



MINISTRY OF WATER & SANITATION AND IRRIGATION



ATHI WATER WORKS DEVELOPMENT AGENCY

BIDDING DOCUMENTS

FOR

EXTENSION OF WATER AND SEWERAGE SERVICES FOR THE AFFORDABLE HOUSING PROGRAM

Lot 3: WATER AND SANITATION INTERVENTIONS FOR KIBERA AND MARIGUINI HOUSING PROJECTS

NCB No: AWWDA/GOK/AHP-W&S/W-03/2021

Employer: ATHI WATER WORKS DEVELOPMENT AGENCY

Issued on: 23RD MARCH, 2021



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

Invitation to Tender

NATIONAL COMPETITIVE BIDDING

EXTENSION OF WATER AND SEWERAGE SERVICES WITHIN NAIROBI

1. The Government of Kenya through Ministry of Water, Sanitation and Irrigation has allocated funds to Athi Water Works Development Agency (AWWDA) extension of water and sewerage services within Nairobi.
2. Athi Water Works Development Agency now invites sealed bids from eligible bidders registered in Category **NCA 6** by the National Construction Authority, and class F with the Ministry of Water, Sanitation and Irrigation, for the Extension of Water and Sewerage Services (**“the Works”**) for the following lots:-

Lot No.	Project Name	Tender Reference Number
1	Water and Sanitation Interventions for Park Road, Starehe & Pangani Housing Projects.	AWWDA/GOK/AHP-W&S/W-01/2021
2	Water and Sanitation Interventions Combined East Nairobi Housing Projects.	AWWDA/GOK/AHP-W&S/W-02/2021
3	Water and Sanitation Interventions for Kibera and Mariguini Housing Projects.	AWWDA/GOK/AHP-W&S/W-03/2021
4	Water and Sanitation Interventions for Dagoretti Area.	AWWDA/GOK/NCRP/AHF-W&S/W-04/2021

The contracts will be awarded in independent lots.

3. The following are mandatory requirements that must be submitted together with the Bid document:
 - Certified Copy of registration in Category **NCA 6 or above**, by the National Construction Authority
 - Certified Copy of Certificate of registration in **Category F or above**, as a water supply & sewerage contractor with the Ministry of Water, Sanitation and Irrigation

- Certified copy of certificate of Incorporation and a valid Tax Compliance Certificate
- Audited Financial Statements for the last 3 years

Further information will be in the bidding document.

- Interested eligible bidders may obtain further information from **Athi Water Works Development Agency, Chief Executive Officer, info@awwda.go.ke**.
- A complete set of bidding documents in English may be downloaded from AWWDA website www.awwda.go.ke, and www.tenders.go.ke free of charge. 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:
- All bids must be accompanied by a bid security in the form of an unconditional Bank guarantee or from an insurance company registered by IRA and approved by PPRA valued at Kshs. 500,000.00 (Kenya Shillings Five Hundred Thousand Only) for each lot.
- Bids must be delivered to the address below on or before **10.00 a.m East African Time on 13th April, 2021**. Late bids will be rejected. Bids will be publicly opened in the presence of all bidders' designated representatives; **ONLY ONE REPRESENTATIVE PER BIDDER** will be allowed to attend at the address below **13th April, 2021 at 10.05 a.m East African Time**.
- 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,
Athi Water Plaza,
Muthaiga North Road, Off Kiambu Road
P.O. BOX 45283-00100,
Nairobi, Kenya.
Tel: 254-715 688272;
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 to be completed and submitted 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 | <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> |
| 17. Tender Currencies | <p>17.1 The unit rates and prices shall be quoted by the Tenderer in the currency as specified in the Tender Data Sheet.</p> <p>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.</p> |

- 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.

	<p>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.</p>
32. National Preference	<p>32.1 In the evaluation of Tenders the Procuring Entity shall apply exclusive preference to citizens of Kenya where:</p> <ul style="list-style-type: none"> 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; <p>32.2 To qualify for the preference the candidate shall provide evidence of eligibility by:</p> <ul style="list-style-type: none"> 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. <p>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.</p>
33. Determination of the Lowest Evaluated Tender	<p>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.</p>
34. Post-qualification of Tenderer	<p>34.1 If specified in the Tender Data Sheet, post-qualification shall be undertaken.</p> <p>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</p>

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

- 47.1** The Administrative Review Board shall within

**Public Procurement
Administrative
Review Board**

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
A. Introduction		
1.	1.1	The Procuring Entity is Athi Water Works Development Agency
2.	1.1	<p>Name of Project is</p> <hr/> <p style="text-align: center;">WATER AND SANITATION INTERVENTIONS FOR KIBERA AND MARIGUINI HOUSING PROJECTS</p> <hr/> <p>AWWDA/GOK/AHP-W&S/W-03/2021</p>
3.	1.2	The expected completion date of the works: is 12 months from the commencement date
4.	1.3	The Objectives of the Project is: Improvement of Water and Sanitation in Kibera and Mariguini Housing Projects
5.	2.1	<p>Name of financing institution is: Government of Kenya</p> <p>Name of the Procuring is Athi Water Works Development Agency</p> <p>Financial Year: FY 2020/2021</p> <p>Describe works under the contracts:</p> <ul style="list-style-type: none"> a) Desilting and Rehabilitation of all Sub trunk sewers pipelines lines with their won-out manholes by raising them above flood levels. b) Laying of 300 mm-450mm dia DWC pipeline sewer as per the drawings. c) Laying of HDPE DN 100mm dia PN 12.5 water reticulation pipeline as per the drawings and specifications.
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	<p>Only Tenderers registered as</p> <p>a) water and sewerage contractor with the Ministry of Water & Sanitation and Irrigation under Category F and above</p> <p>b) Water works contractors NCA 6 and above.</p> <p>This Tender is: exclusively reserved for national contractors</p>
10.	7.3	No pre-bid meeting will be held

