the wall by means of short tube collars.

All trunking shall be protected against damp and corrosion and where entries, joints and/or bends have been installed, cut and/or sawn edges exist, all damaged galvanizing shall be made good by a minimum of two coats of aluminum paint of an approved quality. For extensively damaged galvanized coatings the items shall be re-galvanised or replaced with acceptable components.

Conduit shall be connected to the trunking by means of couplings and male bushes to obtain a good earth connection.

To assist identification within trunking, final circuit wiring shall be formed into groups held by buckle clips or PVC straps. Each group shall be labeled where wiring enters or leaves the trunking and at intervals of approximately 600mm centres to be used as cable supports.

Separate conductors comprising the same circuit shall be run enclosed together throughout their length.

Cables in Conduit

For wiring installations carried out with PVC insulated cables in conduit, the wiring throughout is to be on the "looping in" system and no "Tee" or other intermediate joint between fittings will be permitted, and in no case must the cable be drawn into the conduits until all such conduits, bends, boxes, or other fittings have been fixed permanently in position and approved by the Engineer.

Any water which may accumulate in the conduit during erection shall be removed before any cables are drawn in. Sufficient slack shall be allowed at each point to ensure that all conductors are under no physical strain or tightness.

Separate conductors of the same circuit shall always be drawn into one conduit, but cables forming final circuits shall always be drawn into one conduit, but cables forming final circuits connected to different distribution boards shall not be drawn into the same conduit or box.

The cables shall be coloured RED or BLACK as required to distinguish opposite poles, a BLACK conductor shall be used throughout for neutrals and connected to the neutral pole of the supply system.

No reduction of the strands forming the conductors will be allowed at switch or other terminals; all the strands shall be efficiently secured by screws, nuts and washers or other approved means and all conductors shall be so proportioned that the drop of potential does not exceed that indicated by the IEE Wiring Regulations.

After the Contract award a Table (in duplicate) showing the proposed arrangement of wiring circuits and the size of cables to be used shall be submitted to the Engineer for his approval before any work is put in hand.

Conduit Materials

i) Metal All conduits and fittings shall be Class 4, galvanized steel, heavy gauge welded and welded and screwed smooth bore tube employing threaded couplings and complying with BS 31 and BS 4568. As an exception, lengths of conduit completely encased in structural concrete may be finished with black enamel.

Conduit boxes shall be of malleable cast iron. For surface work the lid shall be of cast iron machined or ground to make good contact with the boxes. Adaptable boxes for surface work shall be of malleable iron.

ii) PVC All conduits and fittings shall be heavy duty gauge PVC in accordance with BS 4607.

iii) Flexible Flexible conduits shall be water proof metallic type PVC sheathed and adaptors to rigid conduit shall be of the internally rifled split brass type.

Flexible conduit shall only be used for bridging expansion joints in a building or for final connections from the rigid conduit system to the terminal boxes of equipment subject to vibration or adjustment. All such conduit shall have an earth continuity conductor connected through the flexible adaptor at each end. Individual lengths of flexible conduit should not exceed 400mm.

Conduit Installations

The conduit system shall be continuous throughout so that the cables are fully protected. No conduit smaller than 20mm shall be used. Provision shall be made for draining condensed moisture where directed by the Engineer.

The conduit throughout shall be of adequate capacity in accordance with IEE Wiring Regulations, and shall be arranged with draw-in boxes to allow for easy draw in or out of any one or all the cables in the conduit. For multiple parallel conduit runs, draw boxes may be combined by an appropriately sized adaptable box provided segregation of services is maintained.

Wherever possible conduits shall be installed either horizontally or vertically and changes in direction shall be effected by easy or well formed sets without altering the section or opening joints; solid or inspection tees shall not be installed.

The inside surfaces of the conduit ends and all fittings shall be smooth and free from burrs and all other defects.

For surface work the conduits shall be fixed by means of spacer and saddles or substantial distance saddles. Where conduits pass directly through concrete or similar floors and where washing down is likely to occur, the conduits shall be sleeved. The sleeve shall be grouted flush with the underside of the floor and extend 75mm above the top surface of the floor. Where conduits are run on steel work, they

shall be fixed by means of purpose-made clips. If the Contractor requires to drill any steel work, permission in writing must be obtained from the Engineer.

If exterior situations, all joint box lids etc. shall be made waterproof with compound or gaskets as appropriate.

Metal conduit installations shall be electrically continuous throughout, and at all terminations conduits shall either be screwed into approved spigot boxes or coupled by means of screwed couplings and smooth bore hexagon bushes. In no cases shall the length of the thread into which the conduit is screwed be less than the outside diameter of the conduit. Where tapped entries are provided and where internal space permits, a ring bush shall be used as a lock nut.

All exposed threads and damaged galvanizing shall be cleaned and thoroughly coated with zinc rich paint. If black enamel conduit has been approved for use, then where the black enamel is damaged the conduit shall be satisfactorily repainted to the approval of the Engineer.

Contact between conduit and gas pipes shall be prevented wherever possible by adequate spacing, or by means of insulating distance pieces. Where the conduit is or may be in contact with any other pipes or metal work and efficient metallic connection shall be made between the conduit and the pipes or metal work and the incoming gas, water and electricity services shall also be bonded together, all as required by the IEE Wiring Regulations.

PVC conduit installations shall have couplers and spouted fittings joined with a permanent solvent adhesive, and provision shall be made in surface conduit installations for expansion by using semi-permanent mastic jointing seal in expansion couplings as necessary.

Conduits shall be fixed by means of spacer bar saddles spaced as defined in the IEE Wiring Regulations.

These figures apply to surface runs at normal room temperature. Where high ambient temperature or rapid fluctuations are likely these spacings shall be reduced as agreed with the Engineer. Conduit shall also be secured 150mm either side of a bend.

The bending radius of PVC conduit shall be not less than 4 times the diameter of the conduit and bending shall be achieved by the use of the correct size bending spring.

If bending is to be carried out in temperatures below normal room temperature, frictional heat shall be applied to the conduit before bending commences.

Potentially Explosive Area conduit installation shall employ metal conduit and comply with the relevant Parts of BS 5345 for the specified zone classification; Ex(d) protection for Zone 1 and Ex(n) protection for Zone 2 Applications.

All screwed joints whether entering into switchgear, junction boxes or couplings, must be secured by a standard locknut to ensure a tight and vibration-proof joint which will not be slacken during the life of the installation and thus impair continuity and flameproofness. The length of thread in the conduit must be the same as the fitting plus sufficient for the locknut. Due to the exposed threads, the use of running joints is not permitted and specially designed flameproof unions shall be used for securing conduit to an internally screwed entry. All unwanted outlets shall be plugged with approved blanking plugs.

When a conduit passes from a hazardous to a safe area, the flame-proof section must be terminated by a stopper box or sealing device mounted in the safe area.

All conduits entering directly into a flame-proof enclosure where exposed terminals are fitted shall be sealed at the point of entry by means of stopper boxes which must be entirely filled with a non-oxidising compound. Conduit boxes or indirect entry compartments not containing exposed terminals do not require sealing.

Conduit stopper boxes of certified design must be used, having splayed, plugged filling spouts in the cover to facilitate the entire filling of the interior with compound.

Intrinsically Safe Conduits

Circuits complying with the requirements of BS 5345 for intrinsically safe circuits shall be arranged such that all cables are identified and segregated as detailed in BS 6739. Conductors forming part of an

intrinsically safe circuit shall only be contained within multicore cables reserved for such circuits and must be terminated separately.

Intrinsically safe circuits shall be connected to a separate earthing system as detailed in BS 6739 and any shunt diode barriers shall be installed in accordance with the certification requirements.

Mineral Insulated Cables

Cables shall be installed saddled to trays, run on the surface or as otherwise specified. The spacing saddles shall be in accordance with the IEE Regulations. Cable termination accessories and saddles shall be brass or copper and shall be supplied by a particular cable manufacturer. All cables shall have a temporary mastic seal applied during installation. Once cut to length, each cable shall be permanently terminated without delay by using an approved seal. Termination seals shall be anchored in approved glands and locked into screwed conduit entries or gland plates forming part of accessories or equipment.

Wherever possible, glands shall be locked in position with locknuts. Shrouds shall be fitted over glands except where they are encased in the structure of the building.

In cables where dampness may be present or where dissimilar metals are present, corrosion inhibiting paste shall be interposed in all voids between surfaces in contact.

Where MICS cable serves an inductive circuit liable to voltage surges or circuits subject to lightning surges, appropriate surge diverters shall be connected across the inductive sources (coil etc.) or between lines and earth at the point of entry in the case of lightning protection.

Sealing Boxes for Lead Sheathed Cables

For terminations at plant items, these will be provided by others except as specified herein and will be of cast iron, compound filling type, provided with filing plugs in the appropriate position for filling with compound when mounted on the associated equipment. Each will be complete with wiping cone armour clamp. For through joints or tee joints, the Contractor shall provide suitable boxes as detailed herein.

All necessary jointing materials, filling compounds and earthing requirements shall be included for all joints to be made under this Specification.

Lead Sheath Cable Terminations

The Contractor shall submit to the Engineer for approval the proposed method for terminating lead sheathed cables. Terminations must ensure that moisture cannot creep along the cores of the cable nor in between cores.

Where cable tails are to be brought out, cores shall be cut back below the level of the sealing compound and connected to the tails using a brass ferrule sweated to provide a solid damp and oil migration barrier between tail and core.

Paper insulated tails shall be double half lapped with an approved non-hygroscopic insulating tape. Alternatively for LV cables, instead of an approved tape, a length of temperature sensitive, PVC sleeving may be heat shrunk over the tail, joint and cores.

The continuity of armoured cables shall be maintained by an efficient bond between the cable armour and, the gland and the metalwork of the equipment at which the cable terminates, in order that a reliable path is provided for fault currents.

When the lead sheath has been wiped on to the cable gland, the steel armouring shall be brought over the wiped joint and clamped to the top of the gland to provide additional earth continuity and mechanical strength to the plumbed joint. The armour clamp shall sandwich a copper braid between the clamp and the armouring to ensure a bedded connection.

Compression gland shall be to an approved pattern provide adequate bonding and armour clamping facilities.

Cable cores shall be fitted with suitable termination lugs and be phase coloured as appropriate and marked with an approved label to correspond with the diagram of connections.

Glands exposed to weathering shall be totally wrapped in impregnated tape to exclude all moisture from the gland connection and have an outer wrapping of PVC tape.

Jointing

Personnel employed for jointing power cables including all types of terminations for aluminum conductors shall have received specialised training. Joints on all buried or stranded cables shall be sweated, but compression joints will be permitted for stranded copper or solid aluminum conductors at terminations only.

Joints shall be completed without pause of unnecessary delay. Reduction in the number of strand is not approved but limited reduction in the cross sectional area of solid conductors by an approved method is permitted. Cable cores shall be cut with due regard to fanned out terminations, leaving a neatly arranged minimum of slack core between cable and terminal. As far as practicable all HV joints shall be made to avoid crossed or twisted cores, final phasing out being arranged at the cable box termination.

Where crossed joint is approved, a sleeve at least 30% longer than standard shall be used to minimize the distortion of cores. The engineer shall witness the final termination in order that the Contractor may prove the phasing before the last joint in a cable run is made.

Cables shall be jointed colour to colour or number to number. Where numbered cores are to be jointed to existing coloured cores etc. the Engineer will direct the system to be used.

A reliable continuity path shall be provided for fault currents flowing via the lead sheath and/or armouring by means of an efficient earth bond between the cable armouring and sheath on each side of the joint.

Any semi-conducting screens incorporated in HV cables (e.g. XLPE rated at 6350/11,000V) are to be thoroughly removed before application of any stress control components supplied with the necessary cable jointing kits.

Sealing Compounds

The outer protection boxes for joints or termination shall be filled with compound of the hot or cold pouring variety of a type compatible with the cable materials to be agreed by the Engineer.

Compound which require heating shall be evenly heated, well stirred and the temperature maintained within the recommended pouring ranges. Cable accessories shall be thoroughly dried before filling and pre-warmed where possible.

Where cable sealing boxes are fitted beneath oil-filled compartments or where inverted cable sealing boxes are used due to cables entering from overhead, the compound shall be of the oil resisting type to prevent any risk of softening due to contamination from the insulating oil.

Cold pouring resin encapsulation materials shall be carefully mixed to avoid entrapped or uncured filler materials.

Single Core Cables

Circuits utilizing single core cables shall be installed under IEE 'Defined Conditions' but to minimize mutually induced voltages, three phase circuits shall be run for as long as possible throughout the route in close trefoil formation. Where a circuit employs more than one cable per phase, each trefoil group shall contain one cable of each phase, allowing at least 50mm clearance between adjacent groups. Cleat spacing shall not exceed 1.2 metres.

Ferrous screens or armour shall not be used on such cables and associated termination or enclosure must avoid the use of magnetic material which would provide a flux path in service.

To control induced voltages, single core cables shall have their metallic sheathing and/or aluminum armouring bonded together at both ends of the run, the bonding being connected directly to the system earth bar or other approved points. Cables having no insulating oversheath shall have their metallic sheaths or armouring bonded together by the use of normally spaced, well fitting, non-magnetic metallic trefoil cleats.

In all cases the bond shall be sized to carry the prospective fault current and have a conductivity not less than that of the cable sheath and/or armouring. Bonds for cables laid in a flat formation shall also allow for the unequal sheath currents.

To prevent circulating currents, bonding and earthing at the supply end only of short runs of single core cables will be permitted where it can be shown to the satisfaction of the Engineer that the induced voltages are safe under fault conditions.

Busducts

Connections between major electrical items shall (where specified) employ a fully integrated, totally enclosed, busduct system to BS 5486 (IEC 439-2), comprising HDHC copper conductors embedded in a non-flammable, self-extinguishing, case epoxy resin insulation.

The complete assembly including junctions shall be completely free of condensation and watertight to IP68. Fire resistance shall be Class M1 (F) and Class B1 (D) to IEC 332.

All parts of the system shall be from the same manufacturer and comprise factory made lengths, bends, tees and terminating pieces to suit the physical application and layout of the installation.

The voltage and prospective fault ratings of the system shall be suitable for the application and the current rating shall be based on the most onerous method of installation for the circuit. The cross sectional area of the conductors shall not be reduced throughout a given circuit.

The installation shall allow for any necessary expansion, be properly supported and connected in accordance with the manufacturer's instructions. Fire and damp-proof barriers shall be provided when passing through walls, floors/ceilings etc.

Conductors shall be jointed by means of double junction plates, one on each side to ensure low joint resistance. The junction shall be compressed by means of high tensile steel nuts and bolts. After assembly, all junctions shall be overcast with the same materials mixed under vacuum, as used for the busduct elements, thus maintaining a homogenous and weatherproof enclosure throughout.

Provision for conductor shifting, transfers and paralleling, shall be made within the terminal elements.

Earthing and Bonding

All non-current-carrying metal parts of the electrical installation and other services shall be properly bonded together and connected by means of a protective conductor to an efficient earth in accordance with IEE Wiring Regulations.

All connections shall be by means of an approved mechanical joint or adjustable clamp which shall be accessible and made secure with brass nuts and bolts. On no account shall plain or spring washers of ferrous metal be used.

Protective conductors shall provide earth continuity either through the conduit, armouring, lead sheathing, steel trunking or by independent earth tapes or PVC sheathed wires, according to the system of wiring employed.

Where PVC conduits or trunking systems are employed the protective conductor shall be routed within the conduit or trunking.

Wherever cable armouring is used as a protective conductor, care must be taken to ensure an adequate earth bond and additional bonds to the metalwork shall be provided as required.

Main Earth Connections

Where a main earth bar is to be installed it shall be connected in a ring with the earth bar provided on the switchgear and any existing main earth ring in the building. The glands and wire armour of cables shall be connected to the switchgear earth bar or directly to the earth ring.

The main earth bar shall be formed from high conductivity, hard drawn copper bar Grade C101 to BS 1433 of not less than 31.5mm x 6.3mm cross-section. Any joints in the earth bar are to be brazed

together using brazing alloy type CP1 to BS 1845 or pan head riveted and sweated. The bar overlap/thickness ratio shall be not less than 5.

The earth bar shall be secured to an inside wall in an accessible position. Connections to the metal work of electrical plant shall be made in soft drawn copper tape or equivalent sized cables. Where plant is subject to vibration, connections shall be made using flexible conductors. All earthing conductors and equipotential bonding cables shall

have a green and yellow PVC sheath, and earth bars shall have a green/yellow marker tape or sheathing applied.

Reinforced concrete or sheet steel piling shall be connected to the earthing system as directed by the Engineer. Structures of steel framed buildings shall be bonded to the main earth bars.

Earth rods are to be 16mm (5/8") diameter driven by an automatic hammer to a depth of approximately 4 metres. Spacing between rods is not to be less than the depth of the rod. Inspection pits shall be provided for each electrode to allow subsequent access for testing.

Where copper earth tape is buried below ground level it is to be served with PVC or double half lap wrapped with an approved grease-impregnated tape for a distance of at least 300mm above and below ground level.

The routing, dimensioning and arrangement of all main earth bars and connections shall be detailed on the schedules and drawings forming part of this Specification as called for in the specific requirements. Disconnecting links for testing purposes shall be provided as shown therein.

s) Civil Works for Cable Installations

General

The works involved are associated with the cable installation and comprise trenching, excavation, supply, laying and jointing of cable ducts; building of jointing and draw-in pits; application of bedding sand and soil; temporary reinstatement of ground. The installation of cables, supply and laying of cable covers and preparation of route record drawings will be carried out by the Contractor appointed to undertake the cable installation. Excavation, duct and cable laying and backfilling shall proceed in accordance with an agreed programme ensuring that all cables and ducts are satisfactorily covered immediately following laying and after approval from the Engineer.

Trenching Measurements

The depths and widths of individual trenches for cables or ducts and the clearances from other services shall be determined by reference to the clauses in this part. For contracts let with scheduled rates it will be assumed upon re-measuring that excavations have been in accordance with this specification unless the engineer has been sent an advice to the contrary.

Coverage for Buried Cables or Ducts

Trenches shall be excavated or ducts laid at such a depth that the minimum coverage to the top of the duct of the cable shall comply with the following:

Type of Services	Vehicular Roadways	Open Ground or Footpaths
HV	1000mm	750mm
Others	750mm	500mm

Clearance between other Services

Where possible electric cables and their ducts shall be routed such that subsequent excavation to expose another service will not disturb cables and electrical ducts.

Where separate routes are not practicable then the following clearances shall be ensured:

Type of Cable	To HV Cable	To LV Cable	To Other Cable	To Gas/Water etc. Pipes
HV	150mm	300mm	300mm	300mm
LV	300mm	150mm	250mm	300mm
Others	300mm	250mm	150mm	300mm

Where such spacings are not possible then 50mm thick concrete or stone slabs may be used as separators with the Engineer's approval. Each cable shall be at least 50mm clear of the side of the trench excavation.

Excavations and Precautions

Turf and topsoil shall be carefully removed and positioned where indicated on the drawings or as directed by the Engineer for subsequent reinstatement in their original position.

Broken land drains and damage to other services shall be reported to the Engineer and marked on site.

Excavations shall be kept free of water and properly shored up. Other services uncovered shall be adequately supported by slings or other means and protected.

Bedding for Cables

Prior to laying the bedding for the cable, the bottom of the trench shall be cleared of loose and projecting rubble etc. and evenly graded.

A sand bedding shall be applied below and around the cables and shall be thoroughly compacted. Thickness of bedding around the cable shall be 60mm except where soil contains coke, ash or other corrosive matter where the thickness shall be 200mm. Bedding shall be well graded sand, free of clay with minimum particle size of approximately 0.08mm (BS sieve No. 200) and maximum particle size of approximately 2 mm (BS sieve No.7). 60% of the material shall pass through BS sieve No. 72. Where the engineer directs, local soil may be used for bedding after passing through a 10mm mesh sieve provided the material is evenly graded.

Ducts and Couplings

Buried cable ducting shall be smooth bore uPVC pipe to BS 4660 (or medium density polyethylene, where greater flexibility is required) jointed by spigotted ends or couplings of compatible, non- deteriorating material. These couplings shall be a self-aligning, push fit and incorporate seals to prevent the ingress of water and other fluids as far as possible and the joint so formed shall be equal in internal diameter to the duct itself.

Ducts entering below ground level into a building or structure shall emerge inside the building either directly into an accessible trench or void, or the duct shall have an upturned bend to emerge adjacent to an inside wall face, or as otherwise specified. All exposed upturned duct ends shall project at least 75mm clear of the finished floor or ground level to prevent unwanted collection of water or debris and protect the cable exit.

Bedding of Ducts

Prior to laying ducts in trenches, the trench bottom shall be evenly graded, cleaned of loose rubble etc. and compacted to form a solid foundation. In rocky soil a layer of loose, rock free earth shall be used for this foundation.

Where ducts are laid beneath vehicular access roads, the ducts shall be haunched in C20 concrete for the full width of the road and extend each side beyond the curbside by at least 300mm.

Duct Alignment and Cleaning

Ducts shall be laid in a straight line as far as possible with minimum deviation. Where bends are required, these may be manufactured, pre-formed bends with a radius of not less than 10 times the bore

diameter. No continuous duct run shall incorporate more than two bends nor turn through a total of more than 135° in any plane. No single bend shall exceed 90°.

Where greater changes of direction are necessary, cable draw pits shall be incorporated in the run as required or defined by the Engineer.

A non-corrodible draw wire or rope shall be left in each duct and plugs shall be inserted at the ends of each section of duct to prevent entry of soil or stones. On completion of the ducts and prior to drawing in cables, a circular wire brush 6mm greater in diameter than the duct shall be pulled through each duct.

Cable Draw Pits

Cable draw pits shall be of brick enclosed construction fitted with suitable removable access covers and have bellmouthed duct entries into the pit interior. The interior dimensions shall be determined by the Engineer but shall be not less than 750 x 600mm in plan and the depth shall be determined by the invert of the lowest duct with a minimum of 50mm clearance to the base of the pit.

Where specified, a pulling eye for the use of 2000kg pulley block shall be provided opposite each group of ducts in the wall of the pits, and positioned to facilitate as straight

a pull as possible in the cables with the use of a pulley block. The base of the pit shall be formed with a fall towards a sump, suitably placed for pumping dry.

Backfilling and Reinstatement

Reinstatement of soil following laying of cable shall be effected by backfilling in 100mm layers. Hand ramming shall be employed for the first two layers and power ramming for subsequent layers. Backfilling shall only proceed in the presence of the Contractor responsible for laying cables.

After hand ramming to a depth of 200mm, a yellow coloured plastic tape approximately 150mm wide with the words 'CAUTION ELECTRIC CABLE BELOW' shall be provided and run over the centre of the route of each cable run.

Top soil is to be replaced and the level of the finished reinstatement shall not protrude more than 500mm above ground level. All surplus spoil is to be removed from the site, and areas surrounding the excavation shall be restored to their original condition. Where tarmac surfaces have been excavated, the final 200 mm backfilling after allowing the settlement shall consist of 120mm of compacted graded hardcore, followed by 60mm concrete screed and a 20mm top dressing of tarmac.

Cable Trenches

Trenches cast in floors of ground shall be of specified internal dimensions to suit the specific installation. They shall have smooth vertical sides and bottom with provision for cover plates to finish flush with the finished floor surface.

Inside bends shall be either radiussed (150mm min) or chamfered at least 100mm back, equally angled from each direction. Such radiussing or chamfers shall extend the full height of the trench, however the top 100mm may be corbelled out to simplify the cover plate arrangement.

Trench covers shall be of aluminum or galvanized mild steel chequer plate (min 8mm thick) supported to prevent undue flexing and having suitable holes to allow removal by standard lifting keys. Support shall be by means of steel curbing rebates cast into the trench top edges, providing a landing width of at least 300mm.

Additional or alternative support for switchboards etc. shall be from at least a 75 x 35 mm channel section cross bearers and transverse trimmers, fixed or cast into the floor and located to suit equipment fixings, access requirements and floor cover spans.

To prevent differential deflection, butt straps shall be fitted to the underside of floor plates which have no other support.

Edging curbs suitable for mild steel chequer plate shall be painted in red oxide primer, the curbing may be tapped to accept cover securing screws. Where aluminum plates are used in contact with any mild steel supports, a bitumen coating on the points of contact shall be used.

Cable Troughs

Pre-cast concrete trough sections shall be laid either flush or upon the finished ground level as specified.

The sections shall be sized and provided with rebated covers to suit the span and any imposed load conditions specified, e.g. at road crossings. Provision shall be allowed for handling/removal of such covers. Pre-formed junctions and turn-outs shall be provided with suitable chamfers inside bends.

Transformer Bays

The dimensions and weight of the transformers are specified herein in order that access clearances and loadings may be determined. The transformer bases shall be located at ground level, accessible from a made up road or hard standing to the bays.

Each transformer bay shall be separately enclosed to prevent unauthorized access and be portioned by plain brick blast walls up to a height of 2.2m, with one side being fitted with full width, lockable open- mesh gates or louvred doors for access and ventilation. Where roof covering is necessary, it shall be of non-flammable construction and allow 800mm clearance at least for natural ventilation of the transformer.

The bay shall be sized at least 1.5m greater than the transformer width (across terminal boxes) and at least 1.0m greater than the transformer depth. A level concrete mounting ramp shall be located within the bay area suitable for rolling the transformer into position, and a pulling eye shall be fitted centrally in the rear wall at the ground level.

Provision shall be made for the oil to be conducted to underground drainage tanks having access for pumping out, separate tanks being provided for each transformer.

Cable ducts shall be arranged to suit the cable routes and have up-turned spouts projecting clear of the designed oil/pebble level for the bund.

Alternatively, the area surrounding the plinth within the bay, and enclosed after the transformer installation by a low bund wall if required, shall be excavated sufficient to accommodate 10% in excess of the transformer oil capacity when filled with fire quenching 50mm graded pebbles having 30% voids. Provision shall be made for drainage if accumulated rainwater.

For silicon cooled transformers of sealed construction, quenching pebbles will not be required, but an oil catchment area shall be provided where specified.

Earthing Connections

Two earthing connection tab shall be welded to the concrete reinforcing bars in the positions shown on the specification drawings and be incorporated in the concrete encased, reinforcing steel network of the building foundations. The network shall be not less than 30m in length, buried at least 1m below ground level. The total length may comprise more than one bar, welded together to form the required minimum length.

Each earthing tab shall be of hot dip galvanized flat bar steel 50mm wide x 6mm thick, attached by welding to at least two parallel reinforcing bars (9mm diameter minimum) and of sufficient length to project beyond the finished concrete surface by at least 100mm in an accessible position.

The welding shall be of good mechanical strength over the full 50mm tab width and shall be located within an area of the rebar not required to provide structural strength, such as a trimmer or surplus length of the bar.

The reinforcing steel of existing buildings may be used to provide the electrode for a new installation or to replace a damaged or deficient conventional earthing system. A substantial rebar of a main beam or column shall be exposed by chipping away its concrete cover. The earthing terminal plate shall be welded to the rebar and the removed concrete replaced by mortar.

t) Electric Actuators

General

Electric actuators shall be suitable for outside installation and all components shall be housed in waterproof enclosures to IP67 or better, which shall incorporate an anti-condensation heater.

The whole actuator shall be of easily maintained, robust construction and shall be sized to guarantee the penstock or valve opening or closing at the maximum differential pressure specified herein. The operating speed shall be approximately 300mm/minute unless otherwise specified.

All actuator component items shall be coupled via flanged mating faces secured by stainless steel bolts, except valve mounting fixings subject to thrust forces which shall be by means of suitably sized, high tensile steel bolts.

The gearbox shall be of the wormgear totally enclosed, oil bath lubricated type, having a cast iron enclosure suitable for operating at any angle and provided with the appropriate filling and drain plugs. The actuator drive bushing shall be easily detachable for machining to suit the valve stem or gearbox input shaft and the length of the drive nut shall be less than 1.25 x the spindle diameter.

The drive shall incorporate a lost motion feature to provide the additional torque required to unseat the valve from the 'Open' or 'Closed' position in the event of the valve being in either position for an extended period. This movement shall give a hammer blow of sufficient force to free the valve.

The output shaft shall be hollow to accept a rising spindle where appropriate, and incorporate thrust bearings of the ball or roller type. The design shall preferably permit the gear case to be opened for inspection without releasing the spindle thrust or taking the penstock/valve out of service.

Motors

All motors fitted to actuators shall be specially designed for the application and of the squirrel cage induction type for operation from the supply system specified.

The rated output of the motors shall be determined by the tenderer in relation to the requirement of the mechanical plant described elsewhere in this specification, and starting torque shall be at least 10% in excess of maximum service requirements.

The motors shall preferably be 4 pole 1440 revs/minute machines designed with adequate thermal capacity to ensure that the actuator and starter can adequately perform, without overheating, the number of successive opening and closing operations called for in the specific requirements, and in no case shall this number be less than three.

Each motor shall be fitted with a thermostat or thermistor arranged to stop the motor in the event of dangerously high temperature in the motor windings due to overcurrent or an abnormally high number of starts per hour.

Manual Operation Interlock

The actuator shall have a handwheel for manual operation which will be at standstill during motor operation. A lever shall be provided for engaging the handwheel drive, and this shall be interlocked so that when starting the motor the handwheel is automatically uncoupled without danger to the operator. Provision shall be made for the lever to be padlocked in either position to prevent hand or motor operation as required.

Position Monitoring

A mechanical position indicator, showing the open, closed or intermediate positions of the valve on a visible dial, shall be incorporated in the actuator housing. Alternatively, where specified, a continuous position indicator shall be provided.

Remote position indicators, where specified, shall be controlled from a suitable potentiometric drive arranged to provide a continuous proportional signal from 'Open' to 'Closed' positions.

Position Control

Where specified for control purposes, a current position transmitter shall be provided to give a positive 4- 20mA signal proportional to the valve position, and shall incorporate zero and span adjustments to suit the actual valve travel.

Torque and Limit Switches

All switches shall be accommodated within the actuator housing and all contacts and mechanism shall be of sealed, rustproof and robust construction and have a self-cleaning wiping action.

Adjustable torque limiting devices and switches shall be provided to trip the starter in the event of mechanism overload due to obstructions or jamming etc. They shall be mechanically latched to prevent torque tripping during unseating.

Limit switches shall be arranged to trip the starters when the 'fully open' or 'fully closed' positions are reached. Should the manufacturer consider it desirable (to ensure proper seating) the travel may be stopped in the 'fully closed' position by the torque limit switches, but in this case the 'fully closed' limit switches shall still be provided, although they will be adjusted to be inoperative.

Auxiliary Switches

Auxiliary changeover switches shall be provided to operate at each end of the travel, in order that they may be used for remote controls or indications monitoring the 'Open' and 'Closed' positions.

Terminal Facilities

All electrical components shall be wired out to terminal blocks in a common terminal chamber incorporated in the actuator housing but separated from all actuator components by means of a watertight seal.

Each terminal shall be labeled to correspond with the diagram of connections and shall be capable of accommodating not less than 2.5mm² copper conductors. AC and DC terminals shall be clearly segregated.

Terminal blocks shall comprise shrouded anti-tracking mouldings of melamine phenolic or comparable material with provision for securing conductors by screw clamp connectors or other vibration-proof devices.

The terminal chamber shall be provided with three tapped conduit entries, 1 x 32mm and 2 x 25mm ET or as otherwise specified. These holes shall be plugged with suitable plugs during transit and storage to prevent ingress of moisture or foreign matter.

Any conduit entries not used after cabling is completed shall be plugged with threaded aluminum blanks and the threaded joints made watertight by using suitable tape or jointing compound.

Starters and Control Gear

The actuator motor shall be controlled through integrally mounted electrically and mechanically interlocked contactors, rated for switching the motor direct on-line, adequate for the duty requirements and complete with all necessary auxiliary contacts for the functions specified herein.

The control circuit shall operate at 24V DC derived from a suitably rated transformer/rectifier with one side of the secondary winding connected to earth or as otherwise specified. Primary and secondary windings shall be protected by cartridge type fuses.

The method of control and operation shall be as called for under the specific requirements and the actuator shall be provided with any facilities called for therein to suit the method of control, whether this be automatic or by hand. Local controls integrally mounted on the actuator shall consist of push buttons for 'Open', 'Close' and "Stop" functions, together with a Remote/Off/Local selector, lockable in all positions. The "Stop" button shall be effective in both local and remote settings and operate directly on the contactor control circuit.

Facilities by means of volt-free contacts shall be provided for remotely monitoring:

-
- motor running
 - actuator is available for remote operation
 - actuator is opened and actuator closed.

Paint Finish

The finish colour shall be gloss, Crimson, Colour No 540 to BS 381C (or 04 D 45 to BS 4800).

Actuator Isolators

The switch shall have a slow make and break mechanism of the two position rotary pattern arranged to isolate the 3 phase supply and all other control circuit supplies to the actuator. The ratings and number of poles required for each duty shall be as detailed in the specific requirements, the isolator rating being based on the actuator average load current being switched normally off-load, but emergency on-load.

Each switch shall be incorporated in a heavy duty, hoseproof, cast aluminum enclosure to IP65, having external fixing lugs and adequate seals and drip shields on the operating shaft and cover. Austinlite rotary type EXO 190 or equal.

Switch positions shall be 90 apart, clearly and permanently inscribed or embossed as 'OFF' and 'ON' on the cover, and the switch handle shall incorporate provision for the switch to be padlocked in both the 'OFF' and 'ON' position. The 'OFF' position to be to the left of centre or vertical, the 'ON' position to the right or horizontal.

It shall be possible to remove the switch cover for access to the terminal without disturbing the switch or its mounting base. The enclosure shall be suitable for mounting on, or adjacent to, the penstock pedestal. If mounted on the penstock pedestal, cabling between the isolator and the actuator above may be arranged through conduit connections, suitable for disconnection should it be necessary to remove the actuator assembly complete.

(This item preferably to be provided by the contractor who is responsible for the cabling).

u) Miscellaneous Equipment

Warning Signs

'Automatic Plant' warning signs shall be provided and erected by the Contractor in the building or on the plant in a prominent position to be agreed.

The 500mm x 300mm x 0.7mm (22SWG) signs shall be located approximately 1.6m above the adjacent floor level to the sign centre.

The sign shall be off 22swg, vitreous enameled aluminum sheet or plastic, having black letters on a yellow background, (see Appendix 5) inscribed as follows:

liii) **CAUTION**

PLANT UNDER AUTOMATIC CONTROL

AND LAIBLE TO START WITHOUT WARNING

ISOLATE AT SOURCE BEFORE ATTEMPTING ANY

MAINTENANCE OF MECHANICAL AND ELECTRICAL PLANT

Equipment for Potentially Explosive Atmospheres

Equipment for use in potentially explosive atmospheres shall be selected and installed in accordance with BS 5345, subject to the temperature classification of the specified gas, vapour or liquid. Ex(d) and Ex(i) classified equipment shall be certified for Apparatus Groups IIA and IIB.

In such areas, aluminum and other light metal alloys shall only be used for enclosure of electrical apparatus and fittings where such enclosures conform to the material requirements of BS 5501 Part 1.

Aluminum and light metal alloy fans on motors may be used if adequately protected, or if plastic fans or cowls are used they shall be of anti-static material.

Where no British Standard is applicable, equipment to an equivalent European standard may be submitted, subject to the approval of the Engineer.

Field Mounted Equipment

Individual starters, fuse-switches, distribution boards and other equipment shall be housed in robust, heavy gauge, rustproofed, metal-clad enclosures having external fixing lugs except where otherwise specified.

Components, fittings and housings shall be as specified elsewhere in this specification.

Equipment housings shall be mounted such that the terminal and covers are readily and safely accessible and are not obstructed or affected by the adjustment or mounting arrangement.

Push button stations shall be single or composite units suitable for accommodating the required buttons in the above enclosures. Each button top shall be fitted with a durable protective flexible boot.

Junction boxes shall be equipped with rail-mounted, dead-through terminals adequately sized to accommodate the cables to be terminated. An earth connection facility shall be provided for each box.

Auxiliary switches shall be mechanically and electrically suitable for the duty and circuit operations specified herein and intended by the switch manufacturer. Roller-lever operated switches shall be of the snap action type.

Where employed for crane or gantry duty, spring failure within a limit switch shall not render it inoperative.

Handgear interlocks shall be fitted to any driven equipment which has provision for manual operation to ensure that it is not possible for drives to start with the handgear in position.

Heavy Duty Electrodes

Each electrode shall comprise a single element mounted in an insulating high impact phenolic moulding, impervious to corrosion and having separate fixings for the flange mounting base and for the cover.

The base shall have a 20mm screwed conduit entry and be suitable for accommodating the electrode length by means of a substantial clamping collar which shall also have a provision for terminating the cable conductor.

A sealing gasket shall be fitted between the base and cap and the whole head shall be sealed to prevent ingress of water after installation is completed.

The electrodes shall be formed of ¾" BSP galvanized steel tubes (approximately 27mm diameter) sealed at one end and cut to suit the specified length, cut ends being dipped or coated with galvanizing paint or similar. Where intermediate steady brackets are required or when otherwise specified, the electrodes shall be sheathed with an insulating material to within 150mm of the electrode tip.

Spacing between electrodes and to the adjacent wall shall be not less than 150mm.

Light Duty Electrodes

Each electrode shall be mounted in an insulating moulded body having a 20mm screwed conduit entry and a screwed cover such that the whole head may be sealed to prevent the ingress of water after installation is completed.

The electrodes shall be formed from not less than 6mm diameter stainless steel rod and should not exceed 1.5m in length for light duty applications. Spacing between electrodes and to the adjacent walls shall be not less than 100mm.

Electrode Circuits

All electrode circuits and components shall comply with BS 5345 and the BAASEEFA requirements for intrinsically safe system for Apparatus Groups IIA and IIB.

The system shall operate by the circulation of an AC current when the circuit is completed by the liquid coming into contact with the electrode, this current operating a

relay to initiate the events specified herein. The relay operation shall incorporate a five second time delay 'On' and 'Off' to allow for spurious initiation.

Intrinsically safe electrode circuits shall be completed by a separate return electrode for each circuit.

Electrode Mounting

The electrode heads shall be mounted on a suitable support bracket at a height well above the expected maximum water level as shown on the specification drawings.

Intermediate steady brackets shall be provided and fitted for every 2m of electrode length, insulated lengths of electrode being fitted where these are used.

Support Brackets and steady brackets shall be hot dipped galvanized to BS 729 or otherwise protected to prevent corrosion.

Emergency Lighting

Emergency lighting shall be provided to maintain sufficient illumination in accordance with BS 5266 for escape routes within the building during mains supply failures.

The luminaries shall comprise at least a single 8w fluorescent tube with a solid state changeover circuit and high efficiency, high frequency, inverter all contained within a die-cast aluminum bulkhead body, having a corrosion resistant, stove enamel finish. The diffuser shall be of unbreakable, opal polycarbonate material, secured by an oil and water proof sealing gasket to result in a laminate rated to IP65.

The luminaries shall be self-contained and shall incorporate a maintenance free, nickel cadmium battery, capable of preserving the light output for a period of at least 3 hours without mains supply, together with an automatic recharging circuit to restore the charge within 24 hours of total discharge. Each luminaire shall incorporate an indicator to show that the charger circuit is healthy and have a hinged gear tray and fused terminal blocks.

The luminaries shall be either of the following forms, as detailed in the Specific Requirements:

- maintained from, normally lit from the mains and automatically switched from mains to battery during mains failure;
- non-maintained form, energized automatically from the battery supply only when the mains fails and the associated local lighting circuit is switched on;
- sustained form, having two lamps, one of which is mains fed only, the other operating from the battery supply during mains failure.

LV Outlet Transformer

Isolating transformers shall be of air cooled, double wound construction in accordance with BS 3535, fitted with an earthed metallic screen between primary and secondary windings and suitable for operation from a 220V 50HZ single phase supply.

The secondary winding shall have a rated output of 100VA continuous (1500VA intermittent tool rating) at 110V and have a centre tapping connected to earth.

The transformer shall be enclosed in a wall mounted sheet steel or moulded casing with external fixings lugs and separate cabling connections. The secondary output shall be via fuses incorporated in the enclosures.

Water Heater

Single point water heaters shall be thermostatically controlled free outlet 'single point' heater suitable for wall mounting. The water inlet shall be 0.5" BSP fitted with a control tap and the outlet swivel spout shall have a reach of approximately 300mm. The heater shall have a capacity of approximately 1.5 gallons (7.0 litres) and an electrical loading of approximately 3kW.

Space Heater

Wall mounted single tier tubular heaters rated at 250 watts/metre and suitable for 220V operation shall be provided.

The heaters shall be mounted approximately 300mm above floor level in the positions indicated on the drawings. They shall be directly connected to heater circuits controlled by the room thermostat, the final connection to the heaters being made by means of flexible conduit and a protective conductor. The flexible conduit shall enter from below the heater.

Space Heater Thermostat

The thermostat shall be a surface mounting 14 Amp bi-metallic strip type, adjustable over the range 0- 30°C and lockable to prevent unauthorized adjustment of the setting.

The room thermostat shall be mounted approximately 2.0m above floor level in the position indicated.

Electric Trace Heating

Heating cables shall comprise a self-regulating, conductive polymer core or double heating elements within a waterproof outer PVC sheath having sealed ends with a cold lead at one end. The cable shall have a flat section to provide efficient heat transfer.

The cable shall be straight laced along the underside of pipes and secured with cable ties at 300mm spacing or be spiraled around the pipe and secured at each end.

All heating cable must be in intimate contact with the pipe and must not be overlapped on itself, additional ties being positioned on either side and close to all flange joints. To avoid mechanical or leakage damage, the cable shall be run over the sides of flanges at 90° to the invert on horizontal pipe runs.

After any thermal insulation has been fitted, wiring labels shall be fitted in prominent positions in the pipework to indicate the presence of trace heating.

Trace Heating Thermostat

A wall mounting, air sensing thermostat set at 5°C shall be provided and arranged to switch on the heater for frost protection. If non-self-regulating heating tapes are used and where lagging is applied, or on PVC pipework, a thermostat shall be located on the pipework and arranged to switch off the heater if the temperature exceeds 60°C.

Liquid filled sensing bulbs and capillary tube connections to the thermostat shall be of stainless steel with a stainless steel flexible sleeve fitted over the capillary tube for mechanical protection.

The air measuring thermostat shall be mounted on the outside wall, 600mm above ground level and adjacent to but not above the protected pipework.

Enclosure and terminal arrangements to be as specified for field mounted equipment.

Lightning Protection

The building shall be protected against lightning strikes by a system consisting of an air termination network, down conductors and a ground termination network. Ground Termination shall be achieved by installation of electrode rods (in pits) connected via tape tails to the bottom of the down-conductor.

The installation shall be complete with a binding connection taken from a down-conductor position to the building main earth terminal bar.

The protection system shall be designed and installed in accordance with BS 6551 by a specialist contractor; with horizontal conductors on the outside walls of the structure.

All metalwork on or around the structure shall be bonded to the lightning protection system. Where connection between dissimilar metals are made, precautions shall be taken to prevent corrosion.

The horizontal and down conductors shall be of 25mm x 3mm copper strip, fixed with leaded gunmetal clamps, secured by phosphor bronze screws or bolts. Each down conductor shall take the most direct route from the air termination network to the earth termination and be provided with a bolted test joint in a position accessible from the ground level.

Earth electrodes of 16mm² copper bonded, steel cored rods shall be driven into the ground as close as practicable to the structure at the end of each down conductor. The rods shall be installed in sections connected by screwed couplers and driven to a depth sufficient to achieve a resistance to earth such that the whole of the lightning protection system shall have a combined resistance to earth not greater than 3 Ω ohms. The screwed couplers shall be long length aluminum bronze material, counterbored to protect the threaded ends from damage and corrosion.

v) Mobile Plant Components

Crane Controls

The electrical controls shall be designed to prevent excessive acceleration, retardation, skidding and load swinging and all motions of the crane shall be arranged to be switched through the slower speed where provided.

The control circuits for the crane/hoist shall operate at not more than 110V and be derived from a double wound, screen earthed isolating transformer with one side of the secondary winding connected to neutral/earth. The primary supply shall normally be from the phase conductors.

Fuses shall be provided on each primary and secondary supply and be clearly labeled and segregated. A link shall be fitted in the neutral/earth connection.

Pendant Controls

A heavy duty, industrial pattern pendant push-button control station shall be provided, having sets on non-maintained push-buttons for each hoist speed and function specified.

Each set of buttons shall be electrically and mechanically interlocked so that conflicting operations are prevented and only one function can be initiated at one time. The push-button enclosure shall be of a tough neoprene rubber suitable for withstanding arduous duty and provide full electrical safety, each button being suitably labeled with its function.

The pendant shall be divorced from the crab and capable of independent cross travel. It shall be suitable for vertical adjustment for operation from alternative levels by means of spring loaded reeling drum fitted with a ratchet device or motor driven reeling drum and have a cable guide runner to assist re-coiling.

Pendant control cables shall be designed for reeling drum application and have stranded copper flexible conductors, ERP insulated 300/500V, multicores laid-up with an internal central textile strain carrier and heavy duty, textile braid reinforced, PCP sheath.

For non-reeling applications, the outer sheath may be flexible PVC, incorporating externally laid, galvanized steel, nylon coated strainer wires.

w) Enclosures

Definitions

The generic term enclosures shall be taken to mean any housing which encloses overall any items of plant or equipment. To distinguish between the different forms of enclosure, the following definitions shall be used.

- Cabinets will be regarded as any wall or pedestal mounted thermally controlled enclosure.
- Kiosks shall mean any floor standing, thermally controlled, overall enclosure which may incorporate either an integral base or use the ground or floor slab as the base of the enclosure. The Kiosks shall be sized to permit man access for servicing the equipment within.
- Shelters shall mean overall floor standing housing providing general weather protection without sealing or thermal control.
- Housing shall mean the specific enclosure without thermal control for items of equipment, either located externally or within another enclosure.
- Compounds shall mean areas enclosed by fencing or walls but generally exposed to the weather.

General

All cabinets and kiosks shall be fully weatherproof enclosures to IP55, manufactured from maintenance-free, resin bonded, glass fibre reinforce, polyester (GRP) inner and outer skins, encapsulating not less than 12mm plywood reinforcement and insulation to give 'u' value of at least 1.5W/m²C. The doors shall have flexible neoprene seals.

All cabinets, kiosks and shelters shall have doors incorporating steel reinforcement for rigidity and self-locking stays to maintain the doors open to at least 90°.

Door hinges shall be black epoxy coated, vandal-proof pattern with stainless steel pins. Locking door handles shall also be black epoxy coated steel with stainless steel cam action locking plates.

Where double doors are provided, shoot bolts shall be fitted to the top and bottom of the left hand door, central dead-locking of latch to right hand door to incorporate a security keyed 'Yale' type lock to suit local key or other specified standards.

The closing edges of the doors shall have an external or internal overlap for weather sealing.

Ventilation to kiosks and shelters shall be provided either as under-eaves or via high level louvred vents protected by affine mesh stainless steel/aluminum insect screen. Ventilation provided shall be equivalent to a 10mm continuous gap around the enclosure perimeter.

The interior shall be finished with white based abrasion resistant vinyl paint. The exterior finish shall be GRP coloured Dark Green to BS 4800 (14 C 30) unless otherwise specified.

Cabinets

Wall mounted equipment cabinets shall have external fixing lugs and have removable gland plates fitted to the base for cable or pipework entry.

All cabinets shall have mounting rails bonded to the rear wall to facilitate equipment fixing and have an anti-condensation heater fitted. Outdoor mounted cabinets shall have a rear sloping top and a 50mm projecting drip canopy above the access door.

Inspection windows of toughened glass secured in a rubber basket shall be provided where specified.

Kiosks

Where control panels are to be protected in outdoor locations they shall be enclosed in a cross ventilated weatherproof kiosk, sized to allow at least 1.0m clear working space in front of the panel. Battens shall be mounted to the inside walls to provide fixings for internal equipment and fittings.

The kiosk materials shall have a ½ hr fire resistance rating for retention of stability, integrity and insulation in accordance with BS 476 Pt 8.

Sectional kiosk shall be pre-assembled and fully sealed before delivery to site.

Fixing holes shall be provided in the base sections and the whole unit shall be fixed and sealed to the concrete base by means of a mastic compound applied before and after the kiosk sections are in place, to prevent ingress of moisture.

Kiosk shall be fitted with:

- A suitable corrosion proof fluorescent light fitting, not less than 60 watt, so arranged to illuminate the face of the control panel complete with MK 'Seal' On/Off switch inside the kiosk, wall mounted adjacent to the kiosk door, and wiring.
- A suitably rated anti-condensation heater complete with thermostat, On/Off switch and wiring.
- All electrical fittings to be connected by wiring in surface mounted PVC conduit to a 2 way metalclad consumer unit.

When space for the metering equipment and cut-outs is specified, a separate section within the main frame of the kiosk is to be provided complete with fire resistant chipboard panel. Details of size required and position in relation to the panel are to be obtained from the appropriate Electricity Supply Authority.

Where specified, a lockable hinged door shall be provided to enable the meters to be read from outside the kiosk.

Where and external generator connection is specified, a small door or 'cat-flap' shall be fitted opposite the panel mounted appliance inlet to provide access for a generator cable and connector. The door shall be large enough to pass the connector and it shall be horizontally hinged at the top. Outward opening and lockable with a suitable padlock.

Shelters

Protection for plant requiring limited attention shall be of maintenance free materials, single skin GRP insulated panels or hot dipped galvanized steel panels with plastic skin external coating and alkyd paint interior. The shelter shall provide a degree of protection to IP44.