B. Tendering Documents		
12.	8.2	The number of copies to be completed and returned with the Tender is Three Copies and One Original
13.	8.1	<p>Address for clarification of Tendering Document is;</p> <p>Chief Executive Officer, Athi Water Works Development Agency, Athi Water Plaza, Muthaiga North Road, Off Kiambu Road P.O. BOX 45283-00100, Nairobi, Kenya. Tel: 254-715 688272; Email: info@awwda.go.ke</p>
14.	8.2	<p>Period to Respond to request for clarification by the Procuring Entity Seven Days (7days)</p> <p>Period Prior to deadline for submission of Tenders for Tenderers to request clarification Fourteen Days (14 days)</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> <p>a) 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</p> <p>b)</p> <p>c) 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:</p>

			Equipment type and characteristics	Minimum number required																													
			1) Excavator	2																													
			2) 2m ³ Concrete dumpers	1																													
			3) Poker vibrator 20 mm diameter	2																													
			4) Tipper Lorry - 7 Ton	2																													
			5) Tipper Lorry - 10 Ton	2																													
			6) Concrete Mixers 1m ³ including batch weighing	1																													
			7) Air compressor (5,000l/min)	2																													
			8) Generator (15kVA)	2																													
			9) Total station/Geodetic equipment	1																													
			10) Dewatering pumps	2																													
d) Required personnel shall have the following experience in works of an equivalent nature and volume.																																	
<table><tr><th>Position</th><th>Total experience (years)</th><th>In similar works (years)</th><th>As manager of similar works (years)</th></tr><tr><td>Site Agent</td><td>10</td><td>8</td><td>6</td></tr><tr><td>Civil site engineer</td><td>10</td><td>8</td><td>5</td></tr><tr><td>Surveyor</td><td>8</td><td>6</td><td>5</td></tr><tr><td>Foreman</td><td>8</td><td>5</td><td>3</td></tr><tr><td>CAD Technician</td><td>8</td><td>5</td><td>3</td></tr><tr><td>Community Liaison officer</td><td>5</td><td>5</td><td>3</td></tr></table>						Position	Total experience (years)	In similar works (years)	As manager of similar works (years)	Site Agent	10	8	6	Civil site engineer	10	8	5	Surveyor	8	6	5	Foreman	8	5	3	CAD Technician	8	5	3	Community Liaison officer	5	5	3
Position	Total experience (years)	In similar works (years)	As manager of similar works (years)																														
Site Agent	10	8	6																														
Civil site engineer	10	8	5																														
Surveyor	8	6	5																														
Foreman	8	5	3																														
CAD Technician	8	5	3																														
Community Liaison officer	5	5	3																														
e) Evidence of adequate working capital for this contract.																																	
f) Information regarding litigation, current																																	
17.	13.4	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, (i) The lead partner shall meet not less than 75% of all the qualifying criteria in above. (ii) The other partners shall meet individually not less than <u>25%</u> of all the qualifying criteria given in above (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.
18.	16.4	The price shall be <i>Fixed</i> Information to be submitted with the Tender are: (state if any).N/A
19.	17.1	The currency in which the prices shall be quoted shall be: <i>Kenyan Shilling</i>
20.	17.2 30.2	The authority for establishing the rates of exchange shall be Central Bank of Kenya. The applicable date for exchange rates for tendering and evaluation purposes is 28 days earlier than the final deadline for the submission of tenders.
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 (500,000 kes) (unconditional bank guarantee or from an approval insurance company registered by IRA and PPRA)
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; Chief Executive Officer, Athi Water Works Development Agency, Athi Water Plaza, Muthaiga North Road, Off Kiambu Road P.O. BOX 45283-00100, Nairobi, Kenya. Tel: 254-715 688272; Email: info@awwda.go.ke
26.	21.2 b)	Project name: WATER AND SANITATION INTERVENTIONS FOR KIBERA AND MARIGUINI HOUSING PROJECTS <hr/> Tender number AWWDA/GOK/NCRP/W-11/2020 Time and date for submission shall be on 13 th April 2021 at 10.00 am
27.	22.1	The deadline for Tender submission is 13th April 2021 at 10.00am
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 date of submission.

E. Opening and Evaluation of Tenders

29.	25.1	The Tender opening shall take place at: Athi Water Works Development Agency, Athi Water Plaza, Muthaiga North Road, Off Kiambu Road P.O. BOX 45283-00100, Nairobi, Kenya. Tel: 254-715 688272; Email: info@awwda.go.ke
30.	32.	Additional Preference <i>None</i>
31.	34.	Post- qualification will “ <i>not be undertaken</i> ”
32.	38.	Percentage for quantities increase or decrease is: <i>N/A</i>
F. Award of Contract		
33.	41.	The amount of Performance Security shall be 10% of the contract price
3.	42.	The Advance Payment shall be 10% of the Contract Price
35.	43.	The proposed adjudicator for the project to be appointed by the chairman of institute of arbitrators. Whose hourly rate shall be Ksh 20,000
G. Review of Procurement Decisions		
37.	46.1	The address for submitting appeals to Administrative Review Board : The Secretary, Public Procurement Administrative Review Board , The Public Procurement Oversight Authority, 10 th 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

APPENDIX TO INSTRUCTIONS TO TENDERERS

CLAUSE

13.3 Eligibility and Qualification requirements

Qualification Criteria: PRELIMINARY EVALUATION (All Are Mandatory)