Housings

Field mounted electrical components and junction boxes shall be heavy duty industrial type, accommodated in totally enclosed hoseproof housings to IP65, of die cast, cast aluminum or rigid non-ferrous/polycarbonate materials having tapped conduit entries and recessed neoprene gaskets to seal the covers, the cover and housing fixings being outside the sealed area of the box.

1104 Mechanical Works

General

Materials

Any non-metallic materials such as may be employed for bellows, packing or sleeves, coatings or linings etc. liable to contact with potable water shall be approved for the purpose by a recognized approval body.

Materials in Contact with Sewage

Materials in contact with sewage shall be suitable for the environment but particularly all bronze materials shall be true bronze (i.e. zinc free) alloys.

Indicator Gauges

All gauges shall be constructed with non-corrodible metal cases and stainless steel bezels. They shall be located to enable easy readings by the plant operator and mounted to preclude damage due to vibration. The cases shall be at least 50mm diameter, unless otherwise specified, scaled in metric units and normally ranged over a 240° arc from zero to 20% - 40% above the system designed operating value for full load conditions; except where finite limits exist, e.g. level/contents gauges which shall be ranged 0-100%, or where restricted ranges are specified.

A schedule of gauges shall be provided for approval, detailing arrangements, scale ranges, designation label inscriptions and any alarm contacts.

Labels shall be securely attached on or adjacent to each gauge and groups of any such instruments shall be of matching appearance and approved layout.

Pressure gauges shall be of the Bourdon tube or diaphragm type. Each gauge shall incorporate a surge damping device and be fitted with its own stainless steel isolating cock.

Pressure gauges incorporating transducers for remote monitoring shall be damped to provide a steady output. The pressure at the tapping point shall give a direct indication on the gauge as well as driving the transducer. Any alarm contact settings shall be independent of the transducer function and nether shall interfere with the direct gauge indication.

Temperature gauges shall be of a type suitable for the application with the sensing element mounted within a thermal well. Where specified, the maximum working temperature under full load conditions shall be marked by means of a preset red pointer.

Pumping station water pressure gauges shall have a dial diameter of not less than 100mm and be calibrated in metres head. The gauges shall be uncorrected for datum and show actual pressure at the tapping point. The label bearing the designation given in the gauge schedule shall include the Ordnance Datum level of the tapping point.

Pump delivery and station delivery pressure gauges shall be mounted at a convenient height for reading on a gauge board of varnished hardwood, 20mm marine plywood or equivalent non-corrodible material with stainless steel capillary pipework, having an isolating cock at each end connecting the pressure tapping bosses and shall be adequately supported.

Fasteners

All bolts, nuts, and studbolts, including those required for installation at terminal points to existing equipment, shall be provided by the Contractor and shall have metric threads to BS 3643.

After tightening, the minimum engagement of the thread shall equal the thickness of the nut. The projection of the head beyond the outer face of the nut shall not exceed one quarter of the outside diameter of the thread. In no circumstances shall galvanised or coated bolts be shortened by cutting.

ii) Washers shall be provided under all nut and bolt heads.

All fastenings and accessories in contact with the process water shall be of stainless steel, cadmium plated mild steel or other corrosion resistant material subject to the approval of the Engineer. All bolts, nuts, screws, washers and other fixings for anchoring the plant to walls, floors, ceilings, etc. shall be of corrosion resistant material or shall have a protective surface treatment to the approval of the Engineer.

All bolts in inaccessible positions shall be secured by either self locking nuts, spring washers and nuts, or castle nuts with split pins. Fasteners associated with items requiring removal during routine maintenance shall be of stainless steel. All other items shall be sheradised or hot dip galvanized in matched condition.

All holding-down or foundation bolts shall be supplied and shall be complete with hexagon nuts and washers. Bolts of steel round bar formed into a loop at one end are not acceptable.

iii) Fastenings to Concrete or Masonry

Anchor bolts for the fixing of small items shall be of the torque-expanded type of approved make, installed strictly in accordance with the manufacturer's instructions. The size of hole required in the Civil work shall not exceed 38mm.

Where the base material will not withstand the expansion stresses imposed by the torque-expanded type or where the highest degree of resistance to vibration is required an approved type of chemically bonded anchor bolt may be used.

The minimum distance from any concrete edge shall be 100mm for expanding type fixings and 75mm for embedded bolts.

iv) Baseplates

Separately mounted items of plant which are required to maintain an accurate alignment shall be mounted on a common baseplate, together with all associated items and guards.

The baseplate shall be of rigid construction, machined on all mating surfaces and drilled for foundation fixings. Machined datum faces shall be provided and leveling facilities incorporated in the underside.

Provision shall be made for the easy removal of any section of the drive and positive re-alignment using dowels or other approved means. Shims and packings shall be kept to a minimum and clearly identified for re-assembly.

All drain points on the assembled plant are to have easy access and drain piping shall extend beyond the baseplate.

v) Provision for Handling

Suitable provision approved by the Engineer shall be made by the Contractor to facilitate the handling of all items in excess of 36kg.

Any item weighing one tonne or over and which may be required to be lifted during operation and maintenance shall be appropriately marked with its weight.

vi) Protection of Moving Parts

All moving parts where accessible to operational personnel shall be protected and guarded to meet relevant regulations. All guards shall be designed to facilitate easy removal.

vii) Balancing

All rotating parts of the machinery shall be statically and dynamically balanced unless otherwise agreed in writing by the Engineer. The complete rotating assembly shall be designed such that any critical speeds are outside the duty running speed range of the machine.

viii) Lubrication

Any components requiring manual lubrication shall be provided with greasing nipples of an approved type mounted on a panel and identified.

A remotely mounted electrically operated lubricator of approved type shall be provided to serve components, if any, requiring continuous lubrication by external mechanical means.

The lubrication tubes, if any, shall be of approved material suitable for high pressure use. The

Contractor shall include for all grease and oil required for testing at works and site.

The first filling after tests shall be provided by the Contractor who shall submit details of his recommended lubricants, which shall be available from any of the major oil companies, for approval by the Engineer.

All bearing surfaces shall be properly charged with grease before the plant is operated.

ix) Nameplates and Labels

Instruction plates, name plates and labels shall be provided for all items of the plant giving particulars of duty, size, serial number and full information for identification and operation. Their construction and engraving shall be to the Engineer's approval.

x) Plant References

After final painting, all plant items shall be identified by a unique reference character as detailed on the specification drawings or otherwise specified. Such references to be affixed in a prominent position on the plant body with characters not less than 100mm high or as otherwise specified. Characters shall be bold capital letters and/or numerals. The abbreviation 'No' shall not be used.

Unit references shall include any associated main and auxiliary drives shall follow a logical sequence bases on layout or history. In any particular installation, a set of similar duty drives where any number of units may run shall be suffixed 1, 2, 2,3, 4 etc. whereas alternative drives for the same duty where only one unit may run (i.e. duty/standby) shall be suffixed A & B.

xi) Tools and Tackle for Maintenance

The Contractor shall supply a complete set of any special tools and other equipment necessary for the dismantling, re-erection and adjustment of the plant.

The tools provided shall be in new condition, adequately labeled as to their use and contained in stout and suitable padlocked boxes. The Engineer's instructions as to who shall be the recipient of the tools shall be sought before delivery is made.

Any special slings required shall be provided and clearly marked by embossed labels to show safe working loads. Test certificates shall be provided where applicable.

xii) Locks and Keys for Mechanical Plant

All locks of the same size shall be of the same type as manufacture but having different keys. Three keys shall be provided for each lock.

Each key shall have prominently attached to it an embossed brass label stating the following:

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- Key number;
 - Location of lock/Item of equipment.

xiii) Noise Level

All plant shall run without undue vibration and with the least practicable amount of noise. Vibration levels shall not exceed these set out in ISO 2372 for the particular type of equipment.

Any items of plant which produce a noise level exceeding 65 dB (A) at 3 metres shall be listed by the Tenderer. It shall be deemed that all items of plant not so listed have a noise level of less than 65 dB (A) at 3 metres.

To meet the environmental requirements, the Contractor shall provide all necessary equipment to meet the following conditions, based on the site layout shown on the specification drawings and with 75% of the plant running simultaneously:

- the noise level generated at the site boundary by any new plant shall not exceed that generated by the existing plant;
- the noise level at 100m from the source does not exceed 65dB (A);
- the noise level in the building (10m from the source) does not exceed 80 dB (A);
- the noise level in the plant room (5m from the source) does not exceed 80dB (A);
- warning notices shall be provided at all entrances to rooms where the noise level will exceed 75 dB (A).

xiv) Frost Protection

The plant shall be adequately protected against damage from freezing, using an approved means of insulation.

Particular attention shall be given to pipework, pump casings, etc. and any part of the plant and equipment likely to stand for periods charged with static water.

Where lagging is used, it shall be suitable for outside installation and completely impervious to all weather and atmospheric conditions on the works. Lagging materials containing asbestos shall not be used.

The lagging shall be sectional and easily removed for maintenance purposes. Joints shall be sealed together with an approved waterproof adhesive tape.

Areas where lagging may be vulnerable to damage shall be suitably protected by an approved means.

xv) Corrosion Protection

Where dissimilar metals are in contact or close proximity and corrosion may occur through electrolytic action or differences in electrical potential, protection shall be afforded by electroplating, suitable gaskets, cathodic protection or other means approved by the Engineer.

Chromium plated parts shall not be used on sewage works or in any other damp or corrosive atmosphere.

All surfaces shall be adequately protected in transit, and any damage shall be removed immediately on off-loading and on completion of erection.

After cleaning and inspection but before the plant leaves the Contractor's works, the machined surfaces of steel and ironwork shall be covered with preserving fluid of an approved type, or otherwise protected to the Engineer's satisfaction.

All external steel screw fittings shall be supplied in the galvanized condition, stainless steel, or sheradised to comply with BS 4921, Class 1 or Class 2 with passivation treatment.

xvi) Surface Preparation and Painting

The whole preparation and paint system shall be suitable for operating environment specified and a painting schedule giving details of preparatory treatment, types of paint, number of coats and method of application shall be submitted with the Tender. (See Particulars of Plant).

Proprietary items may be used in their standard finish subject to the approval of the Engineer. For specified applications, adequate supervision shall be provided for all stages of preparation, application and testing.

All steelwork shall be protected in accordance with BS 5493 and based on a 'long' time to first maintenance. The exterior environment shall be regarded as 'polluted inland' (Table 1 Pt. 2) and the interior environment shall be regarded as 'frequently damp' (Table 1 Pt. 7) unless otherwise specified. Items below water level or subject to immersion shall be treated as Table 1 Pt 8.

After all machining, forming and welding has been completed, all steelwork surfaces shall be thoroughly cleaned of rust, scale, welding slag or spatter and other contaminations prior to any painting.

The system proposed shall be abrasion resistant and conform to the following typical requirements. Preparation of steelwork at the works shall be either:

- Hot dip galvanized to BS 729 with a median thickness of 85 microns (0.0034"); or
- Grit blasted to BS 7079 Grade SA 2.5 and zinc sprayed within 4 hours to BS 2569 Part 1 to a thickness of 125 microns (0.005") followed by one coat of approved etch primer.

Typical finishes (with compatible primers) based on BS 5493 are given below: Steelwork and ferrous castings exposed above water/sewage level

Either high build micaceous iron oxide or chlorinated rubber to give a minimum total dry film thickness of 300 microns, or one coat of two pack epoxy primer and further coats of epoxy paint to give a total dry film thickness of 270 microns;

xvii) Steel work below water/sewage level;

Either epoxy system as above or coal tar epoxy paint system to give a minimum total dry film thickness of 450 microns;

Ferrous castings and fittings without substrate below water level.

Coal tar epoxy paint system to give a minimum total dry film thickness of 450 microns. These coatings shall be subject to the Holiday Test.

The surface of all non-ferrous parts usually painted shall be cleaned, rubbed down, stopped, filled and given one priming coat of paint.

Anti-corrosion coatings used for any steel or iron used in pipework, pumps, valves, etc. in contact with potable water, shall either be a compatible bitumen material to BS 3416 or a polymeric anti-corrosion coating complying with Water Industry Specification WIS 4-52-01.

Any damage occurring to any part of a painting scheme shall be made good to the same standard of protection and appearance as that originally employed. Any finish coat applied onsite shall be considered for decorative purposes only.

Manufactured articles to be galvanized shall be hot dip galvanized after complete fabrication and no bending, cutting, drilling, riveting or threading shall be permitted after galvanizing.

The care of galvanized articles when transporting, storing and erecting them shall be in accordance with the recommendations of BS 729. The renovation of small areas of damaged coating not exceeding 40mm² shall be in accordance with Appendix D of BS 729 and subject to the Engineer's approval.

xviii) Paint Colours

The colours of the primer, intermediate and finishing coats of a paint system shall be easily distinguishable from each other, and the materials used shall be suitable for the method of application and preferably be supplied by one manufacturer who shall ensure that all coatings are compatible.

x) Electromechanical items

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Pump Duty

Pumps shall be of the type specified and arranged as indicated in the Specification Drawings and shown on schedule of pumps. They shall be designed to give specified output against all losses including those relating to the pump.

The Contractor shall match his pump characteristics to the pipe system network to achieve high pump efficiency and reliability.

Each set must be capable of running satisfactorily in parallel with other sets in the system without throttling and by itself, without cavitation or overload under all operating conditions within the system characteristics given.

The pump section and arrangement shall be such as to ensure that the head available exceeds the N.P.S.H. requirements of the pump under all operating condition.

Where the system and pump characteristics are such as to give rise to the possibility of surge in the pipeline with consequential damage, a surge investigation shall be undertaken if the results of the investigation show that there is a problem. Measures shall be proposed by the Contractor to alleviate the problem. These measures shall be agreed with the Engineer.

Centrifugal pumps shall be capable of withstanding without detriment, reverse rotation to a speed that would occur if the pump were to stop when the differential head was at a maximum and the delivery and/or non-return valve failed to close.

For submersible pumps the ability to operate with the maximum reliability is of prime importance, with efficiency being a paramount consideration. The pump shall therefore operate without clogging, being designed to pass a sphere of 125 mm diameter where the size of the delivery mains permits. Whilst the pumps shall be designed to meet a specific duty they shall also be capable of operating over the duty range specified for prolonged period and for standing idle for long periods without attention as in the case of storm pumping.

Centrifugal Pump Casings

Pump casings shall be of the volute type and shall be capable of withstanding all pressures which may be produced due to operating pressure surges.

Particular attention shall be paid to the wear characteristics of the pumps. In the case of submersible pumps, due to the presence of grit in the water, could be appreciable.

The pump design shall ensure that alignment is maintained between the various assemblies by recesses, spigots and dowels and shall be such that all components liable to wear can be replaced.

Components shall be permanently marked with the manufacturer's number and where dowels are not used, permanently marked for correct assembly. The pump casing and the pump impeller should normally have detachable wear rings.

The casings of the pumps shall be of a suitable grade of close-grained grey cast iron or nickel iron and have flanges to match the specified pipework.

The waterways through the pumps shall be smooth in finish and free from recesses and obstructions.

Sewage pump casings shall be of substantial construction to give long life under abrasive conditions and suitably stiffened to withstand shock due to solids in suspension. Inspection holes shall be provided in any section bend and in the pump casing above the impeller for access to facilitate the clearance of obstructions. The inspection hole covers shall be shaped to conform to the interior profile of the waterway when in place and shall be fitted with starting screws where necessary.

Impellers

Impellers shall be securely fitted to pump shafts in such a manner to prevent them becoming loose or detached when the pump is in operation, or when rotating in the reverse direction, either by liquid flow or motor rotation.

The impellers and guide vanes (if any) shall be manufactured from a suitable material, accurately machined and smoothly finished to minimize hydraulic losses.

The rotating elements shall be statistically and dynamically balanced before final assembly. The impeller shall be readily withdrawable from the pump casing without the need to disconnect pipework.

For submersible pumps, the impeller shall be of the open type with the inlet ends of the vanes being of bulbous design and the impeller passages being as large as possible consistent with good performance.

The inlet ends and surfaces of the vanes shall be dressed to give a smooth finish to prevent fouling by rags and fibrous matter within the pumps.

Impellers for both submersible and storm water pumps shall be of the non-shrouded type, constructed normally of close-grained grey cast/nickel-iron, and designed to exclude gritty matter from the shaft and gland.

Clearance at the eye rings and wear plates shall be kept to a minimum, and where it is found necessary to cut back the impeller this it be done on the vanes only.

Pump Shaft

The pump shaft shall be of high tensile or stainless steel adequately sized, with good fatigue, shock load and corrosion resistance. The duty speed range shall be well below the first critical speed of the shaft. Where a change in diameter of the shaft occurs the shoulder shall be radiussed or undercut to the appropriate BS to reduce stress concentration.

The shaft shall be complete with easily renewable steel protecting sleeves at glands and bearings.

Shaft Seals

Pump shaft sealing arrangements shall be suitable for the water pressures and shaft speeds involved.

Pumps fitted with soft re-packable or packed gland type, seals shall have stuffing boxes designed to facilitate adjustment of the packing materials.

Pumps shall be fitted with a split type mechanical shaft seal arranged such that replacement of wearing components can be carried out without the need to dismantle the pump.

Special care in the selection of materials shall be taken in order to avoid binding and electrolytic action between the shaft sleeve and the mechanical seal components, particularly where long periods of idleness are inherent in the duty cycle as in the case of standby and storm pumping.

Bearings

All pumps shall incorporate bearing arrangements which prevent the escape of lubricant into the liquid being pumped. The bearings shall be located in dust/moist-proof housings.

All bearings shall be liberally rated to ensure cool running and meet the load factors specified.

For vertically mounted pumps, the top bearing shall be a combined thrust and journal type, designed to prevent any thrust loads being transmitted to the drive motor. The pump bottom bearing shall be lubricated by an enclosed water lubricated sleeve bearing for potable water applications by grease or other approved means for sewage use. Storm pump bearings shall also be suitable for standing idle for periods of up to 2 months without attention or movement.

Where grease points are necessary they shall be fitted with removable screwed plugs which shall be accessible without removing guards. All bearings having automatic lubrication shall also have provision for hand lubrication.

Baseplates and Stools

For vertical pump units, heavy cast iron or fabricated steel floor plates and motor stools shall be provided for direct mounting in concrete floors or supporting steelwork. Suitable journal and thrust bearings shall be provided in the baseplates to carry out the vertical drive shaft.

Where necessary the motor stools shall be designed to accommodate flywheels and bearing housings.

Floor plates shall be recessed and so arranged that the tops and fixing bolts are level with the finished floor.

The pump units shall be accurately aligned and located on baseplates by set screws and parallel dowels

Lubrication/Cooling Monitoring

A lubrication system shall be arranged for the lubrication of all grease points on the pumps and shafting from motor room level. Individual bearings within the support tunnel tubes and on the pump sets themselves shall receive separate supplies of grease fed by pressure tubes laid from each bearing to battery plates readily accessible from motor floor level for grease gun operation.

Pressure tubes shall be grouped together where possible and securely attached by brackets, straps, etc. to tunnel tubes, with connectors located near to the motor support plate for easy removal of shafting in the event of maintenance work. In exposed positions pressure tubes are protected from damage. Motor grease points will not be included in this lubrication system but shall receive individual attention.

The battery plates shall have sufficient greasing points for all bearings to be located on or adjacent to each pump motor stool.

A notice is to be supplied and fixed on the wall in a prominent position detailing the manufacturer's recommended greasing schedule. The notice shall include a warning of the dangers to bearings from 'over greasing'.

A grease gun shall be supplied for all greasing purposes.

Bearings which require a continuous supply of lubricant shall incorporate a means of monitoring such a supply, either by flow or temperature rise as appropriate for the type of bearing employed; separate monitors being fitted for each bearing feed or housing.

Such monitors shall include all necessary ancillary power of pulse counting devices to enable the operation of any monitor to initiate a volt free contact rated at 240V 0.5 A AC.

Pump Tundish

Where specified, each pump shall be equipped with a cast aluminum or fabricated steel tundish to accommodate the drain lines from mechanical seals, casing vent and other minor drainage points on the pump. A single drain pipe shall be run from the tundish to the common drainage system.

Air Release Cock

The higher point on the pump casing shall be fitted with a manual air release cock have a removable handle or an automatic air release valve with a lockable isolation valve as specified. Air release pipework on sewage pumps shall be not less than 30mm bore and shall discharge back into the wet well at high level and have facilities for rodding. The drain from each air release cock shall discharge via pipework as specified.

Couplings

All couplings shall be of an approved type and the Contractor shall arranged for the provision and fitting of both coupling halves to each respective shaft and shall include for all necessary modifications to any existing shafts to be coupled.

Where specified, the Contractor shall include any equipment required to prevent damage to any part of the drive in the event of reverse rotation of the pumps..

Lubrication

The gear unit shall be grease or oil lubricated, arranged to provide an adequate supply of lubricant for the duty.

Where oil lubrication is employed, the casing shall include an oil breather, level indicator and drain plug.

Units having a rated output greater than 500kW shall have inspection covers and include a forced lubrication system comprising an oil circulating pump, reservoir tank and full flow 'Duplex' type oil filters having re-useable elements together with associated pipework; the oil being circulated by either (a) an internal mechanically driven gear pump and an external electrically driven pump arranged to prime the gears as pre-set timings as recommended by the unit manufacturer, or (b) duplicate external electrically driven pumps, each of which may be selected to prime pre-set intervals and run when the gear unit runs.

Such a lubrication system shall include dial gauges and alarm switches to monitor high oil temperature and low oil pressure.

Reverse Rotation

Where specified, the gear unit shall be capable of withstanding reverse rotation for a limited period with no detriment to the unit. Where a forced lubrication system is used, this shall continue to operate satisfactorily under such conditions.

Diaphragm Pumps

The pump shall be of the diaphragm type utilizing a bullfrog type valve, suitable for the pumping viscous solution containing solids up to 55mm diameter as specified. It shall be driven by an electric motor through an oil bath reduction gear unit.

The main body of the pump shall be manufactured from LM6 aluminum and all wetted parts shall be supplied in 316 stainless steel.

The diaphragm shall be manufactured from neoprene, nitrile, hyperlink or viton elastomers and shall be reinforced with polyester fabric.

Submersible Pumps

Pumps impellers shall be closed or semi open type made from zinc free bronze or such other materials required for use with particular water to be pumped. Pump bodies shall be of zinc free bronze or such other material as required for the water to be pumped, treated against corrosion, and equipped with detachable wear rings. The bowls shall be joined by flanges or by tie rods.

The shaft main guide bearings located in the suction and delivery end housings of the pump shall utilize a leaded-bronze material, and shall be provided with protection guards to prevent ingress of sand and grit. Pump bowl guide bearings shall utilize either leaded bronze or other approved abrasion resistant material.

All pump bearings shall be lubricated by the water to be pumped. The pump delivery end housing shall incorporate a thrust washer of suitable material at the shaft end housing to absorb upthrusts that occurs during pump starting. The pump shall incorporate a mushroom type delivery check valve to prevent reverse rotation of the shaft from back flow of water through the pump. The pumps shall be provided

with a flanged discharge connection suitable for operating against the pump closed valve head or 16 bar whichever is greater. The shaft coupling connecting the pump and driving motor shall be of the stainless steel material accurately machined and keyed to ensure a precise shaft engagement and alignment. A strainer of suitable corrosion and abrasion resistant material, designed to guard against entry of foreign matter but permitting unrestricted flow of water into the pump, shall be provided on the pump suction housing.

Protections against the effect of sand shall be provided by renewable wear rings (made from a hard smooth flexible material such as polymethane) mounted at the seating of the impellers and the passages of the shaft.

The pump shall be designed to pump water having a sand content of up to 80g/m³.

A centralizer shall be fitted to every pump to ensure central alignment of the pumping and motor in the borehole casing.

Electro-submersible motors shall be 'wet' squirrel cage rotor induction type designed to operate continuously under submerged conditions and shall, where appropriate, comply with the requirements of IEC publication 34. They shall have operating speeds not in excess of 3000 rpm.

The motors shall be continuously rated at least 20% above the maximum power absorbed by the pump within the specified operating range. Motors shall be designed to allow three consecutive starts from cold and three starts in any one hour when hot.

The motor housing shall be constructed from close grained cast iron, cast steel or fabricated steel as appropriate, and shall be designed for easy dismantling and re-assembly to facilitate replacement of motor guide and thrust bearings.

The motor windings shall be insulated with an approved heat resistant material of high insulation resistance and impervious to water. All connections on the motor winding shall be made watertight. The temperature rise of motor windings shall be limited to 45°C above ambient temperature.

The motor shall be equipped, in factory with several PTC or Pt100 thermoprobes, 2 minimum, connected to a multifunction protection relay and a pre-selection digital thermometer which cuts off the operation current of the starter when the threshold temperature is reached. The temperature setting of this device shall depend upon the type of the probe determined by the manufacturer according to the insulation class of the motor.

The motor shaft shall be machined from high tensile stainless steel of sufficient diameter to prevent distortion from the dynamic and electro-magnetic stresses imposed on it. Critical shaft speed shall be well above the maximum running speed.

The motor shall be provided with a heavy duty multipad thrust bearing at the base of the motor to absorb the shaft down thrust developed by the pump. The bearing design shall incorporate tilting thrust pads with replaceable segments arranged to self adjust according to the thrust load. The thrust disc shall be of a suitable segment carbon based or similar approved material.

The thrust bearing design shall also be suitable for reverse rotation of the shaft in the event of backflow of water through the pump.

Motor guide bearings shall utilize either leaded bronze, copper impregnated carbon or similar approved material. Rubber, nylon, Tufnell and similar materials will not be accepted for the motor guide bearings.

Motor guide and thrust bearings shall be lubricated by the motor coolant water which shall be effectively isolated from the water to be pumped. A compensating device shall be incorporated in the motor design to allow for expansion of the coolant on rising temperature.

Underground Tank Water Pumps Rising Column

Steel borehole rising column shall be provided in section lengths not exceeding 3 metres with flanged joints or screwed couplings. The rising column shall be sufficiently flexible to allow for small deviations in tank verticality. All nuts, bolts and washers shall be of stainless steel.

Rising column flanges shall incorporate a recess to accommodate and protect the motor power and control cables, water level dip tubing, etc. Cables and tubing shall be securely fixed to the rising column by straps or bands at approximately 1.0 metre intervals.

The rising column shall be sufficient to take the stresses generated by the hanging weight of the pump, motor and rising column, the stresses produced by the water pressure together with any dynamic stresses which may occur under any circumstances including valve closure. Jointing materials shall be selected with care and shall accommodate the extension of bolts due to the expected weight and surge or closed valve pressures generated in the pipeline.

The rising column shall be protected internally and externally against corrosion by a non toxic epoxy resin coating suitable for use with potable water.

Submersible Pumps Headworks

A fabricated steel discharge head piece shall be provided at the top of the tank to support the complete rising column and electro-submersible pumpset assembly, and shall be complete with lifting eye bolts. The discharge head piece shall comprise a heavy duty sealing plate arranged for bolting to the borehole outer casing flange, and a 90° discharge bend arranged for flanged connection to both rising column and horizontal surface pipework. Lifting eyes shall be provided in the sealing plate. A flange shall be provided and welded by the Contractor to the top of the borehole outer casing. The flange shall be suitably drilled to accommodate the discharge head piece sealing plate bolts. Holes shall be provided in the sealing plate to accommodate an air vent pipe, motor and control cables, water level dip tubing, etc. and shall include adequate sealing arrangements to protect against borehole contamination. A 255mm diameter screwed removable plug shall be provided over the dip tubing for water level measurement with electrical contact tape. A stainless steel air vent pipe shall be fitted to the discharge head sealing plate, terminating in an insect proof screen and arranged to prevent entry of rain or surface water.

Tank power and signal cabling shall be brought to separate robust watertight junction boxes in the top of the well head chamber, with separate cabling from the junction boxes to the Motor Control Centre (MCC).

Surge Suppression Equipment

Surge vessels and associated equipment for suppression of surge in pumping systems shall include the following:

Surge pressure vessel designed and constructed to BS 5500, constructed

category 1, 2 or 3, post weld heat treated and with a corrosion allowance of 1mm. The vessel shall be cylindrical, carbon steel, fusion welded with domed ends and mounted either vertically or horizontally on steel supports. The vessel shall be provided complete with including the following fittings:

- McNeil type access manhole with opening not less than 450 mm x 410 mm;
- Water inlet/outlet branch flanged to BS 4504 Table 16 or 25 as necessary;
- 100 mm diameter drain branch with gunmetal valve and handwheel with drain pipework discharging to drainage channel;
- Spring loaded gunmetal safety valve;
- 150 mm diameter pressure gauge complete with isolating cock;

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- Water level sight glass with isolating and blowout prevention valves;
 - Air inlet fitting incorporating an air release valve and isolating and non-return valves;
 - Three stainless steel water level control electrodes of appropriate length, complete with electrode holders, spacers and brackets;
 - Access ladder;
 - Lifting lugs;
 - Nameplate giving vessel details.
 - One or more air compressors with standby facilities. Each compressor shall be capable of charging the pressure vessel from full water in approximately 30 minutes. The compressors shall be air cooled, electrically driven and complete with baseplates.

The compressors are required to deliver completely oil-free air but may be of the air lubricated type with two stage carbon air delivery filters providing complete removal moisture and oil vapour. Each compressor shall be provided with the following fittings:

- Outlet pressure gauge;
- Pressure relief valve;
- Suction filter and silencer;
- Automatic unloading valve for a no-load start under all conditions;
- Non-return valve;
- Protective guard between motor and compressor.

Control equipment to provide fully automatic control of the selected duty compressor from the water level electrodes in the surge vessel. A time delay shall be incorporated to prevent operation of the compressor during water level changes under surge conditions and a push button feature shall be provided for manual test of the system. The control equipment shall be housed in a wall mounted panel fabricated from mild steel to form a rigid box construction of neat appearance providing an enclosure to IP54. The enclosure door shall be hinged with a rotating handle and positive closing action. The equipment shall include:

- A three pole isolating switch, with operating handle interlocked with the enclosure door;
- A water level control module;
- A 0 to 30 minutes adjustable timer;
- A non-latching motor test push-button.

Ductile iron flanged inlet/outlet pipework between a flanged tee on the pumping station or wellhead delivery pipework and the surge vessel. The pipeworks shall include an isolating valve with gearing and handwheel and all necessary bends and fittings.

Small diameter GMS pipework between the air compressors and the surge vessel. The pipework shall be suitably coated and wrapped.

For small installations a vessel with a flexible membrane and hand air pump may be used.

y) **Valves**

Types and Operating Conditions

Valves shall be designed to meet the operational and environmental conditions specified for the types indicated in the specific valve schedule.

The closure rates of all valves shall be designed to prevent the effects of surge. Where necessary, valves with a varying closure rate shall be used.

Valve flanges or couplings shall be as specified in the valve schedule and match those specified for the pipework installation.

Identification

Each valve shall be identified by a unique reference as approved which shall identify the medium/plant controlled and be numbered in a logical sequence.

The reference shall either be engraved on a 3mm thick laminated white/black/white traffolyte disc or stamped on a 1.0mm (19g) thick brass disc. The disc shall be at least 35mm diameter with reference letters and numerals not less than 4mm and 8mm high respectively.

The discs shall be mounted on the hub of the handwheel or where this is impractical, they shall be attached to the valve stem by means of suitable brass 'S' hooks and/or jack chain through a hole at the top of the disc.

Access

All valves, spindles and handwheels shall be positioned to give good access for operational personnel. It shall be possible either to remove and replace or to recondition seats, gates or gland packings which shall be accessible without removal of the valve from the pipework or, in the case of power operated valves, without removal of the actuator from the valve.

Extension spindles shall be supplied wherever necessary to achieve the specified operating requirements.

Hand Operation

All handwheels shall be arranged to turn in a clockwise direction to close the valve or penstock, the direction of rotation for opening and closing being indicated on the handwheels.

The handwheels shall be coated with black plastic and incorporate facilities for padlocking in either the open or closed position.

The operating gear of all valves and penstocks shall be such that they can be opened and closed by one man against an unbalanced head 15% in excess of the maximum

specified service value and any gearing shall be such as to permit manual operation on a reasonable time and not exceed a required rim pull of 200kg.

Power operated valves shall include equipment for manual operation by means of a handwheel or other suitable device which shall be interlocked with, and fixed to, the power unit.

Headstocks and valves of 50mm nominal bore and above shall be fitted with mechanical position indicators to show the amount which the valve is open or closed in relation to its full travel, i.e. 0.25, 0.50, 0.75, 1 etc.

Valve Materials

Valve bodies and other components shall be of corrosion resistant materials, compatible with the medium and of robust industrial design.

For water applications and where specified, valve bodies, discs and wedges shall be of cast iron, with facing rings, wedge nut and other trim of corrosion resistant bronze or gun metal.

The valve stem, thrust washers, screws, nuts and other components exposed to the water shall be of a corrosion resistant grade of bronze or stainless steel.

For water works applications, wedge gate, metal seated valve materials shall be in accordance with BS 5163 Table 6A, fitted with a stuffing box and gland seal on the stem. Oil or grease shall not be used on any bearing or seal that may be in contact with the water being controlled.

Non-Return Valves

All non-return valves shall be of a type that will operate without stock.

Valve bodies shall be of cast iron and shall be fitted with renewable type seatings.

In the case of swing gate type valves the hinge pin shall be of stainless steel, mounted in zinc free bronze bushes and extended and fitted with external levers and counter balance weights, all protected by a screen guard.

Other types of valves will be considered. In every case the non-return valve shall be selected with full consideration of the system characteristics, and shall avoid valve slam, and have low maintenance requirements.

Where specified, limit switches shall be provided to operate from the external lever. The screen guard being slotted to allow the guard to be removed without disturbing the switch cabling.

Butterfly Valves

Butterfly valves shall conform to BS EN 593.

Butterfly valves shall have a high grade cast iron body to BS EN 1561 designed to the specified working and test pressures. The pressure rating valve shall be cast in the valve body.

The disc shall be of high grade cast iron to BS EN 1561 or nodular cast iron to BS 2789 to the defined working and test pressures. It shall have a convex shape designed to achieve low head loss characteristics. The valve shafts shall be of stainless steel operating in self lubricating bushes in the body.

The valve seat shall be of gunmetal to BS 1400. The sealing ring shall be a renewable Ethylene Propylene Diene Monomer (EPDM) rubber attached to the disc edge by a sectional bronze retaining ring to form a resilient and durable seal.

The valves shall be fitted with hand wheel actuators not exceeding 500mm diameter incorporating gearing to allow opening and closing by manual operation at the pressure stated using an effort no greater than 36kg on the hand wheel supplied.

In all cases the gearing shall be designed to close the valve, from fully open to fully closed in a period of not less than ten minutes with this effort. Actuators shall be designed so as to close the valves when the hand wheel is turned in a clockwise direction; the direction of closing shall be clearly cast on the hand wheel. Position indicators shall be fitted to all actuators.

Where required valves shall be electrically actuated with a manual override. Remote actuation shall be provided with a visual indication of valve open, valve closed and percentage opening together with fault indication.

A performance curve, relating percentage valve travel, open area and discharge coefficient shall be submitted to the Engineer. The head loss coefficient with valve fully open shall be defined.

All valves shall be tested in accordance with BS EN 593 and pressure and material test certificates shall be submitted to the Engineer for approval.

Plug Valves

Plug valves shall be of the wedge gate type, with cast bodies. The plug surface shall be coated or lubricated to endure low torque operation with bubble tight shut-off and 'non-sticking' materials.

Isolating Cocks

For isolation of small bore pipework tapings for instrumentation equipment etc. and for individual component isolation, the cocks shall be stainless steel, quarter-turn, ball or plug valves with the operating handle arranged to indicate the open and closed positions. Where specified, means shall be provided for securing the valve body to a front panel or rear surface.

Where corporation cocks are specified, these shall be similar to the above isolating cocks but shall have a detachable key handle for fitting onto a squared operating shaft, the shaft end being marked to indicate the open and closed valve positions.

Air Valves

Air valves shall be either:

- Single (small) orifice valves (SAV), for the discharge of air during the normal operation of the pipeline.
- Double orifice valves (DAV), consisting of a large orifice and a small orifice. These shall permit the bulk discharge of air from the main during filling and air inflow when emptying in addition to the discharge of small quantities of air during normal operating conditions.

Air valves shall be supplied with an independent isolating butterfly valve (DAV) or cock (SAV) which permits the complete removal of the air valve from the main, without affecting the flow of water in the main.

Each air valve assembly shall be suitable for connection to a flange on the pipeline.

At the connection between the air valve and its isolating valve a BSP tapping shall be made suitable for fitting of a pressure gauge. All tapings shall be sealed by a brass plug and copper compression ring gasket.

Air valves shall operate automatically and be constructed so that the operating mechanism will not jam in either the open or closed positions.

Systems Design

All pipe systems shall be arranged, installed, supported and provided with all necessary means of venting, draining and expansion subject to the approval to the Engineer before erection commences.

The pipework layout shall be designed so that items of equipment and sections of pipework can be removed from the pipelines without major disturbance to the adjacent pipework. Particular care shall be taken to ensure that pipework thrusts are not transmitted to machinery or associated apparatus. The Contractor shall indicate on his detailed drawings the thrust blocks required to anchor his pipework.

Dead legs shall be avoided, but where this is not possible provision shall be made for flushing the pipework. Changes in pipe bore sizes shall be by the use of proprietary fittings or fabricated sections to avoid sudden changes.

Where relevant, formed bends and offsets shall be used and be cold formed in a standard pipe bending machine. They shall have an inside radius of not less than 4 times the outside diameter of the pipe.

Hydraulic pipework. Pipework for pressurized hydraulic fluid shall be sized to maintain fluid velocities below those which specified and provide a safety factor of 4:1 on the design pressure, which shall be taken as 120% working pressure;

Compressed air pipework. Air pipework shall be seamless heavy duty Black Mild Steel class C, sized such that the air flow velocity does not exceed 8m/sec. the complete pipework will receive 2 coats of chlorinated rubber paint, with a final 3rd coat, the final finish color to match existing and as approved by the Engineer. All joints will be flanged; no threaded joint will be approved for the entire compressed air pipework assembly. To provide adequate condensate drainage, the pipework system shall be run with a horizontal fall of not less than 1 in 50 in the direction of air flow and incorporate drainage points at distances of not less than 30m. Drainage points shall be formed by the use of equal tees with a down- pointing leg fitted preferably where changes of direction of flow occur.

Any branch take-off shall be from the top of the main and the bottom of any falling pipe shall be drained.

Flanges

Unless otherwise specified flanges shall be faced and drilled to conform to the dimensions specified in BS 4504. Flanges shall be compatible with the pressure rating of the adjacent pipework but not less than 15 bar. Bolts, nuts and washers (two washers per bolt) shall be to BS BS EN 1092-3;2003. No bolt shall project more than two full threads beyond its nut after tightening. In no circumstances shall the shortening of excessively long bolts by cutting be allowed.

Gaskets shall comply with replaced by BS EN 1514 (1997) and replaced by BS EN 681-2 (200) and BS 681-1 (1996) Type W.

Flanges shall be painted with two coats of chlorinated rubber paint.

Mechanical Couplings

Unless otherwise specified or shown in the Drawings pipes and fittings shall be supplied with flexible joints.

Mechanical couplings shall be of the Dresser, Viking Johnson type without a centre register.

Joints rings used shall be of the ethylene propylene rubber (EPDM) or other material approved by the Engineer.

All mechanical couplings and flange adapters including nuts, bolts and washers shall be supplied with 'Rilsan' nylon thermoplastic polyamide applied by fluidized bed dipping.

Materials for the Assembly of Flexible Joints

Lubricant shall be of a kind not conducive to the growth of bacteria and shall have no deleterious effects on either the joint rings or pipes. Lubricants for water supply shall not impart to water, taste, colour, or any effect known to be injurious to health.

Materials

Pipework materials, sizes, pressure rating, fittings, coupling arrangements and median carried shall be as detailed in the Particular Specification, pipework being in standard metric sizes where possible.

General purpose steel pipework with screwed fitting shall be of galvanized mild steel to BS 1387 heavy grade with fittings of galvanized malleable iron to BS 143/1256, having tapered internal and external threads to BS 21.

Flange joints shall be as specified below for the application and all necessary bolts, nuts and washers shall be cadmium plated. Welded joints in carbon steel pipe shall be to Class II quality to BS 2640 or BS 2971. Welding shall only be carried out by welders who are approved in accordance with the relevant BS.

Water pressurized system shall use pipe-work of carbon steel in accordance with BS 3601 with pipe sizes to BS 3600. Sizes greater than 80mm shall be selected from the preferred sizes 100, 150, 200, 300, 450, 600 and 800mm.

Flange sizes shall be according to BS 4505 rated NP16 unless otherwise specified.

All flanged joints shall be made with 3mm thick rubber canvas reinforced insertion rings complying with BS 4865 Part 1 table 16A.

Low pressure large bore systems shall use steel pipes and fittings to BS 4622 unless ductile iron pipes and fittings to BS 4772 are specified. Screwed or cast flanges shall have a minimum NP16 rating and be fitted with 3mm thick rubber canvas-reinforced insertion rings.

Hydraulic pipework shall be of stainless steel high pressure tubing grade CFS 316 to BS 3605 or mild steel grade CDS 23/S to BS 3602 as specified.

Flexible hoses shall be of the twin wire braid reinforced type complying with BS 3832.

Pipe fittings not normally visible or accessible after installation shall be of the welded socket type with break joints at suitable positions for maintenance.

All other fittings shall be of the compression type in mild steel with an electroplated corrosion resistant finish.

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Joint and Pipe Fastenings

All nuts, bolts, washers, flanges, gaskets, flanged tied adaptors, drain valves, special connection pieces, supporting hangers, brackets or clips and temporary supports for the pipework, together with all terminal point connection material shall be supplied and installed under this Contract.

All flanged joints shall be fitted with suitable insertion ring gaskets which shall be carefully adjusted concentric to the bore of the pipe so that no undue strain is placed on any of the bolts or flanges of the pipe when bolting up.

Joints on flanges that exist or have been installed under other contracts shall be made with the same material and suitable for the flange faces.

Flushing and drain connections on pipework below 150mm shall be made using proprietary welded fittings with G series internal parallel threads to BS 2779 which shall be immediately sealed with steel hexagon headed shouldered plugs and seals. Holes thus made in the pipe shall have any burrs removed and be finally pulled through to remove loose particles.

Template Pipes

Template or closure pipes shall be provided where necessary to facilitate erection. The design and construction of the template pipes shall be to the approval of the Engineer, and the Contractor will be responsible for establishing the dimensions of the template pipes such that there will be no strain on the connected items after installation.

By-passes

Where pipeline flow meters are used, particularly electromagnetic meters, by-pass pipework and valves shall be installed to allow removal of the meter without interrupting the process flow. Draining shall either be via backflow or drain valves.

Flanged Adaptors

Flanged adaptors shall be provided as indicated in the Specification drawings. Each adaptors shall be complete with all associated fittings and shall be installed in accordance with the manufacturer's instructions.

Branch Pipe and Bosses

Whenever any small bore pipework makes a connection into the pipeline system, a boss of branch pipe shall be provided which shall be at least twice the diameter in width and one diameter in thickness of the tapped hole which it contains.

Bosses shall be located at the main pipe horizontal centre line and those provided for water sample cocks shall be tapped 38mm (1.5") BSP and have reasonable access for sampling. Bosses provided for instrumentation equipment shall be tapped 1" BSP with a reducer fitted to suit the small bore pipework and isolating cock. Unused bosses shall be fitted with blank plugs having a central squared projection for tightening or removal.

Small Bore Pipework

Small bore pipework up to 15mm OD shall be manufactured from stainless steel tubing with suitable compression type fittings. All small bore pipework and capillary tubes shall be adequately and securely clipped or clamped. Compression fittings bends shall be kept to a minimum, as pipeline bends of generous radii are preferred. Compression couplings shall be heavy series to BS 4386 Part 1.

Any gauges, transducers or switches etc. fed via small bore pipework shall have an individual isolating cock adjacent to each component with adequate space being allowed for component removal for servicing.

Duct Seals

After the pipework is installed, the Contractor shall seal the ends of all ducts, pipes or trenches leading into buildings, whether occupied or not, for pipework associated with this Contract.

The seals shall be approved water, gas and fire sealing transit units with appropriate fillers, and insert blocks shall be fitted to duct trench entries. All steelwork on such transit assemblies and frames shall be hot dip galvanised. Where shown on the Engineer's drawings, transit frames will be incorporated in the construction by the Civil works contractor.

Reference Marking

Prior to dispatch from the manufacturer's works each pipe section shall be marked with an appropriate reference number for future identification.

Protection of Pipework

Immediately after the completion of fabrication at the works or on site and during transport and storage, pipe ends shall be protected from external damage and sealed against ingress of dirt by suitable caps, plugs or other similar means. After cleaning and inspection, machined surfaces of all steel and ironwork shall be covered with preserving fluids of approved type otherwise protected and all flanges shall be fitted with blank discs bolted to each face.

Ductile Iron Pipe Work

ii) General

Ductile iron pipes and fittings for water supply shall comply with BS EN 545.

Ductile iron pipes and fittings for sewers shall comply with BS EN 598.

Ductile iron pipes and fitting for sewerage rising mains shall comply with BS EN 598

Pipes and fittings shall have spigot and socket joints unless otherwise specified or shown on the Drawings.

Spigot and socket flexible joints shall be of the push-fit type with gaskets of ethylene propylene rubber (EPDM).

The Contractor shall supply sufficient pipes suitable for cutting on site to meet his requirements during pipeline construction.

iii) Flexible Joints

Spigot and socket flexible joints shall provide the following minimum angular deflections without leakage at the works test pressure specified.

not exceeding DN 300:	5°	exceeding
DN 300	:	4°

Joint deflection at installation shall not exceed 50% of the manufacturer's maximum allowable.

iv) Self Anchored Flexible Joints

Self anchored flexible joints for pipe diameters up to and including DN 300 shall be standard push-fit type joints but with modified gaskets incorporating stainless steel toothed inserts. The joints shall be suitable for a working pressure of 14 bar with allowable deflection of 5 degrees.

Self anchored flexible joints for pipe diameters exceeding DN 300 shall incorporate a weld on flange and tie bolts or similar self-restrained joint system. The joints shall be suitable for a working pressure of 14 bar with an allowable deflection of 4 degrees.

v) External Coating

Pipes and fittings shall be given an external coating of extruded polyethylene coating to BS EN 545.

Steel Pipe Work

vi) General

Steel pipes shall be manufactured to BS EN 10224 but also current or API Specification 5L and shall be suitable for the pressure ratings required by the Contract. Steel pipes shall be protected with an internal lining and an external coating.

Joints and fittings shall be provided with at least the same degree of corrosion protection as the pipe itself.

Steel pipes shall be manufactured or adapters supplied such that the outside diameters are compatible with the outside diameter of pipes and fittings to which steel pipes interconnect.

vii) Grade of Steel

Unless otherwise specified or necessary to meet the requirements of the Contract steel pipes shall be manufactured from Grad X 42 to API Spec. 5L with a minimum yield stress of 289 MPa and a minimum tensile strength of 413 MPa.

viii) Joints

The pipes and fittings shall be complete with push fit spigot and socket type joints with integral gasket of EPDM rubber or similar. After assembly the joints shall be welded around the socket mouth to seal the annulus and provide end-load resistance without damaging the internal corrosion protection system or the sealing gasket. A tapped hole shall be provided for pressure testing the completed joint. After testing the annulus shall be filled with bitumen and the hole plugged.

Where required by the Engineer the Contractor shall demonstrate his proposal, materials and methods of quality control by undertaking site trials of the jointing system.

ix) Thickness of Pipes and Fittings

The minimum permissible wall thickness of steel pipes and fittings shall be as required by API Specification 5L for the relevant pipeline locations and test pressures, in accordance with the Contract.

The minimum thickness for steel fittings shall take into account flexibility and stress intensification factors.

x) Inspection and Testing of Pipes and Fittings

All pipes and fittings shall be hydrostatically tested at the place of manufacture to the pressures stated in API Specification 5L.

External coatings shall be tested with a Holiday detector, prior to dispatch.

xi) Dimensions of Fitting and Specials

The dimensions of fittings and specials shall be in accordance with BS EN 10224 but also current.

xii) Corrosion Protection

Steel pipes and fittings shall be protected at the manufacturer's works with epoxy resin as follows:-

- Surface Preparation Blast cleaned internally and externally.
- Lining and Coating Internal and external surfaces coated with 10% solids thermosetting fusion bonded epoxy resin Scotchkote 206N or similar approved material. Minimum dry film thickness 300 microns applied by fluidized bed method.

Any damage to the coatings resulting from pipe cutting, jointing, welding, transportation, handling etc. shall be repaired with a two-part chemically cured epoxy resin primer and finish coats applied according to the manufacturer's instructions.

All coating materials shall be approved for contact with potable water.

xiii) Expansion Joints

Expansion joints shall permit expansion or contraction of the pipeline over a range of at least 50 mm either way, i.e. a total movement of 100 mm. Tie bolts shall be provided across the joint to restrict excessive movement of the joint. The expansion joint shall be coated internally and externally with the same material as the adjoining pipework. All bolts, nuts and washers shall be 316 stainless steel.

liv) z) Platforms and Walkways

General

All necessary platforms, toe-plates, ladders, stanchions, handrails, chains and all associated fittings, support structures and curbing shall be supplied to provide a safe and efficient installation.