- i. Bidders shall prepare and submit three copies (marked clearly “**ORIGINAL BID**” and “**COPY BID**”).
- ii. Offered 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
- iii. Attach Copy of Current Valid Tax Compliance Certificate, Business Permit and Certificate of Incorporation
- iv. Form of Tender duly completed, signed, stamped and witnessed. Appendix to Form of Tender shall also be dully 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 from 2017.
- 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 **EVERY** Page of their document with Official rubber Stamp for Ownership
- xi. Bidders **MUST** serialize **EVERY** page of the bid document submitted
- xii. Submit authority to seek references from the Bidders bankers and references
- xiii. 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).
- xiv. Further, the Original Bid Document issued by AWWDA shall be returned as part of the Tender Document. Bidders must submit all the pages of the Bid document as issued without altering the content therein.
- xv. All required information shall be attached to the Original Tender document and neatly bound. Documents submitted as Loose papers will be rejected at Preliminary evaluation stage and shall not progress to Technical Evaluation Stage
- xvi. Submit proof of registration as a water and sewerage contractor with the Ministry of Water & Sanitation and Irrigation under Category F and above, and Water Works Contractor, NCA 6 and above.

A firm lacking in any of the above details **shall be dropped** at this stage and shall not be progressed to the Technical Evaluation stage.

Eligibility and Qualification Criteria			Compliance Requirements				Documentation
No.	Subject	Requirement	Single Entity	Joint Venture (existing or intended)			Submission Requirements
				All Parties Combined	Each Member	One Member	
1. Eligibility							
1.1	Nationality	Nationality in accordance with ITT 2.2	Must meet requirement	Must meet requirement	Must meet requirement	N/A	Form of Tender
1.2	Conflict of Interest	No conflicts of interest in accordance with ITT 2.2	Must meet requirement	Must meet requirement	Must meet requirement	N/A	Form of Tender
1.3	Country Eligibility	Not having been declared ineligible by the procuring country	Must meet requirement	Must meet requirement	Must meet requirement	N/A	Form of Tender
1.4	Government Owned Entity of the Borrower country	Meets conditions of ITT 2.2	Must meet requirement	Must meet requirement	Must meet requirement	N/A	Form of Tender
1.5	United Nations resolution or country law	Not having been excluded as a result of prohibition in the country laws or official regulations against commercial relations with the Bidder's country, or by an act of compliance with UN Security Council resolution, both	Must meet requirement	Must meet requirement	Must meet requirement	N/A	Form of Tender
2. Historical Contract Non-Performance							
2.1	History of Non-Performing Contracts	Non-performance of a contract ¹ did not occur as a result of contractor default since <i>1st January 2014</i> .	Must meet requirement ¹²	Must meet requirements	Must meet requirement ²	N/A	Submit a Letter with Bidders' Letterhead/ Fill the Declaration Form
2.2	Suspension Based on Execution of Bid	Not under suspension based on	Must meet requirement	Must meet requirement	Must meet requirement	N/A	Submit a Letter with Bidders' Letterhead /Fill

¹ Non performance, as decided by the Employer, shall include all contracts where (a) non performance was not challenged by the contractor, including through referral to the dispute resolution mechanism under the respective contract, and (b) contracts that were so challenged but fully settled against the contractor. Non performance shall not include contracts where Employers decision was overruled by the dispute resolution mechanism. Non performance must be based on all information on fully settled disputes or litigation, i.e. dispute or litigation that has been resolved in accordance with the dispute resolution mechanism under the respective contract and where all appeal instances available to the Bidder have been exhausted.

² This requirement also applies to contracts executed by the Bidder as JV member.

Eligibility and Qualification Criteria			Compliance Requirements				Documentation
No.	Subject	Requirement	Single Entity	Joint Venture (existing or intended)			Submission Requirements
				All Parties Combined	Each Member	One Member	
	Securing Declaration by the Employer or withdrawal of the Bid within Bid validity	execution of a Bid Securing Declaration pursuant to ITB 4.6 or withdrawal of the Bid pursuant ITB 19.9.					the Declaration Form
2.3	Pending Litigation	Bidder's financial position and prospective long term profitability sound assuming that all pending litigation will be resolved against the Bidder	Must meet requirement	N/A	Must meet requirement	N/A	Submit a Letter with Bidders' Letterhead/Fill the Declaration Form

Eligibility and Qualification Criteria			Compliance Requirements				Documentation
No.	Subject	Requirement	Single Entity	Joint Venture (existing or intended)			Submission Requirements
				All Parties Combined	Each Member	One Member	
2.4	Litigation History	No consistent history of court/arbitral award decisions against the Bidder ³ since <i>1st January 2014</i> .	Must meet requirement	Must meet requirement	Must meet requirement	N/A	Submit a Letter with Bidders' Letterhead

³ The Bidder shall provide accurate information on the letter of Bid about any litigation or arbitration resulting from contracts completed or ongoing under its execution over the last five years. A consistent history of court/arbitral awards against the Bidder or any member of a joint venture may result in disqualifying the Bidder.