Steelwork

All mild steel item shall be protected to BS 5493 Section II by hot dip galvanizing after fabrication to BS 729 with a minimum thickness of 85 microns (0.0034") unless otherwise specified.

No cutting, drilling, bending, riveting, threading or similar operation will be permitted after galvanizing, and due care shall be exercised in transporting, handling and fixing galvanised metalwork to prevent damage to zinc coating. Under no circumstances shall damage to zinc coating be repaired with rust inhibiting paint.

Platforms

Platforms as indicated on the Specification drawings shall be provided. All platform panels shall be individually secured to the supporting structure and be of suitable size and weight for ease of handling. They shall be cut and fixed to maintain a continuity of pattern.

Platforms, walkways and floor covers shall be adequately supported to prevent undue flexing and have supporting rebates with a minimum landing width of 30mm. Where the supporting structure is concrete, galvanised mild steel angle curbs shall be provided and securely grouted into rebates left in the concrete such that the tops of the panels are flush with the top of the concrete.

Normal access ways shall be suitable for a minimum uniformly distributed load of 5 kN/m² (105 lbf/ft²). Where platforms and floor covers are specified for concentrated loads or machinery support, the uniformly distributed loading shall be not less than 15 kN/m² (315 lbf/ft²).

Plated flooring shall be aluminum chequer plate having a minimum base thickness of 8mm with a non-slip tread pattern, secured to the supporting steelwork with countersunk screws, which shall be cadmium plated when used with aluminum plate. For maneuvering small-wheeled items e.g. switchboards trucks, plain floor sheeting 8mm thickness shall be provided over specified areas.

Open mesh platforms shall be open type, galvanised mild steel flooring.

Hinged Covers

Hinged covers provided in platforms shall have a galvanised, fabricated steel framework, covered to match the surrounding floor strength and pattern.

Covers provided for permanent man access shall be located as indicated on the specified drawings. They shall have a minimum clear opening of 750 x 750 mm and have a locking stay fitted, arranged so that in the fully open position, the stay will hold the cover open until released. Provision for padlocking the cover in the open or closed position shall be provided.

Covers for valve keys or other small openings shall be sized to suit the application and not include either stays or padlocking facilities.

Ladders

Ladders shall be of mild steel construction except where they are subject to prolonged immersion in water where they shall be of stainless steel.

Permanently fixed ladders of the step type shall have flat section, non-slip, open type treads not less than 450mm wide between stringers, with handrails fitted to each side extended to meet the platform handrails at the upper end. Tread width shall be not less than 120mm with a pyramid pattern nosing.

Vertical or near vertical fixed ladders for emergency use shall be in accordance with BS 4211 with equally spaced rungs between 230mm and 260mm apart with a width between stringers not exceeding 400mm. Safety hoops shall be provided where ladders rise more than 2.3m from the ground or platform. The stringers shall be extended at least 1100mm above the upper platform, and suitably opened out for access, or where ladders are below manhole covers, a separate hand hold shall be fixed to the upper platform.

Railings

Guardrails shall be provided for all platforms elevated greater than 500mm and the upper rail shall form the handrail. A knee rail shall be included and located approximately at mid-height.

Stanchions and rails shall be of mild steel or aluminum alloy tubing as specified, not less than 31mm overall diameter and tube thickness 10 SWG set in a twin-rail arrangement with the upper rail not less than 1.1m above the platform level or 900mm above the stringer pitch line for stair flight. Ball type tubular standards are to support the rails at not more than 1.5m centres and arranged so that there is a standard not more than 300mm away from any bend and 150mm from any rail joint. Rails are to be secured to prevent movement within the standards. Standards and rails shall be attached to the platform/walkway and not to any non-structural floor or toe plates.

Any roughness on the external surfaces shall be removed in an approved manner to produce a safe surface to the satisfaction of the Engineer.

A plastic coated finish shall be applied where specified and care should be taken to preserve from damage the plastic coating which may, if desired, be applied at a later date. The Contractor is to include all cleaning and derusting operations necessary.

Whenever possible, runs of guardrail shall be continuous and sharp vertical changes of direction shall be avoided. Handrails shall terminate in swept ends either to the wall or return to the knee rail by means of a U bend which shall not extend greater than 350mm beyond the centre line of the last standard.

Safety Chains

Access openings in guardrailing to ladders and platforms having a direct drop of more than 300mm shall be protected by a double row of safety chains of galvanised or electro-plated zinc mild steel 3 SWG x 3 links per 100mm complete with 'S' hook attachments at one end and permanently fixed at the other.

Toe Plates

All platform and walkway frames shall have toe plates attached to the sides where guardrails are fitted. Only around cut-outs provided in floor plates shall the toe plate be secured to the floor plate by welding.

Toe plates shall be at least 100mm high and 6mm thick, any gaps between the toe plate and the floor should not exceed 15mm.

Trench Covers

Trench covers shall be of minimum or galvanised mild steel chequer plate (min 3mm thick) supported to prevent undue flexing and having suitable holes to allow removal by standard lifting keys. Support shall be by means of steel curbing rebates cast into the trench top edges, such that the top of the covers are flush with the top of the finished floor level and providing a landing width of at least 30mm.

Additional or alternative support for switchboards etc. shall be from at least 75 x 35 mm channel section cross bearers and transverse trimmers, fixed or cast into the floor and located to suit equipment fixings, access requirements and floor cover spans.

To prevent differential deflection, butt straps shall be fitted to the underside of floor plates which have no other support.

Edging curbs suitable for mild steel chequer plate shall be painted in red oxide primer, the curbing may be tapped to accept cover securing screws. Where aluminum plates are used in contact with any mild steel supports, a bitumen coating on the points of contact shall be used.

aa) Cranes and Hoists

General

Cranes and hoists shall be of standard proven design in accordance with BS 466, rated for lifting the specified working loads, utilization and service conditions and shall be suitable for operation from the runway beams provided. Motions shall be motorized as specified with dual speed hoisting facility and controlled from a pendant push button unit via a crane control panel mounted on the gantry.

All operations, whether manual or electric, shall be controlled or performed from motor room floor level unless otherwise specified.

The lifting assembly shall be rated for the highest lift that could occur during installation and maintenance operations, including allowance for stiction.

The crane shall consist of a gantry or jib, crab and hoist assembly, ropes, block and hook together with the necessary running rails and all electrical supply requirements.

Chains used for lifting or travel shall be alloy steel and corrosion protected by an electro-deposited, zinc coated finish after manufacture. They shall not be hot dip galvanised.

Jibs or gantries shall be of plate or box girder design and securely attached to end mountings or carriages.

Hoist

The hoist unit on travelling beams shall be mounted to provide the highest possible lifting facility whilst maintaining adequate clearance between the crab/hoist assembly and the building structure and fittings.

Hoist units fitted to single runway beams, fixed or jib mounted, shall be of the self-suspension type mounted on a single rigid trolley suitable for manual geared travel along the runway beam. Two end stops shall be provided on the beam suitable for the trolley provided. The trolley shall have ball or roller bearings grease packed for life.

The hook shall be fitted with a swivel and a safety catch and be capable of touching the floor and providing a minimum lifting height as specified.

In the case of electrically operated hoist the normal hoist speed shall be approximately 4 metres/min and the creep speed shall be approximately 600mm/min or nearest standards. An overload device and overwind limit shall be included to prevent dangerous overloads. Raise and lower limit switches shall be provided at the maximum and minimum lift positions. Instantaneous fail safe braking in the event of power failure shall be provided.

Where operation is by electric motor a power supply shall be provided under the contract. Power shall be taken from a feed in the main distribution panel forming a part of the works and a wall mounted fused isolator shall be provided at a suitable location approximately 1.5 m above floor level alongside the lifting installation.

Power transmission to the moving installation shall be by pick up shoe running along the underside of shrouded rails, suspended concertina cable running on slides or a rail or a cable from a self winding cable reeling drum. In the latter case the tension in the cable shall be controlled and supported provided to prevent the cable dropping more than one metre below the crane rails(s).

Testing

All lifting equipment shall be tested at the manufacturer's works and on site. Tests on site shall comprise a full load test, including, where applicable, deflection checks on beams. Where the contractor wishes to use lifting equipment forming part of the permanent works for installation purposes he shall have the equipment tested and be in possession of a valid test certificate before using the equipment. All equipment must be tested or retested within one month of handing over to the Employer. Test

certificates shall be provided in triplicate. The Contractor shall be responsible at his own cost for the provision of all weights, slings and other equipment required for testing.

Rating Plates

The SWL shall be clearly marked on the rating plate and shall be legible from the plant working level.

Paint Finish

The finish colour shall be full gloss Yellow Colour No. 356 to BS 381C or equivalent reference 08 E 52 to BS 4800.

Crane Access

Where clearance permit, provision for safe maintenance shall be provided in accordance with BS 466 and shall include a walkway across the span having a height clearance of 2m and be fitted with double- tiered handrails and toe boards.

bb) Air Compressors and Blowers

Air Compressor/Blower

The compressor shall be an air cooled type capable of oil and dust free air delivery at the volume and pressures specified when directly or indirectly driven by an electric motor or diesel engine.

The compressor performance shall be in accordance with BS 1571 for the site condition and duty cycle specified and shall include the following components:

- Suction air filter/silencer;
- Solenoid operated unloader valve;
- Pressure relief valve;
- Non-return valve;
- Isolating valve;
- Low oil pressure switch (or pressure lubricated).

Where necessary, depending on load factor, the compressor shall include cylinder jacket and after cooler facilities for cooling the delivered air, the aftercooler having a suitable pressure relief valve and automatic drain valve.

Air Receiver

The compressor shall deliver air into an air receiver manufactured in accordance with BS 5169 Class III Grade E or F, to accommodate the specified design pressure and internal volume.

The receiver shall incorporate the following items:-

- One safety relief valve;
- One automatic drain valve;
- One pressure gauge (o – bar);
- Pressure and temperature switched to suit the control;
- Inspection access to permit internal examination of the receiver;
- Lifting facilities as determined by the receiver weight.

The receivers shall preferably be located in low ambient temperature areas to minimize condensation and the inlet outlet pipe connections shall be arranged to promote air circulation.

Separators

The air distribution main shall include a separator to remove suspended moisture in the air main.

Compressed Air Filters

The air supply shall incorporate filters of the disposable element type as near as possible to the point of use.

Filtration shall be carried out using two filters in series, the first filter graded for course filtration and the second for fine filtration as defined in the Specific Requirements.

Drain Traps/Strainers

Automatic drain traps shall be provided for air receivers, filters and separators. Strainers shall be provided for protection of the drain traps. Ball traps shall have cast iron bodies with stainless steel internal parts (Spiraax Sarco or equal).

Air Pressure Control

The compressor shall be arranged to maintain the air pressure in the system within the specified limits by means of pressure switches in conjunction with unloader valves and timers to prevent prolonged off- load running.

The frequency of starting and stopping shall be within the limitations of the drive arrangement.

Where two compressors are operated on a duty/standby basis, the duty compressor shall operate whenever the low pressure switch closes and shall cease operation when the high pressure switch opens. Should the pressure fall to the standby low pressure, the standby compressor shall operate in conjunction with the duty compressor and shall similarly cease operation when the high pressure switch opens.

The circuits for the compressor motor starters shall be completely separate. Either unit shall be capable of duty or standby operation and periodically their modes will be reversed.

The blower shall discharge continuously the specified free air delivery at specified suction and delivery pressures.

The blower shall be of the centrifugal or positive displacement rotary type with cast iron casings capable of delivering oil-free air. The blower shall be fitted with mechanical seals and incorporate a mechanical oil lubrication system, including an oil flow indicator, level indicator, pressure gauge, filling and drain plugs.

The design of the blowers is to be such that the noise level is kept to a minimum. The impellers shall each be equipped with heavy duty spherical roller bearing at each end. Gear end bearings shall be axially located on the inner and outer races to control thrust and maintain factory set clearances at all times.

The two timing gears shall be accurately machined to position the impellers in the impeller case and shall be secured to the shafts by locking kits. Gears shall be enclosed in an oil-tight housing.

The shaft sealing arrangement shall comprise a garter spring viton lip seal and a piston ring seal with an intermediate space vented to atmosphere.

Gears and gear end bearings shall be lubricated by a splash oiling system from oil maintained in the gear housing. Drive end bearings shall be grease lubricated or lubricated by a splash oiling system from oil maintained in the drive cover, depending upon gear size.

Each blower is to be direct driven through a flexible coupling, or indirectly via 'V' belts, by means of an electric motor, the complete assembly being mounted on a cast iron combination base plate. Both driver and driven units are to be dowelled or otherwise positively located to the base plate and substantial guards provided over all moving parts.

All covers and flanges associated with spigotted joints should be provided with easing screws if possible.

Blower Accessories

Each blower shall include a tachometer, an adjustable weight operated lever type air relief valve, delivery pressure and suction gauges each with isolating cocks mounted on a panel secured to a blower. An automatic unloader vented to outside atmosphere or an approved by-pass system is also to be included if this will assist starting.

The air relief valve is to be of double flanged cast iron construction with gunmetal trim. The adjustable weight shall have provision for locking to prevent any unauthorized interference.

Bosses shall be provided on each blower discharge pipe, upstream of the non-return valves, suitably tapped for connection by capillary tubing to pressure switches.

Blower Filters

The filters shall be capable of handling the designed throughput of air with the minimum of pressure drop whilst excluding 99.7% of all particles down to 2 microns.

The filters shall be of the two stage type comprising a hand operated roller mounted first stage roll type element and a disposable cartridge type second stage having access from one side only. The first stage unit is to be mounted in a galvanized sheet steel case with easily removable covers, the roller handle being conveniently positioned for easy adjustment of the roll.

The second stage unit is to be mounted in a galvanized sheet steel case and the units connected by a transition piece, a further transition piece being arranged between the second stage and the silencer. Connections with isolation taps are to be provided on both sides of each stage and suitable manometers fitted to allow for measurement of the differential pressure.

Each unit shall be supported from the floor on substantial steel frames with welded plate feet.

Air Silencers

Single inlet and outlet silencers shall be included for the blowers and manufactured of sheet steel, comprising a perforated inner tube and an outer galvanized casing, the space between being filled with a sound absorbing material. A flange is to be provided at each end, and all necessary supports extending to floor level are to be included. The silencers are to be designed for the minimum pressure drop..

Noise Attenuating Enclosure

The enclosure shall be removable pre-fabricated type designed to reduce the noise level by approximately 20 dB (A).

The enclosure shall incorporate access doors or panels such that routine maintenance can be carried out without removing the entire closure. It shall be possible to remove the enclosure without disconnection of the silencer mounted outside the enclosure. The operating sound pressure level of the set, measured in accordance with BS 4196 at a distance of 3 metres, with the exhaust silencer and the noise attenuating enclosure in position, shall be a maximum of 80 dB (A).

cc) Miscellaneous Equipment

Submersible Mixers

The mixer shall be of the propeller type where the motor, gear unit, shaft, and propeller comprise a compact unit which is completely submerged.

The complete unit shall be of materials suitable for the particular application.

The junction box shall be completely sealed from the surrounding liquid and from the motor unit to prevent ingress of liquids.

The gear unit shall be fitted with spur gears with helical teeth to provide the desired speed reduction to suit the particular application.

The motor shall be of submersible type in accordance with Section 6 – Electrical Specification. The mechanical shaft seal shall have working faces of material to suit the particular application.

Bearings shall be of the deep groove ball or roller type designed for an L10 life in excess of 25,000 hours of continuous operation.

The whole mixer unit shall be mounted on guide rails and shall be complete with all necessary chains and shackles for safe and effective removal.

A lifting davit suitable for removal of the mixer unit shall be provided which shall be tested in accordance with the relevant British Standards. Test certificates shall be provided and the safe working load shall be clearly marked. The lifting capacity of the davit shall exceed the maximum weight of the unit by 100% minimum to overcome binding of the mixer unit on the guide rail.

Tank Covers

Tanks shall conform to the following:

- Tank covers are to be provided where specified in order to retain odours. They shall be purpose designed and manufactured for the particular application from ultraviolet resistant Glass Reinforced Plastic (GRP) or glass-coated steel, and shall be provided with all necessary ribs and stiffeners on the underside to provide a rigid and robust structure;
- They shall rise from the tank walls to the centre of the tank, shall be self-draining and shall not sag or form hollows;
- They shall be suitable for use with sewage sludge and sludge gases, including those dissolved in water;

GRP covers shall comply with the relevant provision of BS 4994 as appropriate. Glass coated steel covers shall comply with the specification requirements for glass coated steel tanks, as appropriate;

Loading shall be in accordance with the provisions of BS 6399 (Roofs with no access) except where permanent access is specifically provided, in which case loadings shall be to BS 6399 (Roofs with access). In the case of GRP roofs, the maximum strain shall be limited to 0.3%. Calculations shall be provided for all roofs and covers;

The corners and edges of cover panel shall be smooth and uniform. All joints (viz. panels to wall, panels to bridge or panel to panel) shall be sealed with a flexible strip and pliant sealant to produce a close seal. The joints around openings, such as hatch covers, shall be sealed with a flexible strip firmly attached to the fixed portion of the covers;

Each cover shall incorporate 2 No. hinged, locking manholes at positions to be agreed, not less than 0.8m square. The lids shall be strengthened to prevent twisting on opening and shall be designed to fold back flat on opening with securely fixed handles;

The manhole and tank covers shall be provided a separate 200mm diameter stiffened opening with a sealing plate for instrumentation use. Where the covers are to be fitted to a tank at a roof height of more than 2m above ground level, suitable safety harness fixing points shall be provided adjacent to each manhole opening;

Each cover shall be provided with 2 No. 500mm square openings, one near the centre, one at the edge, in positions to be agreed, with stiffened edges, for fitting of ventilation equipment, and shall be sealed with removable plates;

In case where the covers are to be supplied together with new tanks or new scraper bridges, then they shall be designed in co-operation with the relevant manufacturers to ensure compatibility;

Where specified and where necessary for machinery access, special sealed access openings shall be provided shaped to suit the machinery concerned;

The method of fixing and sealing to the tank walls shall be for the supplier to decide, and shall be stated in the Tender. All supports, fixings etc. shall be manufactured from corrosion resistant material. Galvanized or plated mild steel is not acceptable.

Location

The works will be located in Machakos County.

Scope of Works

The Electrical sub-contractor shall supply and install the complete Electrical Services installation systems comprising but not limited to the following:

4.2.1 High Pressure protection

It shall be possible to program a “high-pressure” safety cut-out, set 1.5 bar above the duty pressure. The pumps set shall automatically shut down in the event of the above pressure being identified. Following a shut-down the controller shall (a) re-start the pump set automatically once the high condition has disappeared, or (b) will remain shut down until manually re-started by an authorised person. (The preferred option shall be agreed with the end user prior to hand over and the controller programmed accordingly).

4.2.2 Low Pressure/pipe burst protection

It shall be possible to program a “Low-pressure” safety cut-out, set 1 bar below the duty pressure. The pumps set shall automatically shut down in the event of the above pressure being identified. Following a shut-down the controller shall (a) re-start the pump set automatically once the high condition has disappeared, or (b) will remain shut down until manually re-started by an authorised person. (The preferred option shall be agreed with the end user prior to hand over and the controller programmed accordingly).

4.2.3 Soft pressure build up.

The panel shall incorporate a slow-speed/one-pump-only start up, following a power outage or maintenance shutdown to gradually fill up the pipeline and reduce risk of airlocks and water hammer.

4.2.4 Redundant sensor

The controller shall have a feature that gives an alarm if there is incoherency between the two discharge sensor signals.

4.2.5 Testing and Commissioning:

Once installed on site, with all necessary permanent water services, power supplies, control and alarm systems completed and tested. The panel manufacturer shall be invited to site to commission, test and demonstrate the operation of the panel to the full satisfaction of the Engineer and End User.

Working Drawings /Fabrication Drawings

Upon award of the subcontract the subcontractor shall produce three sets of the working drawings to Engineer prior to commencement of the work. The Engineer has to approve the drawings for the subcontractor to proceed with the works. The drawings shall be in A2 hard copies.

Fabrication drawings of the pumps control panel shall be submitted to the engineers for approval before fabrication commences.

Introduction

The Athi Water Works Development Agency proposes to construct two three bedroom site houses for the supervising team for the DESTP rehabilitation works. This technical specification describes the nature of the buildings works required.

Supervision of these works

These works are to be undertaken on public land. After construction, the houses are to be occupied by the supervision team or any other person designated by them. The AWWDA shall act as the Client for these works, and shall nominate one or more individuals to act as Engineers to supervise the works on their behalf. The AWWDA shall pay for the works and the supervision under the contract.

Tendering for these works is restricted to qualified contractors.

Location of the works

The works shall be carried out at existing boreholes within the above areas as shown to the contractors during the site visits.

Description of the works

The works shall comprise any or all of the following: –

- 1) Mobilisation and demobilisation.
- 2) Site excavations for the houses and septic tank.
- 3) Fittings including plumbing, electrical wiring etc

Programme of the works

The Contractor shall provide the Engineer with a Programme of Works that shall be mutually agreed on before Works commence. The Contractor shall adhere strictly to this Programme of Works unless otherwise authorised by the Engineer.

Site access

The Client shall obtain any permission required to gain access to the sites. The Contractor shall be responsible for carrying out any minor works necessary to access sites.

Provision of equipment, materials and labour

The Contractor shall provide all equipment, transport, materials consumables and labour necessary for the satisfactory completion of the Works in compliance with this Specification.

The Contractor will provide details of all plant to be deployed and present Method Statements describing in detail his approach to these works.

Diligent Performance

The Contractor shall at all times perform works diligently and in accordance with sound professional practice. The Contractor shall not proceed from one stage of works to another without the express permission of the Engineer.

SPECIFICATIONS FOR. 4X4 WD DOUBLE CABIN

SPECIFICATION NO.
DESCRIPTION: DOUBLE CABIN VEHICLE

a) Supplied new.	Yes (Mandatory)
b) Manufacturer's Literature & Brochures Supplied.	Yes (Mandatory)
c) Manufacturer's Authorization Supplied	Yes (Mandatory)
d) A standard production, 4x4, Diesel utility Double Cabin of latest design in the class, robust construction in current production and marketed in Kenya.	Yes (Mandatory)
e) Designed for light duty specifications, capable of operating in tropical conditions of mud and dust.	Yes (Mandatory)
f) Most suitable for operating on both "on and off" road conditions.	Yes (Mandatory)
g) Most suitable for personnel and cargo transportation.	Yes (Mandatory)
h) Technical Specification Sheet fully completed and submitted.	Yes (Mandatory)
1. ENGINE FOR THE VEHICLE	
a) Engine performance curves supplied	Yes
b) Engine type	4 stroke, 4cylinders. Inline
c) Valve mechanism	16 valve, DOHC
d) Engine cooling system	Water
e) Engine Air Supply System	Turbo charged
f) Piston displacement	2500cc-3000cc
g) Bore mm	92.0-95
h) Stroke mm (maximum)	103.6
i) Compression ratio	Specify
j) Maximum power (HP/Kw)	177/132
k) Engine speed at rated maximum power.	3400 rpm
l) Maximum torque developed.	450 Nm
m) Engine speed at maximum torque.	2400 rpm
n) Engine brake power	Specify
o) Air cleaner type	Disposable
p) Oil and fuel filter type	Disposable
q) Fuel tank capacity, minimum	80 Litres
r) Fuel system	Common rail diesel

a) Timing belt warning	Yes
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1. TRANSMISSION		
a) Automatic Transmission	Mandatory	
b) Number of speeds, min.	6F, 1R	
c) Gear shift	Floor board	
d) Drive configuration	4x4	
e) Differential gear ratio approx.	4	
f) Maximum Speed (Km/h)	180	
g) Freewheeling hubs, mechanical	Yes	
h) Differential lock provided	Yes	

1. DIMENSIONS		
a) Exterior Length in mm (minimum)	5300	
b) Exterior Width in mm (minimum)	1800	
c) Exterior Height in mm (minimum)	1800	
d) Wheelbase in mm	3080	
e) Minimum Ground Clearance (approximate)	310mm	
f) Minimum turning Circle (body) (approximate)	6700mm	
g) Minimum turning Circle (Tyre) (approximate)	6300mm	
h) Approach angle ($^{\circ}$) (minimum)	30 $^{\circ}$	
i) Departure angle ($^{\circ}$) (minimum)	21 $^{\circ}$	
j) Ram angle ($^{\circ}$) (approximate)	Specify	

1. WEIGHT		
a) Gross vehicle weight Kg	2800-3050	
b) Kerb weight Kg	1950-2150	
c) Payload Kg	800-1100	
d) Towing capacity with brakes Kg Minimum	2700	
e) Towing capacity without brakes Kg	750	

1. WHEELS ,BRAKES		
a) Front brakes	Ventilated disc brake	
b) Rear brakes	Leading trailing drum	
c) Tyre dimension	265/65 R17	
d) Alloy wheels	Yes	
e) Parking brake	Yes	
2. SUSPENSIONS		
Front suspension	Independent suspension, double wishbone with coil springs	
Rear suspension	Leaf spring/rigid axle	

1. STEERING		
a) Power Steering	Yes	
b) Tilt and telescoping steering adjustment	Yes	
c) Leather steering wheel	Yes	
2. BODY AND FINISH.		
a) All exterior body panels made non-corrosive, and all external steel fitting to be galvanized or painted	Yes	
b) Body finish, high gloss current NCWSC colour (to be specified by user)	Yes	
c) Vehicle to be painted in NCWSC paints as specified by the user.	Yes	

1. ELECTRICAL SYSTEM, INSTRUMENTS AND TOOLS		
a) Radio AM/FM, MP3,CD/DVD	Yes	
b) System voltage, negative earth, with alternator charging	12V, Yes,	
c) Battery capacity aprox..	Mandatory	
d) Maintenance free Battery	Mandatory	
e) Full lighting to conform to Kenya Traffic Act	Yes	
f) 6 speakers	Yes	
g) Outside mirror electrically adjustable & retractable.	Yes	
h) Parking brake lamp and emergency signal	Yes	
i) Power windows auto up/down (all)	Yes	
j) Window jam protection on all	Yes	
k) Glove box with key and damper	Yes	
l) Automatic air conditioner	Yes	
m) Automatic light control	Yes	
n) Fuel gauge	Yes	
o) Fuel gauge	Yes	
2. EQUIPMENT		
a) Hydraulic jack suitably rated to lift the unit with full load	Yes	
b) Wheel spanner, Set of hazard reflectors,	Yes	
c) Front fender fitted.	Yes	
d) Towing hitch and hook at rear and front respectively	Yes	
e) Sun visors supplied.	Yes	
f) Spare wheel supplied	Yes Mandatory	
g) Safety belts provided for all forward facing seats	Yes (Mandatory)	
h) Anti-theft alarm fitted	Yes (Mandatory)	
i) Metallic Hazard Triangles 2No and 1 Kg fire extinguisher	Yes (Mandatory)	
j) Supply addition Loose Floor rubber mats	Yes	
k) Standard First Aid KS-2094-2007 as per the KEBS specifications.	Yes (Mandatory)	
3. EXTRA ACCESSORIES.		
a) Leather shift leaver & knob	Yes	
b) High quality fabric seats	Yes	
c) Front seat adjustment	Yes	

a) Seat back pockets with hooks	Yes	
b) Side step with black cover, narrow	Yes	
c) Chrome door grill handles and outside mirror	Yes	
d) Front grill in chrome	Yes	
e) Chrome rear bumper	Yes	
f) Mud guard (front and rear)	Yes	
g) Seat adjustment for driver	Yes	
h) Anti-lock braking system		
i) Driver and passenger airbags (SRS)		
1. WARRANTY		
a) Specimen of vehicle warranty to be submitted when tendering	Yes	
b) Each vehicle supplied should carry a statement of warranty	Yes	
c) Equipment supplied to be covered by manufacturer's warranty.125,000Km or one year whichever comes first)	(Mandatory)	
d) First and second FREE services to including FREE Parts and Labour.	Yes	
2. MANUALS.		
All literature in English language	Yes (Mandatory)	
Repair manuals, supplied	Yes (Mandatory)	
Parts catalogue /microfiche/CD, supplied	Yes (Mandatory)	
Drivers handbook supplied	Yes (Mandatory)	
Service schedule supplied	Yes (Mandatory)	
3. OTHER REQUIREMENTS.		
Evidence (in form of purchase documents) of minimum 10 units sold and serviced in Kenya.	Yes (Mandatory)	
Vehicle to be registered by Registrar of Motor Vehicles.	Yes (Mandatory)	
Vehicle to be inspected by the NCWSC Mechanical Engineers prior to delivery.	Yes (Mandatory)	
Franchise Holders and dealers who own fully fledged workshops with adequate equipment and facilities.	Yes (Mandatory)	
Body construction and all fitments to conform to Kenya Traffic Act CAP 403.	Yes (Mandatory)	
Car identity on all Glasses and Lights.	Yes (Mandatory)	
Indicate name and physical addresses of all Dealers / Agents where Genuine Spares and back-up service can be obtained	Attach list Yes (Mandatory)	

As Built Drawings

The subcontractor shall prepare the As-Built drawings at the completion for the subcontract. The drawings shall be in AUTOCAD and 3No. Sets of A3 hard copies.

Abbreviations

The following abbreviations are used in these documents:

FIDIC	Federation International des Ingenieurs – Conseils
BS	British Standards
CP	Code of Practice
GRP	Glass Reinforced Plastic
AC	Asbestos Cement
DI	Ductile Iron
Ch	Chainage
PVC	Polyvinyl Chloride
kPa	kilo Pascal
g	acceleration due to gravity - (9.807m/s ²)
gpm	gallons per minute
mgd	million gallons per day
mm	millimeters
m	metres
mhd	metres head
m ³	cubic metres
m ³ /day	cubic metres per day
m/s ²	metres per second head 1/head/day
	litres per head per day
kW	kilowatts
kVa	kilovolt-ampere
kWh	kilowatt hour
ISO	International Standards Organization
CFM	cubic feet per minute
AOD	Above ordnance datum
SWL	Static water level
PWL	Pumping water level
GL	Ground level
EOH	End of hole

SECTION VI- DRAWINGS

SECTION VII – BILLS OF QUANTITIES

1.1 Preamble To Bill of Quantities

- a) The Bill of Quantities shall form part of the Contract Documents and is to be read in conjunction with the Instructions to Tenderers, Conditions of Contract Parts I and II, Specifications and Drawings.
- b) The brief description of the items in the Bill of Quantities is purely for the purpose of identification, and in no way modifies or supersedes the detailed descriptions given in the conditions of Contract and Specifications for the full direction and description of work and materials.
- c) The Quantities set forth in the Bill of Quantities are estimated and provisional, representing substantially the work to be carried out, and are given to provide a common basis for tendering and comparing of Tenders. There is no guarantee to the Contractor that he will be required to carry out all the quantities of work indicated under any one particular item or group of items in the Bill of Quantities. The basis of payment shall be the Contractor's rates and the quantities of work actually done in fulfillment of his obligation under the Contract.
- d) The prices and rates inserted in the Bills of Quantities will be used for valuing work executed, and the Engineer will measure the whole of the works executed in accordance with this Contract.
- e) A price or rate shall be entered in ink against every item in the Bill of Quantities with the exception of items, which already have provisional sums, affixed thereto. The Tenderers are reminded that no "nil" or "included" rates or "lump-sum" discounts will be accepted. The rates for various items should include discounts if any. Tenderers who fail to comply will be disqualified.
- f) Provisional sums (including Day works) in the Bill of Quantities shall be expended in whole or in part at the discretion of the Engineer in accordance with Sub-clause 52.4 and Clause 58 of part of the Conditions of Contract.
- g) The price and rates entered in the Bill of Quantities shall, except insofar as it is otherwise provided under the Contract, include all Constructional plant to be used, labour, insurance, supervision, compliance, testing, materials, erection, maintenance or works, overheads and profits, taxes and duties together with all general risks, liabilities and obligations set out or implied in the Contract, transport, electricity and telephones, water, use and replenishment of all consumables, including those required under the Contract by the

Engineer and his staff.

- h) Errors will be corrected by the Employer for any arithmetic errors in computation or summation as follows:
 - (a) Where there is a discrepancy between amount in words and figures, the amount in words will govern; and
 - (b) Where there is a discrepancy between the unit rate and the total amount derived from the multiplication of the unit price and the quantity, the unit rate as quoted will govern, unless in the opinion of the Employer, there is an obviously gross misplacement of the decimal point in the unit price, in which event the total amount as quoted will govern and the unit rate will be corrected.
 - (c) If a Tenderer does not accept the correction of errors as outlined above, his Tender will be rejected.
- i) The Bills of Quantities, unless otherwise expressly stated therein, shall be deemed to have been prepared in accordance with the principles of the latest edition of the Civil Engineering Standard Method of Measurement (CESMM).
- j) “Authorised” “Directed” or “Approved” shall mean the authority, direction or approval of the Engineer.
- k) Unless otherwise stated, all measurements shall be net taken on the finished work carried out in accordance with the details shown on the drawings or instructed, with no allowance for extra cuts or fills, waste or additional thickness necessary to obtain the minimum finished thickness or dimensions required in this Contract. Any work performed in excess of the requirements of the plans and specifications will not be paid for, unless ordered in writing by the Engineer.
- l)
 - (a) Hard material, in this Contract, shall be defined as the material which, in the opinion of the Engineer, require blasting, or the use of metal wedges and sledgehammers, or the use of compressed air drilling for their removal, and which cannot be extracted by ripping with a dozer tractor of at least 150 brake horse power (112 kilowatt) with a single, rear-mounted, hydraulic ripper. Boulders of more than 0.2m³ occurring in soft material shall be classified as hard material.
 - (b) Soft material shall be all material other than hard material.

2.1 The objectives of the Bills of Quantities are;

- (a) to provide sufficient information on the quantities of Works to be performed to enable tenders to be prepared efficiently and accurately; and

- (b) when a Contract has been entered into, to provide a priced Bills of Quantities for use in the periodic valuation of Works executed.

In order to attain these objectives, Works should be itemized in the Bills of Quantities in sufficient detail to distinguish between the different classes of Works, or between Works of the same nature carried out in different locations or in other circumstances which may give rise to different considerations of cost. Consistent with these requirements, the layout and content of the Bills of Quantities should be as simple and brief as possible.

3.1 The Bills of Quantities should be divided generally into the following sections:

(a) Preliminaries.

The preliminaries should indicate the inclusiveness of the unit prices, and should state the methods of measurement which have been adopted in the preparation of the Bills of Quantities and which are to be used for the measurement of any part of the Works.

The number of preliminary items to be priced by the tenderer should be limited to tangible items such as site office and other temporary works, otherwise items such as security for the Works which are primarily part of the Contractor's obligations should be included in the Contractor's rates.

(b) Work Items

- (i) The items in the Bills of Quantities should be grouped into sections to distinguish between those parts of the Works which by nature, location, access, timing or any other special characteristics may give rise to different methods of construction or phasing of the Works or considerations of cost. General items common to all parts of the Works may be grouped as a separate section in the Bills of Quantities.
- (ii) The brief description of the items in the Bill of Quantities should in no way modify or supersede the detailed descriptions given in the Contract drawings, Conditions of Contract and Specifications.
- (iii) Quantities should be computed net from the Drawings, unless directed otherwise in the Contract, and no allowance should be made for bulking, shrinkage or waste. Quantities should be rounded up or down where appropriate.

- (iv) The following units of measurement and abbreviations are recommended for use.

<i>Unit</i>	<i>Abbreviation</i>	<i>Unit</i>	<i>Abbreviation</i>
cubic meter	m ³ or cu m	millimeter	mm
hectare hour	ha	month number	mon
kilogram	h kg	square meter	nr
lump sum	sum	square millimeter	m ² or sq m mm ²
meter metric	m	week	or sq mm wk
ton (1,000 kg)	t		

- (v) The commencing surface should be identified in the description of each item for Work involving excavation, boring or drilling, for which the commencing surface is not also the original surface. The excavated surface should be identified in the description of each item for Work involving excavation for which the excavated surface is not also the final surface. The depths of Work should be measured from the commencing surface to the excavated surface, as defined.

(c) Daywork Schedule

A Daywork Schedule should be included if the probability of unforeseen work, outside the items included in the Bills of Quantities is relatively high. To facilitate checking by the Employer of the realism of rates quoted by the tenderers, the Daywork Schedule should normally comprise:

- (i) a list of the various classes of labour, and materials for which basic Daywork rates or prices are to be inserted by the tenderer, together with a statement of the conditions under which the Contractor will be paid for Work executed on a Daywork basis; and
- (ii) a percentage to be entered by the tenderer against each basic Daywork Subtotal amount for labour, materials and plant representing the Contractor's profit, overheads, supervision and other charges.

Provisional Quantities and Provisional Sums

- (iii) Provision for quantity contingencies in any particular item or class of Work with a high expectation of quantity overrun should be made by entering specific “Provisional Quantities” or “Provisional Items” in the Bills of Quantities, and *not* by increasing the quantities for that item or class of Work beyond those of the Work normally expected to be required. To the extent not covered above, a general provision for physical contingencies (quantity overruns) should be made by including a “Provisional Sum” in the Summary of the Bills of Quantities. Similarly, a contingency allowance for possible price increases should be provided as a “Provisional Sum” in the Summary of the Bills of Quantities. The inclusion of such provisional sums often facilitates budgetary approval by avoiding the need to request periodic supplementary approvals as the future need arises.
- (iv) Provisional Sums to cover specialized works normally carried out by Nominated Sub Contractors should be avoided and instead Bills of Quantities of the specialised Works should be included as a section of the main Bill of Quantities to be priced by the Main Contractor. The Main Contractor should be required to indicate the name (s) of the specialised firms he proposes to engage to carry out the specialized Works as his approved domestic sub- contractors. Only Provisional Sums to cover specialized Works by statutory authorities should be included in the Bills of Quantities.
- (v) Unless otherwise provided in the Contract, the Provisional Sums included in the Bills of Quantities should always be expended in whole or in part at the discretion of the Engineer after full consultation with the Employer.
- (d) Summary

The Summary should contain a tabulation of the separate parts of the Bills of Quantities carried forward, with Provisional Sums for Dayworks, physical (quantity) contingencies, and price contingencies (upward price adjustment) where applicable.

GRAND SUMMARY PAGE		
Bill No.	Description	Amount (KSh.)
1	Preliminaries and General Items	
1a	Offices for the Resident Engineer	
2	Anaerobic Ponds, 3 No.	
3	Facultative Pond, 1 No.	
4	Maturation Ponds, 3 No.	
SUBTOTAL 1		
Add 10% Contingencies		
SUBTOTAL 2		
14% VAT		
GRAND TOTAL		

Bidder's Name

Signature and Stamp.....

Date.....

BILL NO. 1 - PRELIMINARIES AND GENERAL ITEMS					
Item No	Description	Unit	QTY	Rate (KSh.)	Amount (KSh.)
	CLASS A - GENERAL ITEMS				
	Contractual Requirements				
A110	Performance Security	sum			
A120	Insurance of the Works, plant and materials against loss or damage.	sum			
A130	Third Party Insurance	sum			
A140.2	Provide for preparation and submission to the employer 1No set of both pdf and Autocad and 2 No sets of blue print copies (A1 SIZE) of as built drawings for all the lines in the contract(should be geo-referenced to the national grid).	sum	1		
	Specified Requirements				
A211	Provide for contractor's yard including offices and stores. Rate to include for all necessary equipping to meet the contractor's requirements (Amount to be for the entire contract).	sum	sum		
	Specified Requirements				
	Services for Engineer's Staff				
A221	Allow for Purchase of 2 no Project Vehicles, 4WD, Double Cabin of cc not less than 2,800 for sole use by the supervising Engineer during the execution period. Ownership to revert to the employer upon completion of the project, as per specifications attached in the Employers requirements.	No	2		
A222	Allow for provisional sum to Maintain, fuel, lubricate, and servicing of the transport vehicles under bill A221 for sole use by the supervising Engineer to the project for the contract period	km	60,000.00		
A224	Allow the Provisional Sum of KShs.2,000,000 to cover supervision costs of Engineers assigned on the project from the Employer's head office to cover expenses for communications, transport, allowances, etc to be expended as directed by the Project Manager.	sum			2,000,000.00
A225	Allow Kshs 1,000,000 for Engineers staff miscellaneous expenses including communication costs during the construction period.	PC			1,000,000.00
	Contractor's mark up to items A224-A225 above.	%	3,000,000.00		
	Specified Requirements				
	Testing of Materials and Works				
A250	Provide for concrete strength test..Rate to include for casting of the necessary number of cubes, curing, transport from site to testing institution and fees payable for the service.	nr	20		
	Total C/F to Next Page				

Item No	Description	Unit	QTY	Rate (KSh.)	Amount (KSh.)
	Total B/F From Previous Page				
	Temporary Works				
	Temporary Works				
A279	Allow for Provision, fixing and maintainance of publicity project signboards	nr	4		
	Other Provisional Sums				
A411	Dayworks	Sum			
A420.1	Allow PC for Communication Documentary as directed by the Project Manager	PC			5,000,000.00
A420.3	Allow for engagement of sociologists and community leaders in sensitization of the residents on the project.Rate to include for payable allowances and cost for barazas organization.	PC			1,000,000.00
A420.4	Allow for desilting of the existing manholes, and sewer channels in vicinity of the works and as instructed by the Engineer. Rate to include repair/replacement and realignment of the of damaged/collapsed sections of the manholes and disposal of the solid and liquid wastes to appropriate sites.	pc			1,000,000.00
A420.5	Contractor's mark up to items A420.1-A420.4 above.	%		7,000,000.00	
	Total Carried to Collection Sheet				

DAY WORKS					
ITEM NO.	DAY WORKS SCHEDULE	UNIT	QTY	RATE (Kshs)	AMOUNT (Kshs)
	CLASS A - GENERAL ITEMS				
	The rates entered in the following schedules will be used in assessing the cost of any extra work ordered by the Engineer for execution on a Dayworks basis.				
	If any rate is found to be grossly in excess of prevailing market rates the Engineer shall use the market rate for this purpose. The rates indicated are to include for Contractor's profit, administration, tools, supervision, overheads and all other costs in relation to the provision of labour, materials or plant indicated.				
	PLANTS AND EQUIPMENT				
A415.1	Welding machine (gasoline powered)	Hr	1		
A415.2	Grinding machine	Hr	1		
A415.3	Generator set	Hr	1		
A415.4	Porker vibrator	Hr	1		
A415.5	Concrete mixer	Hr	1		
A415.6	Dewatering pump	Hr	1		
A415.7	Excavator with bucket	Hr	1		
A415.8	Excavator with Hammer	Hr	1		
A415.9	Low bed truck	Hr	1		
A415.10	Lorry mounted Crane	Hr	1		
A415.11	Compressor	Hr	1		
A415.12	Backhoe Excavator	Hr	1		
A415.13	Damper	Hr	1		
A415.14	Damping truck	Hr	1		
A415.15	Single cabin pickup	Hr	1		
A415.16	Double cabin pickup	Hr	1		
A415.17	7 Ton Lorry	Hr	1		
A415.18	18 Ton Lorry	Hr	1		
A415.19	Pressure testing machine	Hr	1		
A415.20	45 ton compactor	Hr	1		
A415.21	5 ton Roller	Hr	1		
A415.22	Vehicle mounted lifting crane	Hr	1		
A415.23	Water tanker	Hr	1		
A415.24	Hand compactor	No	1		
	MATERIALS				
	LABOUR				
A411.1	Site Agent	hr	1		
A411.2	Assistant Engineer	hr	1		
A411.3	General fore man	hr	1		
A411.4	Foreman	hr	1		
A411.5	Supervisor	hr	1		
A411.6	Graded Artisan	hr	1		
A411.7	Ungraded Artisan	hr	1		
A411.8	Guard	hr	1		
A411.9	Welder	hr	1		
A411.10	Driver	hr	1		
A411.11	Machine operator	hr	1		
A411.12	Mason	hr	1		
A411.13	Plumber	hr	1		
A411.14	Store keeper	hr	1		
A411.15	unskilled labour	hr	1		
A411.16	Plant operator	hr	1		
A411.17	Site Clerk	hr	1		
A411.18	Painter	hr	1		
A411.19	Carpenter	hr	1		
A411.20	Office assistant	hr	1		
A411.21	Blaster(Certified)	hr	1		
A411.22	Pipelayer	hr	1		
A411.23	Concretor	hr	1		
A411.24	Surveyor	hr	1		
A411.25	Chainman	hr	1		

BILL NO. 1a - DESTP RESIDENT ENGINEER'S OFFICES

Bill. 1.1a-Excavations and wallings

Item No	Description	Unit	QTY	Rate (KSh.)	Amount (KSh.)
1	Strip the site for the houses of all vegetation, tree stumps and shrubs for depth not exceeding 200m	M2	320		
2	Excavate in natural earth for the house foundation	M3	400		
3	Excavate for the strip foundation 600mm wide for depths not exceeding 1.0m	M3	400		
4	Allow for placement of class 15 blinding concrete 50mm thick in strip foundation as indicated in drawings	M3	35		
5	Allow for placement of Class 20 concrete strip foundation, 200mm thick	M3	100		
6	Supply, lay and join with sand cement mortar 300mm thick stone masonry wall in strip foundation	M2	2400		
7	Allow for backfilling the strip foundation with compacted hardcore	M3	150		
8	Supply, place and compact 300mm thick blinding hardcore to ground floor slab as directed	M3	70		
9	Supply, place and compact 100mm thick class 20 concrete as specified in the drawing for the ground floor slab	M3	35		
10	Allow for termite and insect treatment of foundation	Sum	1		
11	Supply, join with sand cement mortar 200mm thick masonry walling as specified in the drawings. Stone dressing to be specified and approved by the Engineer.	M ²	1250		
12	Supply, join with sand cement mortar 200mm thick gable	M ²	175		
13	Supply and install approved bituminous felt damp proof course 300mm wide	M	300		
14	Allow for the construction of the fire place chimney in	Sum	1		
15	Supply, place and compact Class 25 reinforced concrete 300mm x 200mm lintel beam. Allow for all necessary formwork including shaping at verandahs	M3	28		
16	Supply and place Y12 high strength steel bars in the ring beam	Nr	460		
17	Supply materials and cast reinforced class 25 concrete verandah	M3	10		
18	Supply and lay 1000 gauge polythene sheet DPM sheet under the floor slab	m3	220		
19	Supply and place 50mm thick compacted murrum hardcore blinding layer	m3	15		
20	Allow for installation of permanent vents on top of doors, windows and gables. Specifications to be approved by Engineer	Nr	200		
21	Allow for the placement of precast reinforced concrete window sills as directed by the Engineer	Nr	30		
Total to Excavations and wallings Bill to Summary					

Bill. 1.2a-Doors and Windows

Item	Description	Unit	QTY	Rate	Amount
No				(KSh.)	(KSh.)
1	Supply and install steel casement windows size 2000mm x 1500	Nr	6		
2	Supply and install steel casement windows size 1800mm x 1500	Nr	12		
3	Supply and install steel casement windows size 1500mm x 1500	Nr	18		
4	Supply and install steel casement windows size 1200mm x 1500	Nr	6		
5	Supply and install steel casement windows size 1000mm x 1200	Nr	12		
6	Supply and install steel casement windows size 1000mm x 900	Nr	18		
7	Supply and install steel casement windows size 600mm x 900	Nr	12		
8	Supply and install steel casement windows size 600mm x 900	Nr	12		
9	Supply and install hardwood panel door size 900mm x 2400 with fanlight	Nr	12		
10	Supply and install steel casement door size 1200mm x 2400	Nr	6		
11	Supply and install steel grille door size 900mm x 2100	Nr	6		
12	Supply and install hardwood panel door size 1000mm x 2400 with fanlight	Nr	12		
13	Supply and install solid flush door size 900mm x 2400 with fanlight	Nr	24		
14	Supply and install solid flush door size 800mm x 2400 with fanlight	Nr	24		
15	Supply and install solid blockboard double leaf door size 1000mm x 2400 with fanlight	Nr	6		
Total for Doors and Windows Bill to Summary					

Bill. 1.3a-Roofing					
Item No	Description	Unit	QTY	Rate (KSh.)	Amount (KSh.)
1	Supply, join and place 100mm x 50mm timber wall plate as directed	m	750		
2	Supply, join and place 150mm x 50mm timber rafters and ceiling hoists in trusses as specified in drawings	m	1750		
3	Supply, join and place 100mm x 50mm timber struts in trusses as specified in drawings	m	1700		
4	Supply, join and place 100mm x 50mm timber purlins in trusses as specified in drawings	m	2600		
5	Supply, join and place 25mm x 25mm timber battens in roof trusses as specified in drawings	m	1		
6	Supply and place Gauge 28 Box iron sheets, pre painted as directed.	m2	1800		
7	Supply and place selected clay tile roof covering	Nr	1		
8	Supply and place 75mm x 50mm timber ceiling branderings as specified in the drawings	m	1200		
9	Supply and place 50mm x 50mm timber ceiling branderings as specified in the drawings	m	1175		
10	Supply and place selected celotex ceiling as directed by the Engineer	m2	1900		
11	Supply and install 100 x 100mm mild steel square hollow section pillar for the car ports as specified in the drawings	m	32		
12	Allow for roofing the car port as specified in the drawing and directed by Engineer	Sum	1		
Total for Doors and Windows Bill to Summary					