3. Financial Situation and Performance							
3.1	Financial Capabilities	<p>(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. 30,000,000 (or equivalence amount in freely convertible currency) for the subject contract(s) net of the Bidders other commitments</p> <p>(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.</p> <p>(iii) The audited balance sheets or, if not required by the laws of the Bidder's country, other financial statements</p>	Must meet requirement	Must meet Requirement	N/A	N/A	Financial Accounts
			Must meet requirement	Must meet requirement	N/A	N/A	
			Must meet requirement	N/A	Must meet requirement	N/A	

		acceptable to the Employer, for the last three years shall be submitted and must demonstrate the current soundness of the Bidder's financial position and indicate its prospective long-term profitability.					
3.2	Average Annual Construction Turnover	Minimum average annual construction turnover of Kshs. 80,000,000 Million , calculated as total certified payments received for contracts in progress and/or completed within the last three 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

4. Experience							
4.1 (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 three (3) years, starting 1 st January, 2017, 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
4.2 (a)	Specific Construction & Contract Management Experience	(i) A minimum number of similar ⁴ contracts specified below that have been satisfactorily and substantially ⁵ completed as a prime contractor, joint venture member ⁶ , management contractor or sub-contractor ⁶ between 1 st January, 2016 and application submission deadline: (i) at least 2 (Two) contract, each of minimum value Kshs 50 million ;	Must meet requirement	Must meet requirement ⁷	N/A	N/A	Proof of works undertaken
4.2 (b)		For the above and any other	Must meet requirements	Must meet requirements	N/A	Must meet the	Proof of undertaking

⁴ 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.

⁵ Substantial completion shall be based on 80% or more works completed under the contract.

⁶ 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.

⁷ 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.

		<p>contracts completed and under implementation as prime contractor, joint venture member, management contractor or sub-contractor⁸ on or after the first day of the calendar year during the period stipulated in 4.2 (a) above, a minimum construction experience in the following key activities successfully completed⁹:</p> <p><i>1. Trunk sewerage within minimum diameter of 300mm DWC and length of 5km</i></p> <p><i>2. River and Road crossings</i></p> <p><i>3. Concrete production of 300m3 in 3 months</i></p> <p><i>4. Earthwork production rate of 400m3/month</i></p>				requirements for the key activities listed	scope of works required.
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⁸ For contracts under which the Bidder participated as a joint venture member or sub-contractor, only the Bidder's share shall be counted to meet this requirement.

⁹ Volume, number or rate of production of any key activity can be demonstrated in one or more contracts combined if executed during same time period. The rate of production shall be the annual production rate for the key construction activity (or activities).

5. Personnel

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

Position	Total experience (years)	In similar works (years)	As manager of similar works (years)
Site Agent	10	8	6
Civil site engineer	10	8	5
Surveyor	8	6	5
Foreman	8	5	3
CAD Technician	8	5	3
Community Liaison officer	5	5	3

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

6. Equipment

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

Equipment type and characteristics	Minimum number required
1) 1.5 m3 or 20 ton Excavator	2
2) 2m3 Concrete dumpers	1
3) Poker vibrator 20 mm diameter	2
4) Tipper Lorry - 7 Ton	1
5) Tipper Lorry - 10 Ton	1
6) Concrete Mixers 1m ³ including batch weighing	1
7) Air compressor (5,000l/min)	2
8) Generator (15kVA)	2
9) Total station/Geodetic equipment	1
10) Dewatering pumps	2
11) Mobile rubber tyred crane(5 ton)	1
12) Pick up	1

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

Financial Evaluation:

The lowest evaluated tender shall be awarded the contract.

N/B: No corrections of errors

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

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.

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 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 non competitive 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, 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 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** 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.
- 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.
- 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** 12.1 From the Start Date until the Defects Correction Certificate has been issued, the following are Procuring Entity's risks:
- a) The risk of personal injury, death, or loss of or damage to property (excluding the Works, Plant, Materials, and 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 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. Commenceme
nt 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 approval by the Project Manager before their use.

**20. Protection of
the**

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

Environment	<p>other results of his operations.</p> <p>20.2 The Contractors shall ensure that emissions, surface discharges and effluent from his activities shall not exceed prescribed values in the environmental laws.</p>
21. Labour Laws	<p>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.</p> <p>21.2 The Contractor shall require his employees to obey all applicable laws, including those concerning safety at work.</p>
22. Health and Safety	<p>22.1 The Contractor shall at all times take all reasonable precautions to maintain the health and safety of his personnel.</p> <p>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.</p> <p>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.</p> <p>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.</p>
23. Discoveries	<p>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.</p>
24. Possession of the Site	<p>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 Procuring Entity will be deemed to have delayed the start of the relevant activities, and this will be a Compensation Event.</p>

- 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**
- 26.1 The Contractor shall carry out all instructions of the Project Manager which comply with the applicable laws where the Site is located.
- 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
- 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**
- 28.1 The Adjudicator shall give a decision in writing within 28 days of receipt of a notification of a dispute.
- 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.
- 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**.
- 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 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
- 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 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 Quantities

- 40.1 The Bill of Quantities shall contain items for the 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 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 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.
- (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 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 ‘**F**’.

$$F = P_n x P_c$$

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 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 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 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 **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 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 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.

Contract Data Sheet

Instructions for completing the Contract Data Sheet

CDS Clause	GCC Clause	Description
1	1.1	<p>A. General</p> <p>(Itemise Definitions to take the same numbering as per the General Conditions)</p> <p>The Procuring Entity is <i>Athi Water Works Development Agency</i></p> <p>The Adjudicator shall be appointed by chairman of the institute of arbitrators</p> <p>The Defects Liability Period is <i>12 months</i></p> <p>The Project Manager is Chief Manager Water and Sanitation Athi Water Works Development Agency, Athi Water Plaza, Muthaiga North Road, Off Kiambu Road P.O. BOX 45283-00100, Nairobi, Kenya. Tel: 254-715 688272; Email: info@awwda.go.ke</p> <p>The name and identification number of the Contract is AWWDA/GOK/AHP-W&S/W-03/2021</p> <p>The Works consist of</p> <ol style="list-style-type: none"> Desilting and Rehabilitation of all Sub trunk sewers pipelines lines with their won-out manholes by raising them above flood levels. Laying of 300 mm dia DWC pipes Arterials connecting to Motoini sewer as per the drawings. Provision of ablution blocks as specified by client and location to be provided by the community Laying of 300 mm dia DWC pipeline Extension to Kenya science and Nairobi trade fair sewer as per the drawings. Provision of 10 solid waste collection points generated Provision of pedestrian 1 access bridges as per the design. Construction of 1 water kiosk as per the drawings and specifications. Laying of HDPE DN 50mm dia PN 6 water reticulation pipeline as per the drawings and

		<p>specifications.</p> <p>The objectives of the contract is <i>Improving Water and Sanitary conditions in Kibera and Mariguini Housing Projects</i> which is mandatory requirements that override any detail which may be provided below.</p> <p>The Start Date shall be instructed by the project manager-.</p> <p>The Intended Completion Date for the whole of the Works shall be <i>12 months from Commencement date</i></p> <p>The following documents also form part of the Contract:</p> <ul style="list-style-type: none"> (a) <i>Contract Agreement</i> (b) <i>Letter of Acceptance</i> (c) <i>The minutes of negotiation</i> (d) <i>The Letter of Tender</i> (e) <i>The Particular Conditions of Contract including Contract Data (Appendix to Tender)</i> (f) <i>The General Conditions of Contract</i> (g) <i>Specifications</i> (h) <i>Drawings</i> (i) <i>Bills of Quantities, Price Adjustment Schedule</i> (j) <i>The Contractor's Submission</i> <p>The Site is located at Kenya Science, Kenya Trade Fair and Kibera along Motoine river up to Soweto and is defined in the drawings</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	The language of the Contract documents is <i>English</i> The law that applies to the Contract is the Kenyan Law.
5.	9.1	Include the Schedule of Other Contractors, if any.
6.	10.1	Include the Schedule of Key Personnel. <i>As indicated in the ITTs</i>
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 <i>[Kshs 2,000,000];</i> (b) loss of or damage to Equipment <i>[Kshs 2,000,000];</i> (c) loss of or damage to property (except the Works, Plant, Materials, and Equipment) in connection with the Contract <i>[Kshs 2,000,000];</i> and (d) Personal injury or death <i>[Kshs 3,000,000];</i>
8.	15.1	Site Investigation Reports available to the Tenderers are:

		N/A
9.	22.4	<p>The other measures include:</p> <p><i>a. Minimising the number of migrant workers employed on the project and household in the site camp</i></p> <p><i>b. Providing access to voluntary counselling and testing (VCT)</i></p> <p><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></p> <p><i>d. Providing condoms (male and female) to workers</i></p>
10.	24.1 & 47.1	The Site Possession Date shall 28 days after date of contract signature

11.	28.2	<p>Hourly rate of Fees payable to the Adjudicator is: KES 20,000</p> <p>Types of reimbursable expenses to be paid to the Adjudicator include: <i>[insert types of reimbursable expenses]</i>.</p> <p>a) Transport</p> <p>b) Communication</p> <p>c) Accommodation</p>
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

B. 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 30 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

C. Quality Control

17.	38.1	The Defects Liability Period is 365 days
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D. Cost Control

18.	45.7	Minimum Amount of Interim Payment Certificate will be KES 5,000,000
19.	46.1	The interest rate shall be N/A above prevailing interest rate for commercial borrowing from the contractor's 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 0.15 percent of contract price per day
	52.1 62.2 (g)	The maximum amount of liquidated damages is 5% of Contract Price
24.	53.1	The bonus for early completion is N/A
25.	54.1	The amount of advance payment shall be 10 per cent of the contract sum payable after submission of unconditional bank guarantee of equivalent amount
		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.
		E. 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 300,000 The amount to be withheld by the Project Manager in the case the contractor does not submit operating manual is: KES 300,000
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%

SECTION VI: TECHNICAL SPECIFICATIONS

Specifications

SECTION 1	GENERAL REQUIREMENTS
SECTION 2	EARTHWORKS, BACKFILLING AND RESTORATION
SECTION 3	CONCRETE WORKS - GENERAL
SECTION 4	PIPELINES, PIPEWORK
SECTION 5	BUILDINGS AND STRUCTURES
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

Nairobi is the capital and largest city of Kenya. The city and its surrounding area also form Nairobi County. With a population of about 3.36 million estimated in 2011, Nairobi is the second-largest city by population in the African Great Lakes region after Dar es Salaam, Tanzania. According to the 2009 census, in the administrative area of Nairobi, 3,138,295 inhabitants lived within 696 km² (269 sq mi). Nairobi is the 14th-largest city in Africa, including the population of its suburb

The city is situated at 1°17'S 36°49'E and occupies 696 square kilometres (270 sq mi).

The Nairobi River and its tributaries traverse through the Nairobi County. Nobel Peace Prize laureate Wangari Maathai has fought fiercely to save the indigenous Karura Forest in northern Nairobi which was under threat of being replaced by housing and other infrastructure.

Nairobi's western suburbs stretch all the way from the Kenyatta National Hospital in the south to the UN headquarters at Gigiri suburb in the north, a distance of about 20 kilometres (12 mi). The city is centred on the City Square, which is located in the Central Business District. The Kenyan Parliament buildings, the Holy Family Cathedral, Nairobi City Hall, Nairobi Law Courts, and the Kenyatta Conference Centre all surround the square.

1.2 Scope of Works

The following works are to be carried.