Bill. 1.4a-Plumbing, Fittings and Finishing works					
Item No	Description	Unit	QTY	Rate (KSh.)	Amount (KSh.)
1	Provide for supply and installation of plumbing facilities in the two houses as specified in the drawings. Include for installation of water closets, cisterns shower fittings, stainless steel sinks, dhobi sinks, hand wash basins, overhead storage reservoirs, foul water collection pipe systems and other plumbing accessories as specified and directed by the Engineer. Allow for connection to the existing water main	Sum	1		
2	Provide for supply and installation of all fittings in the two houses as specified in the drawings. Include for installation of table tops, shelves above and under the table tops, wardrobes, store shelves, kitchen shelves and work tops, and other accessories as specified and directed by the Engineer	Sum	1		
3	Provide for supply and installation of all electrical fittings in the two houses as directed by the Engineer. Include for complete wiring, installation of consumer meters, power sockets, lighting systems and connection to existing grid as directed	Sum	1		
4	Allow for the supply and installation of floor ceramic tiles	m2	1430		
5	Allow for ground preparation, supply and installation of concrete tiles with respect to the verandar, and roof eaves covering round the houses	m2	1200		
6	Allow for ground preparation, supply and installation of cabro blocks tiles with respect to the car ports.	m2	1160		
7	Supply and paint the undercoat, secondary and final layer for the house walls as directed by Engineer	m2	420		
8	Supply and paint the undercoat, secondary and final layer for the house celotex ceiling as directed by Engineer	m2	430		
9	Allow for supply of materials including concrete posts, and fencing with chicken mesh wire, 2.5m high fence for the two houses surrounds as directed. Including for installation of two 5m wide double leaf gates.	m	200		
10	Allow for grading the houses access road and placement of a murrum wearing surface to the houses as specified in drawings and directed by Engineer.	m	200		
Total for Plumbing, Fittings and Finishing works Bill to Summary					

Bill. 1.5a-Septic Tank works					
Item	Description	Unit	QTY	Rate	Amount
No				(KSh.)	(KSh.)
1	Strip the site for the septic tank of all vegetation, tree stumps and shrubs for depth not exceeding 200m	m2	60		
2	Excavate in natural earth for the house foundation to shape as directed for the septic tank	m3	120		
3	Allow for placement of class 15 blinding concrete 50mm thick in septic tank floor as indicated in drawings	m3	5		
4	Allow for placement of class 20 concrete 200mm thick in septic tank floor as indicated in drawings	m3	5		
5	Allow for placement of Class 25 reinforced concrete in septic tank walls, inlet, outlet base slabs, 200mm thick. Include for all formwork	m3	15		
6	Allow for supply of materials and casting of class 25 reinforced concrete slab for the septic tank as specified and directed by the Engineer. Include for all formwork	m3	4		
7	Allow for manholes, installation of stainless steel frames and manhole covers as shown in drawings and directed by Engineer	Nr	4		
8	Allow for construction of the vent pipes, inlet and outlet pipe connections. Allow for the construction of the reinforced 100mm thick sum baffle	Sum	1		
9	Allow for construction of the manholes, depths not exceeding 1.5m as shown by the Engineer	Sum	1		
10	Allow for trench excavation depth not exceeding 1.5m, supply and laying 8 inch pvc sewer/foulwater sewerline. Allow for connecting to the septic tank and testing.	m	300		
Total for Septic Tank works Bill to Summary					

Bill No.	Description	Amount (Kshs)
1.1a	Excavations and walling	
1.1b	Doors and windows	
1.1c	Roofing	
1.1d	Plumbing and fittings	
1.1e	Septic tanks	
Sub-total Resident Engineer's offices to Grand Summary		

Bill 2: BREAKDOWN OF WORK FOR STABILIZATION PONDS

Item No.	Item Description	BOQ
		Amount Kshs
	Anaerobic Ponds 3 No.	
	Mauration Ponds 3 No.	
	Fulcaltative Pond 1 No.	
	Total waste stabilization ponds	

ITEM No.	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
WASTE STABILISATION PONDS					
Anaerobic Ponds (3No)					
	General clearance				
D100	Open bush and thicket in and around the ponds. Locally disposed	ha	4.00		
	Removal of trees and stumps				
D210	Trees of girth: 500mm - 1m, locally disposed (provisional)	nr	2.00		
	<u>(A) INLET CHAMBERS (1 No)</u>				
	Excavation for structures				
E422	Excavate in embankment for channel in soft material	m ³	436.00		
	Filling and compaction				
E637	300mm compacted hardcore to bottom of structure	m ³	65.00		
	Provide and place In-situ concrete to specifications				
F511	75mm thick grade C15 blinding concrete	m ²	210.00		
F621	Grade C25/20 reinforced concrete	m ³	182.00		
G2	High yield steel reinforcement to specifications	t	13.00		
	Concrete ancillaries				
G241.1	F1- Plane vertical curved formwork to walls	m ²	330.00		
G241.2	F3- Plane vertical curved formwork to walls	m ²	825.00		
	<u>(B) INLET DISTRIBUTION CHAMBERS (1 No)</u>				
	Excavation for structures				
E422	Excavation in embankment for chambers	m ³	33.00		

	Filling and compaction				
E637	300mm selected granular fill from stockpile and as directed by the Engineer	m ³	1,555.00		
	Provide and place In-situ concrete to specifications				
F511	75mm thick grade C15/20 blinding concrete	m ³	19.00		
F522	Class C20 mass concrete bedding	m ³	1.00		
F621	Grade C25/20 reinforced concrete	m ³	18.00		
G22	High yield steel reinforcement to specifications	t	2.00		
	Concrete ancillaries				
G241.1	F1- Plane vertical formwork to walls	m ²	50.00		
G241.2	F3- Plane vertical formwork to walls	m ²	80.00		
G651.1	Form movement joints in walls and floors, including sealant, filler e.t.c complete as detailed	m	10.00		
G651.2	Water stops for expansion joints	m	40.00		
	Miscellaneous Works				
N18	GMS open mesh flooring	m ²	11.00		
N13	Supply and Install of stainless steel steps as shown in Drawing	nr	8.00		
N162.1	Supply and install DN 700mm stainless steel penstocks to specifications	nr	3.00		
N162.2	Supply and install DN 700mm stainless steel weir plates to specification	nr	3.00		
I342.1	Supply and install DN 700mm DI pipe from distribution to inlet chamber in accordance to specification	m	200.00		

	<u>(C) INLET CHAMBERS (3 No)</u>				
	Excavation for structures				
E422	Excavation in embankment for chamber	m ³	33		
	Provide and place In-situ concrete to specifications				
F511	75mm thick grade C15 blinding concrete	m ²	18.0		
F522	Grade C20 mass concrete bedding	m ³	1.0		
F622	Grade C25/20 reinforced concrete	m ³	15.00		
G22	High yield steel reinforcement to specifications	t	2.00		
	Concrete ancillaries				
G241.1	F1- Plane vertical curved formwork to walls	m ²	75.00		
G241.2	F3- Plane vertical curved formwork to walls	m ²	105.00		
G651	Form movement joints in walls and floors, including sealant, filler e.t.c complete as detailed	m ²	6.00		
G651	Water stops for expansion joints	m	37.00		
	Miscellaneous Works				
N18	GMS open mesh flooring	m ²	7.00		
N13	Supply and Install of Stainless steel Steps as shown in Drawing	nr	18.00		
I331	Supply and install DN 600mm DI inlet pipe to the ponds in accordance with the specification	m	123.00		
	<u>(D) POND CONSTRUCTION (3 No)</u>				
	Excavation for structures				
E44	General excavation in loose material to be disposed offsite as directed by the Engineer. Distance n.e. 5km one way (Provisional).	m ³	138,600.00		

E411	Excavation of Top soil,max depth n.e 0.25m; and srockpile/re-use as directed by the Engineer	m ³	11,550.00		
E422.1	Bulk excavation in soft material and stockpile on-site for re-use as directed by the Engineer	m ³	34,650.00		
E423	Extra over for general excavation in hard material (Provisional)	m ³	56,725.00		
	Filling to stated depth or thickness including compaction				
E624	Fill and compact the embarkment with material from stock pile as directed by the Engineer	m ³	34,650.00		
E622	Fill and compact the embarkment with imported material as directed by the Engineer. Cost to include overhaul of the material.	m ³	4,215.00		
E614.1	300mm thick pond lining with suitable excavated material re-used from stockpile	m ³	6,513.00		
E635.1	Provide and place lateritic gravel to embarkments as detailed, 500mm minimum thickness	m ³	5,058.00		
E635.2	Provide and and lay road wearing course to embarkements, minimum thickness 150mm laid to falls with side slopes as detailed	m ³	1,245.00		
E637	300mm compacted hardcore to bottom of piers and concrete protection slab	m ³	5.00		
	Provide and place in-situ concrete to specifications				
F511	75mm thick blinding on embankment for erosion protection slab and piers.	m ²	2,732.00		
	Grade C25/20 reinforced concrete using sulphate resisting cement				
F621.1	75mm thick concrete slab on embankment	m ³	237.00		
F621.2	225mm thick concrete erosion protection slab	m ³	12.00		
F653	Grade C25/20 reinforced concrete piers	m ³	26.00		
G22	High yield steel reinforcement to specifications for concrete erosion protection slab & piers	t	3.00		

G200.2	Provide and fix A252 fabric reinforcement to 75 mm thick slab	m ²	2,733.00		
E730	500 gauge polythene sheeting on blinding concrete	m ²	2,733.00		
G651.1	Provide full contraction joints to 75mm thick slab, and thickening as specified	m ²	60.00		
G651.1	Provide full expansion joints to 75mm thick slab, and thickening as specified	m ²	56.00		
G651.1	Expandite or similar approved	m	129.00		
	Concrete ancillaries				
G241.1	F1- Plane vertical formwork to pier footings	m ²	18.00		
G242.2	F3- Plane vertical formwork to pier columns	m ²	181.00		
	<u>(E) ACCESS RAMP (3No)</u>				
E634	Selected lateritic gravel fill on slopes and floor of pond for ramp	m ³	4,128.00		
	Provide and place in-situ concrete to specifications Grade C25/20 reinforced concrete using sulphate resisting cement				
F621.1	150mm thick concrete slab on top of ramp with ribbing	m ³	57.00		
F621.2	75mm thick concrete slab on ramp embankment	m ²	185.00		
G2	Provide and fix A252 fabric reinforcement to 150mm and 75mm thick slab	m ²	2,343.00		
E730	500 gauge polythene sheeting on blinding concrete	m ²	2,343.00		
G621.1	Provide full contraction joints to 75mm thick slab and thickenings, as detailed	m	35.00		
G621.2	Provide full expansionion joints to 75mm thick slab and thickenings, as detailed	m	35.00		

G621.3	Expandite or similar approved waterstops	m	126.00		
	<u>(F) DRAINAGE PLATFORM (3No)</u>				
E422	Excavate in embankment and base of pond for footings	m ³	70.00		
E423	Extra Over for excavation in hard material	m ³	7.00		
	Filling and compaction				
E637	300mm compacted hardcore to bottom of structures	m ³	10.00		
E634	Backfilling and compaction	m ³	47.00		
	Provide and place In-situ concrete to specifications using sulphate resisting cement				
F511	75mm thick blinding under footings	m ³	75.00		
F621	Grade C25/20 reinforced concrete for piers, Platform and sump	m ³	169.00		
G2	High yield steel reinforcement to specifications	t	16.00		
	Concrete ancillaries				
G241.1	F1- Plane vertical formwork to footings	m ²	60.00		
G241.2	F3- Plane vertical formwork to walls	m ²	190.00		
G241.3	F3- Plane vertical formwork to piers	m ²	181.00		
G211	F3- Plane horizontal formwork to soffit of slab	m ²	383.00		
	<u>(E) OUTLET CHAMBERS (6 No)</u>				
	Excavation for structures				
E422	Excavation in embankment for chambers	m ³	238.00		
E423	Extra Over for excavation in hard material	m ³	23.00		
	Filling and compaction				

E637	Compacted hardcore to bottom of structure as directed by the Engineer	m ³	58.00		
	Provide and place In-situ concrete to specifications				
G511	75 mm thick grade C15 blinding concrete	m ³	255.00		
F621	Grade C25/20 reinforced concrete	m ³	54.00		
G22	High yield steel reinforcement to specifications	t	4.00		
	Concrete ancillaries				
G241.1	F1- Plane vertical formwork to walls	m ²	75.00		
G241.2	F3- Plane vertical formwork to walls	m ²	265.00		
G241.3	F3- Plane vertical formwork to soffit of slab	m ²	54.00		
	Miscellaneous				
I242	Provide and lay DN 600mm concrete pipe with flexible joint, including building in of pipe to 200mm thick wall	m	6.00		
G651	Provide movement joints in floor and walls including sealant, filler and water stops	m ²	24.00		
G241.2	Water stops for expansion joints	m	160.00		
	<u>(F) OUTLET CHANNEL</u>				
	-				
	General excavation				
E42	Excavate in embankment for channel in soft material	m ³	662.00		
	Filling and compaction				
E637	Fill under channels with 300mm compacted hardcore	m ³	67.00		
	Provide and place In-situ concrete to specifications				
F511	75 mm thick grade C15 blinding concrete	m ²	395.00		
F621	Grade C25/20 reinforced concrete	m ³	240.00		

G2	High yield steel reinforcement to specifications	t	21.00		
	Concrete ancillaries				
G241.1	F1- Plane vertical formwork to walls	m ²	934.00		
G241.2	F3- Plane vertical formwork to walls	m ²	1,327.00		
F622	200mm thick RC slabs over channel complete with upstand as specified	m ³	14.00		
G651	Provide movement joints in floor and walls including sealant, filler and water stops	m ²	20.00		
G241.2	Water stops for expansion joints	m	55.00		
	Miscellaneous Work				
J88.1	Supply and install complete as specified 1000mm wide x 1000mm deep stainless steel penstock to specifications in the existing feed channel	nr	2.00		
J88.2	Supply and install complete as specified 1200mm wide x 1000mm deep stainless steel penstock to specifications in the existing feed channel	nr	2.00		
J88.3	Supply and install complete as specified 1400mm wide x 1000mm deep stainless steel penstock to specifications in the existing feed channel	nr	2.00		
TOTAL BILL No. 2D - ANAEROBIC PONDS					

MATURATION PONDS, 3 NO.					
ITEM No.	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
Maturation Ponds (3No)					
	General clearance				
D100	Open bush and thicket in and around the ponds. Locally disposed	ha	17		
	Removal of trees and stumps				
D210	Trees of girth: 500mm - 1m, locally disposed (provisional)	nr	3		
	<u>(A) INLET CHAMBERS (1 No)</u>				
	Excavation for structures				
E422	Excavate in embankment for channel in soft material	m ³	484		
	Filling and compaction				
E637	300mm compacted hardcore to bottom of structure	m ³	72		
	Provide and place In-situ concrete to specifications				
F511	75mm thick grade C15 blinding concrete	m ²	876		
F621	Grade C25/20 reinforced concrete	m ³	759		
G2	High yield steel reinforcement to specifications	t	54		
	Concrete ancillaries				
G241.1	F1- Plane vertical curved formwork to walls	m ²	366		
G241.2	F3- Plane vertical curved formwork to walls	m ²	916		
	<u>(B) INLET DISTRIBUTION CHAMBERS (1 No)</u>				
	Excavation for structures				
E422	Excavation in embankment for chambers	m ³	37		

	Filling and compaction				
E637	300mm selected granular fill from stockpile and as directed by the Engineer	m ³	1,726		
	Provide and place In-situ concrete to specifications				
F511	75mm thick grade C15/20 blinding concrete	m ³	21		
F522	Class C20 mass concrete bedding	m ³	1		
F621	Grade C25/20 reinforced concrete	m ³	1,881		
G22	High yield steel reinforcement to specifications	t	2		
	Concrete ancillaries				
G241.1	F1- Plane vertical formwork to walls	m ²	209		
G241.2	F3- Plane vertical formwork to walls	m ²	334		
G651.1	Form movement joints in walls and floors, including sealant, filler e.t.c complete as detailed	m	42		
G651.2	Water stops for expansion joints	m	44		
	Miscellaneous Works				
N18	GMS open mesh flooring	m ²	46		
N13	Supply and Install of stainless steel steps as shown in Drawing	nr	6		
N162.1	Supply and install DN 700mm stainless steel penstocks to specifications	nr	2		
N162.2	Supply and install DN 700mm stainless steel weir plates to specification	nr	2		
I342.1	Supply and install DN 700mm DI pipe from distribution to inlet chamber in accordance to specification	m	222		
	<u>(C) INLET CHAMBERS (3 No)</u>				
	Excavation for structures				
E422	Excavation in embankment for chamber	m ³	37		

	Provide and place In-situ concrete to specifications				
F511	75mm thick grade C15 blinding concrete	m ²	75		
F522	Grade C20 mass concrete bedding	m ³	1		
F622	Grade C25/20 reinforced concrete	m ³	17		
G22	High yield steel reinforcement to specifications	t	2		
	Concrete ancillaries				
G241.1	F1- Plane vertical curved formwork to walls	m ²	313		
G241.2	F3- Plane vertical curved formwork to walls	m ²	438		
G651	Form movement joints in walls and floors, including sealant, filler e.t.c complete as detailed	m ²	25		
G651	Water stops for expansion joints	m	154		
	Miscellaneous Works				
N18	GMS open mesh flooring	m ²	29		
N13	Supply and Install of Stainless steel Steps as shown in Drawing	nr	9		
I331	Supply and install DN 600mm DI inlet pipe to the ponds in accordance with the specification	m	137		
	<u>(D) POND CONSTRUCTION (3 No)</u>				
	-				
	Excavation for structures				
E44	General excavation in loose material to be disposed offsite as directed by the Engineer. Distance n.e. 5km one way (Provisional).	m ³	153,846		
E411	Excavation of Top soil,max depth n.e 0.25m; and srockpile/re-use as directed by the Engineer	m ³	12,821		
E422.1	Bulk excavation in soft material and stockpile on-site for re-use as directed by the Engineer	m ³	38,462		
E423	Extra over for general excavation in hard material (Provisional)	m ³	62,965		

	Filling to stated depth or thickness including compaction				
E624	Fill and compact the embankment with material from stock pile as directed by the Engineer	m ³	38,462		
E622	Fill and compact the embankment with imported material as directed by the Engineer. Cost to include overhaul of the material.	m ³	4,679		
E614.1	300mm thick pond lining with suitable excavated material re-used from stockpile	m ³	7,229		
E635.1	Provide and place lateritic gravel to embankments as detailed, 500mm minimum thickness	m ³	5,614		
E635.2	Provide and and lay road wearing course to embankments, minimum thickness 150mm laid to falls with side slopes as detailed	m ³	1,382		
E637	300mm compacted hardcore to bottom of piers and concrete protection slab	m ³	6		
	Provide and place in-situ concrete to specifications				
F511	75mm thick blinding on embankment for erosion protection slab and piers.	m ²	11,392		
	Grade C25/20 reinforced concrete using sulphate resisting cement				
F621.1	75mm thick concrete slab on embankment	m ³	263		
F621.2	225mm thick concrete erosion protection slab	m ³	13		
F653	Grade C25/20 reinforced concrete piers	m ³	29		
G22	High yield steel reinforcement to specifications for concrete erosion protection slab & piers	t	3		
G200.2	Provide and fix A252 fabric reinforcement to 75 mm thick slab	m ²	11,397		
E730	500 gauge polythene sheeting on blinding concrete	m ²	11,397		
G651.1	Provide full contraction joints to 75mm thick slab, and thickening as specified	m ²	250		

G651.1	Provide full expansion joints to 75mm thick slab, and thickening as specified	m ²	234		
G651.1	Expandite or similar approved	m	538		
	Concrete ancillaries				
G241.1	F1- Plane vertical formwork to pier footings	m ²	75		
G242.2	F3- Plane vertical formwork to pier columns	m ²	755		
	<u>(E) ACCESS RAMP (3No)</u>				
E634	Selected lateritic gravel fill on slopes and floor of pond for ramp	m ³	4,582		
	Provide and place in-situ concrete to specifications Grade C25/20 reinforced concrete using sulphate resisting cement				
F621.1	150mm thick concrete slab on top of ramp with ribbing	m ³	57		
F621.2	75mm thick concrete slab on ramp embankment	m ²	185		
G2	Provide and fix A252 fabric reinforcement to 150mm and 75mm thick slab	m ²	2,343		
E730	500 gauge polythene sheeting on blinding concrete	m ²	2,343		
G621.1	Provide full contraction joints to 75mm thick slab and thickenings, as detailed	m	35		
G621.2	Provide full expansionion joints to 75mm thick slab and thickenings, as detailed	m	35		
G621.3	Expandite or similar approved waterstops	m	126		
	<u>(F) DRAINAGE PLATFORM (3No)</u>				
E422	Excavate in embankment and base of pond for footings	m ³	70		
E423	Extra Over for excavation in hard material	m ³	7		
	Filling and compaction				
E637	300mm compacted hardcore to bottom of structures	m ³	10		

E634	Backfilling and compaction	m ³	47		
	Provide and place In-situ concrete to specifications using sulphate resisting cement				
F511	75mm thick blinding under footings	m ³	75		
F621	Grade C25/20 reinforced concrete for piers, Platform and sump	m ³	169		
G2	High yield steel reinforcement to specifications	t	16		
	Concrete ancillaries				
G241.1	F1- Plane vertical formwork to footings	m ²	60		
G241.2	F3- Plane vertical formwork to walls	m ²	190		
G241.3	F3- Plane vertical formwork to piers	m ²	181		
G211	F3- Plane horizontal formwork to soffit of slab	m ²	383		
	<u>(E) OUTLET CHAMBERS (6 No)</u>				
	-				
	Excavation for structures				
E422	Excavation in embankment for chambers	m ³	238		
E423	Extra Over for excavation in hard material	m ³	23		
	Filling and compaction				
E637	Compacted hardcore to bottom of structure as directed by the Engineer	m ³	58		
	Provide and place In-situ concrete to specifications				
G511	75 mm thick grade C15 blinding concrete	m ³	255		
F621	Grade C25/20 reinforced concrete	m ³	54		
G22	High yield steel reinforcement to specifications	t	4		
	Concrete ancillaries				
G241.1	F1- Plane vertical formwork to walls	m ²	75		

G241.2	F3- Plane vertical formwork to walls	m ²	265		
G241.3	F3- Plane vertical formwork to soffit of slab	m ²	54		
	Miscellaneous				
I242	Provide and lay DN 600mm concrete pipe with flexible joint, including building in of pipe to 200mm thick wall	m	6		
G651	Provide movement joints in floor and walls including sealant, filler and water stops	m ²	24		
G241.2	Water stops for expansion joints	m	160		
	<u>(F) OUTLET CHANNEL</u>				
	-				
	General excavation				
E42	Excavate in embankment for channel in soft material	m ³	662		
	Filling and compaction				
E637	Fill under channels with 300mm compacted hardcore	m ³	67		
	Provide and place In-situ concrete to specifications				
F511	75 mm thick grade C15 blinding concrete	m ²	395		
F621	Grade C25/20 reinforced concrete	m ³	240		
G2	High yield steel reinforcement to specifications	t	21		
	Concrete ancillaries				
G241.1	F1- Plane vertical formwork to walls	m ²	934		
G241.2	F3- Plane vertical formwork to walls	m ²	1,327		
F622	200mm thick RC slabs over channel complete with upstand as specified	m ³	14		
G651	Provide movement joints in floor and walls including sealant, filler and water stops	m ²	20		
G241.2	Water stops for expansion joints	m	55		

	Miscellaneous Work				
J88.1	Supply and install complete as specified 1000mm wide x 1000mm deep stainless steel penstock to specifications in the existing feed channel	nr	2		
J88.2	Supply and install complete as specified 1200mm wide x 1000mm deep stainless steel penstock to specifications in the existing feed channel	nr	2		
J88.3	Supply and install complete as specified 1400mm wide x 1000mm deep stainless steel penstock to specifications in the existing feed channel	nr	2		
TOTAL FOR MATURATION STABILISTION PONDS					

ITEM No.	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
WASTE STABILISATION PONDS					
Falcultative Ponds (1 No)					
	General clearance				
D100	Open bush and thicket in and around the ponds. Locally disposed	ha	26		
	Removal of trees and stumps				
D210	Trees of girth: 500mm - 1m, locally disposed (provisional)	nr	5		
	<u>(A) INLET CHAMBERS (1 No)</u>				
	Excavation for structures				
E422	Excavate in embankment for channel in soft material	m ³	1,099		
	Filling and compaction				
E637	300mm compacted hardcore to bottom of structure	m ³	72		
	Provide and place In-situ concrete to specifications				
F511	75mm thick grade C15 blinding concrete	m ²	1,361		
F621	Grade C25/20 reinforced concrete	m ³	1,179		
G2	High yield steel reinforcement to specifications	t	84		
	Concrete ancillaries				
G241.1	F1- Plane vertical curved formwork to walls	m ²	832		
G241.2	F3- Plane vertical curved formwork to walls	m ²	2,079		
	<u>(B) INLET DISTRIBUTION CHAMBERS (1 No)</u>				
	Excavation for structures				
E422	Excavation in embankment for chambers	m ³	83		
	Filling and compaction				