- ix. Desilting and Rehabilitation of all Sub trunk sewers pipelines lines with their won-out manholes by raising them above flood levels.
- x. Laying of 300 mm dia DWC pipes sewer as per the drawings.
- xi. Laying of 300 mm-450 mm dia DWC sewer pipeline in Kibera and Mariguini
- xii. Laying of HDPE DN 50mm-100 dia PN 12.5 water reticulation pipeline as per the drawings and specifications.

1.3 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 conditions.

1.4 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.

1.5 Operation and Maintenance Manuals

The Contractor shall submit to the Project Manager for approval four copies of the Operation and Maintenance (O&M) Manuals.

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.

1.6 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.

1.7 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.

The Contractor shall prepare detailed setting out drawings and data sheets as necessary and submit them to the 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.

1.8 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.

1.9 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.

1.10 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.

1.11 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.

1.12 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.

1.13 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.

1.14 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.

1.15 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.

1.16 Project Manager's Office

The offices of the Project Manager shall comprise reception area, two offices, a meeting room, kitchen and separate WC. They shall be served with electric lighting power, telephone line, potable water, networked broadband internet connection, heating and air conditioning. The broadband connection shall be networked throughout the office allow up to six computers to access the network. A wireless network is acceptable.

The Contractor shall make adequate provision for the drainage rainwater, sink waste (grey water) and foul sewage. Fly screens shall be fitted on every opening window and steps shall be provided where the entrance is elevated above ground level. The Contractor shall arrange for the regular cleaning of the facilities and the removal of the solid waste. He shall maintain all equipment in working order throughout the duration of the contract and arrange for the supply of all consumables including mobile phone vouchers, stationery, etc.

Each of the two offices, office 1 and office 2 shall have a minimum covered floor area of 12 m² and 20 m² respectively and each shall contain the following:

Office 1	Office 2
1 x double pedestal desk	2 x double pedestal desks
3 x chairs	6 x chairs
1 x 4 drawer lockable filing cabinet	2 x 4 drawer lockable filing cabinet
1 x 5 tier shelving unit to take A4 files	2 x 5 tier shelving unit to take A4 files
1 x plan table	1 x plan table
1 x telephone unit	2 x telephone units.

The meeting room shall have a minimum covered floor area of 20m² and shall contain the following:

- 1 x table (or tables of the same size) to accommodate 8 persons
- 8 x chairs
- 1 x wall mounted pin board, 2m x 1m
- 1 x wall mounted white melamine board, 2m x 1m
- 1 x AO size vertical plan chest
- 1 x A3/A4 printer/photocopier/scanner/fax
- 1 x A4 colour photo printer
- 1 x telephone unit
- The kitchen shall be equipped with a sink, a 4 burner gas cooker, electric kettle and fridge together with appropriate work surfaces.
- The separate WC shall be equipped with a low level WC suite with dual flush. Automatic air ventilation shall be provided where there is no opening window.

Other equipment to be supplied for the sole use of the Project Manager shall include:

- 1 x Toshiba Satellite P105 laptops or equivalent
- 1 x Desktop computer of at least equivalent specification
- 1 x 5 Megapixel Digital Camera
- 4 x mobile phones
- 1 x automatic level + tripod
- 1 x 3 m survey staff
- 3 x 5 m tapes

- 2 x 50 m tape
- 2 x 100 m tape
- 6 x survey books
- 2 x waterproof rubber torches with batteries
- 10 x safety helmets
- 6 x pair rubber boots (sizes to be advised)
- 10 x high visibility vests.

The Contractor shall provide adequate space and facilities at a convenient location for meetings between the Project Manager and Contractor.

The Project Manager's office shall be in a well lit, surfaced, fenced and secure compound with sufficient dedicated parking for 6 vehicles.

The compound shall be provided with 24 hour manned gate security to the approval of the Project Manager.

1.17 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.

1.18 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.

1.19 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.

1.20 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, unreliable or of bad character. Such employee shall not again be employed on the Works.

1.21 Project Management

1.21.1 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.

1.21.2 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.

1.21.3 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.

1.22 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.

1.23 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 anytime 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.

1.24 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.

1.25 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.

1.26 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.

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

1.28 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.

1.29 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.

1.30 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.

1.31 Units

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

1.32 Inspection and Testing during Manufacture

1.33 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

2.1 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.

2.2 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.

2.3 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.

2.4 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.

2.5 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.

2.6 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.

2.7 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.

2.8 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.

2.9 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.

2.10 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.

2.11 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.

2.12 Rock Surfaces under Concrete Structures

2.12.1 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 may direct before concrete is placed.

2.12.2 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.

2.13 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.

2.14 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.

2.15 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.

2.16 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 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.

2.17 Compaction Fraction Test

2.17.1 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.

2.17.2 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.

2.18 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.

2.19 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.

2.20 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.

2.21 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.

2.22 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 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.

2.23 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.

2.24 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:

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.

2.25 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.

2.26 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.

2.27 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.

2.28 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.

2.29 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.

2.30 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.

2.31 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

3.1 Scope

This Specification applies to structural concrete in small structures such as manholes, chambers and superstructure elements of small building works. This specification also applies to concrete in thrust blocks, blinding, supports, fill etc

3.2 Concrete

3.2.1 Classes

This Specification includes 4 grades of concrete

Grade CI5

Grade C20

Grade C25

Grade C30

The grade refers to the 28 day characteristic strength in N/mm²

3.2.2 Composition

The concrete composition shall generally conform to the requirements of the prescribed mix design, as set out in BS 5328 Tables I and 2. Small quantities of concrete may with the approval of the Project Manager be batched in accordance with the Table 3.1 of Nominal Mixes

Table 3.1 Nominal Mixes

Grade of concrete	Approx. volume of Aggregate m ³ per m ³ concrete		Approx. cement per m ³ finished concrete in bags (each 50 kg)	Remarks
	Fine	Coarse		
CI5	0.450	0.900	5	Aggregate max. size to be 20 mm. Fine aggregate to Zone M of BS 882 Water not to exceed 28 litres per 50kg of Cement
C20	0.400	0.875	6	
C25	0.375	0.825	8	
C30	0.350	0.725	11	

3.2.3 Structural Concrete

Structural concrete shall be Grade C20, C25 or C30, as shown on the drawings. The cement content shall not be less than 320 kg per cubic metre and the water/cement ratio shall not exceed 0.55 (27.5 litres per 50 kg of cement). The slump shall be 50 mm +/- 15mm when tested to BS 1881.

Unless otherwise approved by the Project Manager, the fine aggregate shall comply with Zone M or Zone F of BS 882. Coarse aggregate shall be 20 mm max size. The proportions of the mix shall be approximately as shown in the Tables 1 and 2 of BS 5328 but these proportions may be varied to obtain the specified strength requirements. Admixtures may not be used in ordinary structural concrete. A trial mix of the concrete to be used shall be made in

the presence of the Project Manager's Representative sufficiently in advance of the commencement of concreting to permit the 28 day compression test result of the cubes taken from the mix to be approved by the Project Manager's Representatives. 28 day compression cube tests shall be carried out taking one sample for each 20 m³ of concrete placed with a minimum of one sample per day. Three cubes are to be cast from each sample. If more than 5% of test results fall below the specified characteristic strength when tested to BS 1881, adjustments to the mix shall be made in order to obtain the strength required and the Project Manager may require concrete already placed to be made good as described in this Specification.

3.2.4 Cement

Cement for normal concrete shall be Ordinary Portland or Rapid Hardening cement to BS 12 or shall be CEMI-32.5, CEMII-32.5 or CEMIV-32.5 or higher strength grade in accordance with Kenya Standard KS 1725 Part 1 and Part 2. Cement for sulphate resisting concrete shall be sulphate resisting cement to BS 4027. Cement which is not fresh and dry before mixing shall not be used in the Works.

3.2.5 Water

Water shall be potable

3.2.6 Aggregates

Fine aggregate shall be clean natural sand. Coarse aggregate shall be crushed stone, washed gravel or other inert granular material as approved by the Project Manager.

All aggregates shall comply with the requirements of BS 882 and grading curves shall be provided for all aggregates used.

3.3 Reinforcement

Reinforcement shall comply with BS 4449 and shall be bent in accordance with BS 4466. Fabric reinforcement shall be made from cold-drawn high tensile steel and shall comply with BS 4483. Reinforcement which is rusted shall be wire brushed before use to remove mill scale.

3.4 Formwork

3.4.1 Requirements

Formwork shall be accurately formed and shall be of sufficient strength and rigidity as to carry the weights and pressures of the concrete without deformation. It shall be tight so as to avoid the loss of grout and shall be clean and free from damage.

"Rough Finish Formwork" shall consist of sawn boards or sheet metal panels and shall only be used where specified in the Bill to produce a rough finish.

"Fair Finish Formwork" shall produce a high standard of finish. Where not otherwise specified in the Bill of Quantities this formwork shall be used throughout the Works. It shall consist of wrought timber boarding 40 mm thick tongued and grooved, or framed plywood, and arranged in a uniform pattern.

3.4.2 Striking and Removal of Formwork

Striking of formwork shall be carried out having regard for the climatic conditions prevailing, and shall be 'undertaken at the sole risk of the Contractor. Where premature removal of formwork takes place and deformation is apparent, with or without distress in the concrete, the work shall be made good as described in this Specification. The following striking' times are included as a guide for normal conditions and shall be treated as a minimum requirement:

Suspended Slabs	(props left under)	5 days
Ditto	(props removed)	10 days
Beam soffits	(props left under)	9 days
Ditto	(props removed)	19 days
Sides of beams, walls and columns		1 day

All exposed concrete arrises are to have 20mm x 20mm chamfer unless otherwise shown on the drawings.

3.5 Concreting

3.5.1 Requirements

The finished concrete shall be dense durable and free from cracks and honeycombing.

3.5.2 Mixing, Transporting and Placing

All concrete shall be made in a mechanical mixer. Concrete shall be placed within 30 minutes of completing the mixing or agitation. Mixing may be continued in the mixer or agitator up to a maximum period of 90 minutes and for not less than the period required to achieve an even consistency of the mix. All concrete shall be compacted by a mechanical vibrator and a slump test shall be carried out on each batch mixed, unless otherwise approved by the Project Manager's Representative.

3.5.3 Concreting in difficult weather conditions

Concreting during hot or cold weather conditions shall comply with the established requirements of good practice. During wet weather adequate covering shall be provided to both materials and concrete.

3.5.4 Curing

All concrete shall be properly cured for 7 days, by wetting or by use of an approved curing membrane.

3.5.5 Finishes to Concrete

All exposed faces of concrete shall be hard, smooth and free from honeycombing and other blemishes. All projections shall be rubbed down with carborundum stone. The normal finish to slabs and screeds, unless otherwise specified, shall be formed by wood floating the accurately levelled or screeded surface.

3.5.6 Making Good

Any section of the work which, in the opinion of the Project Manager, does not conform to

the requirements or clear intent of this Specification, or to the requirements of established good practice, shall be made good or removed and replaced as directed by the Project Manager at the expense of the Contractor.