E637	300mm selected granular fill from stockpile and as directed by the Engineer	m ³	3,919		
	Provide and place In-situ concrete to specifications				
F511	75mm thick grade C15/20 blinding concrete	m ³	48		
F522	Class C20 mass concrete bedding	m ³	3		
F621	Grade C25/20 reinforced concrete	m ³	474		
G22	High yield steel reinforcement to specifications	t	5		
	Concrete ancillaries				
G241.1	F1- Plane vertical formwork to walls	m ²	324		
G241.2	F3- Plane vertical formwork to walls	m ²	518		
G651.1	Form movement joints in walls and floors, including sealant, filler e.t.c complete as detailed	m	65		
G651.2	Water stops for expansion joints	m	101		
	Miscellaneous Works				
N18	GMS open mesh flooring	m ²	72		
N13	Supply and Install of stainless steel steps as shown in Drawing	nr	3		
N162.1	Supply and install DN 700mm stainless steel penstocks to specifications	nr	3		
N162.2	Supply and install DN 700mm stainless steel weir plates to specification	nr	3		
I342.1	Supply and install DN 700mm DI pipe from distribution to inlet chamber in accordance to specification	m	504		
	<u>(C) INLET CHAMBERS (3 No)</u>				
	Excavation for structures				
E422	Excavation in embankment for chamber	m ³	83		

	Provide and place In-situ concrete to specifications				
F511	75mm thick grade C15 blinding concrete	m ²	117		
F522	Grade C20 mass concrete bedding	m ³	3		
F622	Grade C25/20 reinforced concrete	m ³	38		
G22	High yield steel reinforcement to specifications	t	5		
	Concrete ancillaries				
G241.1	F1- Plane vertical curved formwork to walls	m ²	486		
G241.2	F3- Plane vertical curved formwork to walls	m ²	680		
G651	Form movement joints in walls and floors, including sealant, filler e.t.c complete as detailed	m ²	39		
G651	Water stops for expansion joints	m	240		
	Miscellaneous Works				
N18	GMS open mesh flooring	m ²	45		
N13	Supply and Install of Stainless steel Steps as shown in Drawing	nr	9		
I331	Supply and install DN 600mm DI inlet pipe to the ponds in accordance with the specification	m	310		
	<u>(D) POND CONSTRUCTION (3 No)</u>				
	Excavation for structures				
E44	General excavation in loose material to be disposed offsite as directed by the Engineer. Distance n.e. 5km one way (Provisional).	m ³	349,272		
E411	Excavation of Top soil,max depth n.e 0.25m; and srockpile/re-use as directed by the Engineer	m ³	29,106		
E422.1	Bulk excavation in soft material and stockpile on-site for re-use as directed by the Engineer	m ³	87,318		
E423	Extra over for general excavation in hard material (Provisional)	m ³	142,947		

	Filling to stated depth or thickness including compaction				
E624	Fill and compact the embankment with material from stock pile as directed by the Engineer	m ³	87,318		
E622	Fill and compact the embankment with imported material as directed by the Engineer. Cost to include overhaul of the material.	m ³	10,622		
E614.1	300mm thick pond lining with suitable excavated material re-used from stockpile	m ³	16,413		
E635.1	Provide and place lateritic gravel to embankments as detailed, 500mm minimum thickness	m ³	12,746		
E635.2	Provide and and lay road wearing course to embankments, minimum thickness 150mm laid to falls with side slopes as detailed	m ³	3,137		
E637	300mm compacted hardcore to bottom of piers and concrete protection slab	m ³	13		
	Provide and place in-situ concrete to specifications				
F511	75mm thick blinding on embankment for erosion protection slab and piers.	m ²	17,703		
	Grade C25/20 reinforced concrete using sulphate resisting cement				
F621.1	75mm thick concrete slab on embankment	m ³	597		
F621.2	225mm thick concrete erosion protection slab	m ³	30		
F653	Grade C25/20 reinforced concrete piers	m ³	66		
G22	High yield steel reinforcement to specifications for concrete erosion protection slab & piers	t	8		
G200.2	Provide and fix A252 fabric reinforcement to 75 mm thick slab	m ²	17,710		
E730	500 gauge polythene sheeting on blinding concrete	m ²	17,710		
G651.1	Provide full contraction joints to 75mm thick slab, and thickening as specified	m ²	389		

G651.1	Provide full expansion joints to 75mm thick slab, and thickening as specified	m ²	363		
G651.1	Expandite or similar approved	m	836		
	Concrete ancillaries				
G241.1	F1- Plane vertical formwork to pier footings	m ²	117		
G242.2	F3- Plane vertical formwork to pier columns	m ²	1,173		
	<u>(E) ACCESS RAMP (3No)</u>				
E634	Selected lateritic gravel fill on slopes and floor of pond for ramp	m ³	10,403		
	Provide and place in-situ concrete to specifications Grade C25/20 reinforced concrete using sulphate resisting cement				
F621.1	150mm thick concrete slab on top of ramp with ribbing	m ³	57		
F621.2	75mm thick concrete slab on ramp embankment	m ²	185		
G2	Provide and fix A252 fabric reinforcement to 150mm and 75mm thick slab	m ²	2,343		
E730	500 gauge polythene sheeting on blinding concrete	m ²	2,343		
G621.1	Provide full contraction joints to 75mm thick slab and thickenings, as detailed	m	35		
G621.2	Provide full expansionion joints to 75mm thick slab and thickenings, as detailed	m	35		
G621.3	Expandite or similar approved waterstops	m	126		
	<u>(F) DRAINAGE PLATFORM (3No)</u>				
E422	Excavate in embankment and base of pond for footings	m ³	70		
E423	Extra Over for excavation in hard material	m ³	7		
	Filling and compaction				
E637	300mm compacted hardcore to bottom of structures	m ³	10		

E634	Backfilling and compaction	m ³	47		
	Provide and place In-situ concrete to specifications using sulphate resisting cement				
F511	75mm thick blinding under footings	m ³	75		
F621	Grade C25/20 reinforced concrete for piers, Platform and sump	m ³	169		
G2	High yield steel reinforcement to specifications	t	16		
	Concrete ancillaries				
G241.1	F1- Plane vertical formwork to footings	m ²	60		
G241.2	F3- Plane vertical formwork to walls	m ²	190		
G241.3	F3- Plane vertical formwork to piers	m ²	181		
G211	F3- Plane horizontal formwork to soffit of slab	m ²	383		
	<u>(E) OUTLET CHAMBERS (6 No)</u>				
	-				
	Excavation for structures				
E422	Excavation in embankment for chambers	m ³	238		
E423	Extra Over for excavation in hard material	m ³	23		
	Filling and compaction				
E637	Compacted hardcore to bottom of structure as directed by the Engineer	m ³	58		
	Provide and place In-situ concrete to specifications				
G511	75 mm thick grade C15 blinding concrete	m ³	255		
F621	Grade C25/20 reinforced concrete	m ³	54		
G22	High yield steel reinforcement to specifications	t	4		
	Concrete ancillaries				
G241.1	F1- Plane vertical formwork to walls	m ²	75		

G241.2	F3- Plane vertical formwork to walls	m ²	265		
G241.3	F3- Plane vertical formwork to soffit of slab	m ²	54		
	Miscellaneous				
I242	Provide and lay DN 600mm concrete pipe with flexible joint, including building in of pipe to 200mm thick wall	m	6		
G651	Provide movement joints in floor and walls including sealant, filler and water stops	m ²	24		
G241.2	Water stops for expansion joints	m	160		
	<u>(F) OUTLET CHANNEL</u>				
	-				
	General excavation				
E42	Excavate in embankment for channel in soft material	m ³	662		
	Filling and compaction				
E637	Fill under channels with 300mm compacted hardcore	m ³	67		
	Provide and place In-situ concrete to specifications				
F511	75 mm thick grade C15 blinding concrete	m ²	395		
F621	Grade C25/20 reinforced concrete	m ³	240		
G2	High yield steel reinforcement to specifications	t	21		
	Concrete ancillaries				
G241.1	F1- Plane vertical formwork to walls	m ²	934		
G241.2	F3- Plane vertical formwork to walls	m ²	1,327		
F622	200mm thick RC slabs over channel complete with upstand as specified	m ³	14		
G651	Provide movement joints in floor and walls including sealant, filler and water stops	m ²	20		
G241.2	Water stops for expansion joints	m	55		

	Miscellaneous Work				
J88.1	Supply and install complete as specified 1000mm wide x 1000mm deep stainless steel penstock to specifications in the existing feed channel	nr	2		
J88.2	Supply and install complete as specified 1200mm wide x 1000mm deep stainless steel penstock to specifications in the existing feed channel	nr	2		
J88.3	Supply and install complete as specified 1400mm wide x 1000mm deep stainless steel penstock to specifications in the existing feed channel	nr	2		
TOTAL FACULTATIVE STABILISTION PONDS					

VIII – STANDARD FORMS

LIST OF STANDARD FORMS

- (i) Form of Invitation for Tenders
- (ii) Form of Tender
- (iii) Appendix to Form of Tender
- (iv) Letter of Acceptance
- (v) Form of Agreement
- (vi) Form of Tender Security
- (vii) Performance Bank
Guarantee(unconditional)
- (viii) Bank Guarantee for Advance Payment
- (ix) Tender Questionnaire
- (x) Confidential Business Questionnaire
- (xi) Statement of Foreign Currency Requirement
- (xii) Schedule of Materials;- Basic Prices
- (xiii) Schedule of Labour;- Basic Prices
- (xiv) Schedule of Plant and Equipment
- (xv) Details of Sub-Contractors
- (xvi) Certificate of Tenderer's Site visit
- (xvii) Form of Written Power of Attorney
- (xviii) Key Personnel
- (xix) Completed Civil Works
- (xx) Schedule of Ongoing Projects
- (xxi) Other Supplementary Information
- (xxii) Declaration Form
- (xxiii) Request for Review

Name and Title

FORM OF TENDER

TO: _ *[Name of Employer]* _ *[Date]*
 _ *[Name of Contract]*

Dear Sir,

1. In accordance with the Conditions of Contract, Specifications, Drawings and Bills of Quantities for the execution of the above named Works, we, the undersigned offer to construct, install and complete such Works and remedy any defects therein for the sum of
 Kshs._ *[Amount in figures]*/Kenya
 Shillings_ *[Amount in words]*
 _
2. We undertake, if our tender is accepted, to commence the Works as soon as is reasonably possible after the receipt of the Project Manager's notice to commence, and to complete the whole of the Works comprised in the Contract within the time stated in the Appendix to Conditions of Contract.
3. We agree to abide by this tender until _ *[Insert date]*, and it shall remain binding upon us and may be accepted at any time before that date.
4. Unless and until a formal Agreement is prepared and executed this tender together with your written acceptance thereof, shall constitute a binding Contract between us.
5. We understand that you are not bound to accept the lowest or any tender you may receive.

Dated this _ day of _ 20_

Signature _ in the capacity of _

duly authorized to sign tenders for and on behalf of

_ *[Name of Employer]*
 of *[Address of Employer]*

Witness; Name_

Address_

Signature_

Date_

APPENDIX TO FORM OF TENDER

LETTER OF ACCEPTANCE

[letter head paper of the Employer]

[date]

To: _
 [name of the Contractor]

[address of the Contractor]

Dear Sir,

This is to notify you that your Tender dated _ for the execution
 of _

[name of the Contract and identification number, as given in the Tender documents]

for the Contract Price of Kshs. _ *[amount in*
figures][Kenya Shillings_ *(amount in words)]* in
 accordance with the Instructions to Tenderers is hereby accepted.

You are hereby instructed to proceed with the execution of the said Works in accordance with the
 Contract documents.

Authorized Signature Name and

Title of Signatory Attachment :

Agreement

FORM OF AGREEMENT

THIS AGREEMENT, made the _____ day of _____ 20____
 between office _____ is situated at] _____ of [or whose registered
 (hereinafter called “the Employer”) of the one
 part AND
 _____ of [or whose registered
 office is situated at] (hereinafter called “the
 Contractor”) of the other part.

WHEREAS THE Employer is desirous that the Contractor executes

(name and identification number of Contract) (hereinafter called “the Works”) located at _____ *[Place/location of the Works]* and the Employer has accepted the tender submitted by the Contractor for the execution and completion of such Works and the remedying of any defects therein for the Contract Price of Kshs_ *[Amount in figures]*, Kenya Shillings_ *[Amount in words]*.

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 hereinafter referred to.
2. The following documents shall be deemed to form and shall be read and construed as part of this Agreement i.e.
 - (i) Letter of Acceptance
 - (ii) Form of Tender
 - (iii) Conditions of Contract Part I
 - (iv) Conditions of Contract Part II and Appendix to Conditions of Contract
 - (v) Specifications
 - (vi) Drawings
 - (vii) Priced Bills of Quantities
3. In consideration of the payments to be made by the Employer to the Contractor as hereinafter mentioned, the Contractor hereby covenants with the Employer to execute and complete the Works and remedy any defects therein in conformity in all respects with the provisions of the Contract.
4. The Employer hereby covenants to pay the Contractor in

consideration of the execution and completion of the Works 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 thereto have executed caused this Agreement to be the day and year first before written.

The common Seal of _

Was hereunto affixed in the presence of _

Signed Sealed, and Delivered by the said _

Binding Signature of Employer _

Binding Signature of Contractor _

In the presence of (i) Name_

Address_

Signature_

[ii] Name _

Address_

Signature_

FORM OF TENDER SECURITY (UNCONDITIONAL BANK GUARANTEE)

WHEREAS(hereinafter called “the Tenderer”) has submitted his
tender dated for the construction of
.....
..... (*name of Contract*)

KNOW ALL PEOPLE by these presents that WE having our registered office
at(hereinafter called “the Bank”), are bound unto
.....(hereinafter called “the Employer”) in the sum of
Kshs..... for which payment well and truly to be made to the said Employer, 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 after tender opening the tenderer withdraws his tender during the period of tender validity specified in the instructions to tenderers
Or
2. If the tenderer, having been notified of the acceptance of his tender by the Employer during the period of tender validity:
 - (a) fails or refuses to execute the form of Agreement in accordance with the Instructions to Tenderers, if required; or
 - (b) fails or refuses to furnish the Performance Security, in accordance with the Instructions to Tenderers;
 - (c) Rejects a correction or an arithmetic error in the tender.

We undertake to pay to the Employer up to the above amount upon receipt of his first written demand, without the Employer having to substantiate his demand, provided that in his demand the Employer will note that the amount claimed by him is due to him, owing to the occurrence of one or both of the two conditions, specifying the occurred condition or conditions.

This 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 said date.

<hr style="border: none; border-top: 1px solid black; margin-bottom: 5px;"/> <i>[date]</i>	<hr style="border: none; border-top: 1px solid black; margin-bottom: 5px;"/> <i>[signature of the Bank]</i>
<hr style="border: none; border-top: 1px solid black; margin-bottom: 5px;"/> <i>[witness]</i>	<hr style="border: none; border-top: 1px solid black; margin-bottom: 5px;"/> <i>[seal]</i>

(Amend accordingly if provided by the Insurance Company)

PERFORMANCE BANK GUARANTEE (UNCONDITIONAL)

To: _ (Name of Employer) _ (Date)
 _ (Address of Employer)

Dear Sir,

WHEREAS _ (hereinafter called “the Contractor”) has
 undertaken, in pursuance of Contract No. _ dated _ to execute
 _ (hereinafter called “the Works”);

AND WHEREAS it has been stipulated by you in the said Contract that the Contractor shall furnish you with a Bank Guarantee by a recognised bank for the sum specified therein as security for compliance with his obligations in accordance with the Contract;

AND WHEREAS we have agreed to give the Contractor such a Bank Guarantee: NOW THEREFORE we

hereby affirm that we are the Guarantor and responsible to
 you, on behalf of the Contractor, up to a total of Kshs. _ (amount of
Guarantee in figures) Kenya Shillings
 (amount of *Guarantee in words*), and we undertake to pay you, upon your first written demand and
 without cavil or argument, any sum or sums within the limits
 of Kenya Shillings _ (amount of *Guarantee in words*) as
 aforesaid without your needing to prove or to show grounds or reasons for your demand for the sum
 specified therein.

We hereby waive the necessity of your demanding the said debt from the Contractor before presenting us
 with the demand.

We further agree that no change, addition or other modification of the terms of the Contract or of the
 Works to be performed there under or of any of the Contract documents which may be made between
 you and the Contractor shall in any way release us from any liability under this Guarantee, and we hereby
 waive notice of any change, addition, or modification.

This guarantee shall be valid until the date of issue of the Certificate of Completion.

SIGNATURE AND SEAL OF THE GUARANTOR _

Name of Bank _

Address _

Date _

(Amend accordingly if provided by Insurance Company)

Address _

Date _

Witness: Name: _

Address: _

Signature: _

Date: _

31. TENDER QUESTIONNAIRE Please

fill in block letters.

1. Full names of tenderer

.....

2. Full address of tenderer to which tender correspondence is to be sent (unless an agent has been appointed below)

.....

3. Telephone number (s) of tenderer

.....

4. Telex address of tenderer

.....

5. Name of tenderer's representative to be contacted on matters of the tender during the tender period

.....

6. Details of tenderer's nominated agent (if any) to receive tender notices. This is essential if the tenderer does not have his registered address in Kenya (name, address, telephone, telex)

..... Signature of

Tenderer

Make copy and deliver to : _

(*Name of Employer*)

CONFIDENTIAL BUSINESS QUESTIONNAIRE

You are requested to give the particulars indicated in Part 1 and either Part 2 (a), 2 (b) or 2 (c) and 2 (d) whichever applies 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; Country/Town..... Plot

No..... Street/Road Postal

Address..... Tel No..... Nature of

Business..... Current Trade Licence

No..... Expiring date.....

Maximum value of business which you can handle at any time: K. pound.....

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

Give details of partners as follows:

<i>Name in full</i>	<i>Nationality</i>	<i>Citizenship Details</i>	<i>Shares</i>
1.....			
2.....			
3.....			

Part 2(c) – Registered Company:

Private or public.....

State the nominal and issued capital of the Company-

Nominal Kshs..... Issued

Kshs..... Give details of

all directors as follows:

Name in full. Nationality. Citizenship Details*. Shares.

1.
..... 2.
..... 3.
..... 4.
.....

Part 2(d) – Interest in the Firm:

Is there any person / persons in(Name of Employer) who has interest in this firm? Yes/No.....(Delete as necessary)

I certify that the information given above is correct.

.....
(Title) (Signature) (Date)

* Attach proof of citizenship

STATEMENT OF FOREIGN CURRENCY REQUIREMENTS

(See Clause 60[5] of the Conditions of Contract)

In the event of our Tender for the execution of _____
 - _____ (*name of Contract*) being accepted, we would require in
 accordance with Clause 21 of the Conditions of Contract, which is attached hereto, the
 following percentage:

(Figures)..... (Words).....

of the Contract Sum, (Less Fluctuations) to be paid in foreign currency.

Currency in which foreign exchange element is required:

.....

Date: The Day of 20.....

Enter 0% (zero percent) if no payment will be made in foreign currency.

Maximum foreign currency requirement shall be
 - _____ (percent) of the Contract Sum, less Fluctuations.

(Signature of Tenderer)

SCHEDULE OF MATERIALS;-BASIC PRICES
(Ref: Clause 70 of Conditions of Contract)

MATERIAL	UNIT	ORIGIN AND PRICE			TRANSPORT ATION COST FROM SOURCE OF ORIGIN	
		COUNTRY OF ORIGIN	SUPPLIER	PRICE	MODE	PRICE (KSHS)
Cement	Mg					
Lime	Mg					
Sand	Mg					
Aggregate	Mg					
Diesel	L					
Regular Petrol	L					
Super Petrol	L					
Kerosene	L					
Structural steel	Mg					
Gabion Mesh	M2					
Reinforcement Steel	Mg					
Explosives	Kg					
Oil and Lubricants	L					
Bitumen Emulsion A3	L					
Bitumen Emulsion A4	L					
Bitumen Emulsion K1	L					
Bitumen Emulsion K3	L					
Bitumen 80/100	Kg					
Bitumen MC 30	ML					
Bitumen MC 70	L					
Bitumen MC 3000	L					
Ammonium nitrate for blasting	Kg					

I certify that the above information is correct.

.....
 (Title)

.....
 (Signature)

.....
 (Date)

The prices inserted above shall be those prevailing 30 days before the submission of Tenders and shall be quoted in Kenya Shillings using the exchange rates

specified in the Appendix to Form of Tender.

Prices of imported materials to be quoted CIF Mombasa or Nairobi as appropriate depending on whether materials are imported by the tenderer directly or through a local agent.

Transportation costs for imported materials to be quoted from Mombasa or Nairobi as appropriate to _ (Contract Site) depending on whether materials are imported directly by the tenderer or through a local agent.

SCHEDULE OF LABOUR:- BASIC RATES
(Reference: Clause 70 of Conditions of Contract)

LABOUR CATEGORY	UNIT (MONTH/SHIFT/HOUR)	RATES

Categories to be generally in accordance with those used by the Kenya Building Construction and Engineering and Allied Trades Workers' Union.

DETAILS OF SUB-CONTRACTORS

If the Tenderer wishes to sublet any portions of the Works under any heading, he must give below details of the sub- contractors he intends to employ for each portion.

Failure to comply with this requirement may invalidate the tender.

(1) Portion of Works to be sublet:

.....

[i] Full name of Sub-contractor

and address of head office:

.....

(ii) Sub-contractor's experience of similar works

carried out in the last 3 years with

Contract value:

.....

.....

.....

(2) Portion of Works to sublet:

.....

(i) Full name of sub-contractor and address of
head office:

.....

.....

.....

(ii) Sub-contractor's experience of similar

works carried out in the last 3 years with

contract value:

.....

.....

[Signature of Tenderer)

Date

CERTIFICATE OF TENDERER'S VISIT TO SITE

This is to certify that [Name/s].....

.....

Being the authorized representative/Agent of [Name of Tenderer]

.....

.....

participated in the organized inspection visit of the site of the works for the (Name of Contract:
.....)

..... day of..... 20.....

Signed.....

(Employer's Representative)

.....

NOTE: This form is to be completed whether the site visit is made at the time of the organized site or privately organized.

FORM OF WRITTEN POWER-OF-ATTORNEY

The Tenderer consisting of a joint venture shall state here below the name and address of his representative who is authorised to receive on his behalf correspondence in connection with the Tender.

.....
(Name of Tenderer's Representative in block letters)

..... (Address of
Tenderer's Representative)

..... (Signature of
Tenderer's Representative)

KEY PERSONNEL

DESIGNATION	NAME	NATIONALITY	SUMMARY OF QUALIFICATIONS AND EXPERIENCE
Headquarters: 1. Director 2. 3. 4. 5. etc.			
Site Office: 1. Site Superintendent 2. 3. 4. 5. etc.			

I certify that the above information is correct.

.....
(Title)

.....
(Signature)

.....
(Date)



**SCHEDULE OF COMPLETED CIVIL WORKS CARRIED OUT BY THE TENDERER IN
THE LAST EIGHT YEARS**

DESCRIPTION OF WORKS AND CLIENT	TOTAL VALUE OF WORKS (KSHS)	CONTRACT PERIOD (YEARS)	YEAR COMPLETED

I certify that the above Civil Works were successfully carried out and completed by ourselves.

.....
(Title)

.....
(Signature)

.....
(Date)

*Value in Kshs using Central Bank of Kenya mean exchange rate at a reference date 30 days before date of tender opening.



SCHEDULE OF ONGOING PROJECTS

DESCRIPTION OF WORK AND CLIENT	CONTRACT PERIOD	DATE OF COMMEN- CEMENT	DATE OF COMPLETION	TOTAL VALUE OF WORKS (KSHS.)	PERCENTAGE COMPLETED TO DATE

I certify that the above Civil Works are being carried out by ourselves and that the above information is correct.

.....
(Title)

.....
(Signature)

.....
(Date)

OTHER SUPPLEMENTARY INFORMATION

1. Financial reports for the last five years, balance sheets, profit and loss statements, auditors' reports etc. List them below and attach copies.
.....
.....
.....
2. Evidence of access to financial resources to meet the qualification requirements. Cash in hand, lines of credit etc. List below and attach copies of supporting documents
.....
.....
.....
3. Name, address , telephone, telex, fax numbers of the Tenderer's Bankers who may provide reference if contacted by the Employer.
.....
.....
.....
4. Information on current litigation in which the Tenderer is involved.

OTHER PARTY (IES)	CAUSE OF DISPUTE	AMOUNT INVOLVED (KSHS)

I certify that the above information is correct.

.....

Title

Signature

Date



DECLARATIONFORM

Date _

To

The tenderer i.e. (name and address)_

-

_declare the following:

- a) Has not been debarred from participating in public procurement.
- b) Has not been involved in and will not be involved in corrupt and fraudulent practices regarding public procurement.

Title

Signature

Date

(To be signed by authorized representative and officially stamped)



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



FORM RB 1

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