3.6 Ready Mixed Concrete

Ready mixed concrete shall comply with the requirements of this Specification and to those other requirements of BS 5328 which do not conflict with the Specification.

3.7 Granolithic Concrete

Granolithic concrete shall conform to the recommendations laid down in the "Specification for Granolithic floor toppings laid on in-situ concrete" as published by the Cement and Concrete Association with special reference to monolithic construction.

3.8 Concrete Benching

Concrete benching shall consist of structural concrete, as herein specified, placed to a low workability and finished while still green with 50 mm Grade C25 fine concrete using a maximum aggregate size of 10 mm and steel trowelled to a smooth dense finish to the concrete contours.

3.9 Precast Concrete Units

3.9.1 Requirements

Precast concrete units, unless otherwise stated, shall be obtained from an approved manufacturer and shall be true to dimension and shape with true arrisses 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. In addition, the following requirements particular to the various units shall be complied with:

3.9.2 Kerbs

Precast concrete kerb shall conform to BS 340, except that coarse aggregate shall conform to BS 882. 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. In such cases the moisture absorption limits set out in BS 340 may be neglected subject to the concrete satisfying an approved freeze-thaw test based on thirty cycles of exposure.

3.9.3 Flags

Flags shall conform to BS 368

3.9.4 Other Blocks

Blocks used for building work shall conform to BS 6073/2028.

Section 4 Pipelines, Pipework

Section 4A. Materials

4.1 General

4.1.1 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 or supplier specified in the Contract.

4.1.2 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.

4.1.3 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.

4.1.4 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.

4.1.5 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.

4.1.6 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.

4.1.7 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.

4.1.8 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.

4.1.9 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.

4.1.10 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.

4.2 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.

4.3 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.

4.4 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.

4.5 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.

4.6 Ductile Iron Pipes

4.6.1 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.

4.6.2 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.

4.7 Galvanised Steel Pipes

Galvanised steel pipes shall be medium duty manufactured to BS 1387.

4.8 Steel Pipes

4.8.1 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.

4.8.2 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.

4.9 Glass Reinforced Plastic (GRP) Pipes and Fittings

Glass reinforced plastic (GRP) pipes and fittings for sewers 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.

4.10 DWC Sewers and Pressure Pipes and Fittings

STRUCTURED WALL PIPING SYSTEMS IN POLYPROPYLENE (PP) AND POLYETHYLENE (PE) ISO 21138/3 - DWC

General appearance

Double wall corrugated pipes must be manufactured using two layers or either PP or PE that are bonded in the extrusion process. The pipe will have a corrugated outer skin, forming ribs and bonded to the internal skin of the pipe leaving a smooth inner surface. This inner surface will be free of cracks, deformities and will ensure smooth flow properties throughout the

pipeline. The pipe shall be socketed on one side, and have a spigot on the other. The internal colour shall be a light reflective colour to reflect light to ease camera inspection. An elastomeric rubber water sealing ring will be placed on the spigot side to create a strong seal between the spigot and socket.

The pipe must have a coextruded line on the pipe of a different colour for easy identification of the fluid within the pipe. **Pipes that do not have this coextruded stripe will not be accepted**

The pipe must also be produced with a reinforced air channel for added rigidity

Manufacturing process

The pipe must be manufactured in **a horizontal corrugator with water cooled mould blocks** that keeps the ovality to a minimum, and contraction consistent. The pipes shall use suitable

PP or PE to acquire the required stiffness and deflection characteristics describe below. The pipe will have inline socketing, with the required socket diameter to create a water tight seal with the help of an elastomeric ring.

Corrugated construction

The pipe will have a plain smooth inside surface, with an annular ribbed external surface. As shown in the diagram below:

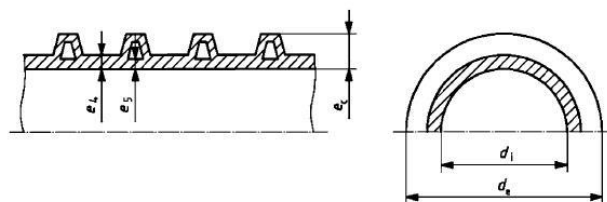


Figure 1 – corrugation diagram

The profile of the corrugation may change to design requirement for desired ring stiffness for pipe.

Materials

PP (Polypropylene) material characteristics described in the table below:

Characteristic	Requirements	Test parameters		Test method
Resistance to internal pressure, 140 h ^{a, b}	No failure during the test period	End caps	Type A or B	ISO 1167-1
		Test temperature	80 °C	ISO 1167-2
		Orientation	Free	
		Number of test pieces	3	
		Circumferential stress	4,2 MPa	
		Conditioning period	In accordance with ISO 1167-1	
		Type of test	Water-in-water	
		Test period	140 h	
Resistance to internal pressure 1 000 h ^{a, b}	No failure during the test period	End caps	Type A or B	ISO 1167-1
		Test temperature	95 °C	ISO 1167-2
		Orientation	Free	
		Number of test pieces	3	
		Circumferential stress	2,5 MPa	
		Conditioning period	In accordance with ISO 1167-1	
		Type of test	Water-in-water	
		Test period	1 000 h	
Melt mass-flow rate	≤ 1,5 g/10 min	Temperature	230 °C	ISO 1133:2005
		Loading mass	2,16 kg	Condition M
Thermal stability, OIT ^c	≥ 8 min	Temperature	200 °C	ISO 11357-6
^a For extrusion compounds this test shall be carried out in the form of a solid-wall pipe made from the relevant extrusion material. ^b For injection-moulding compounds this test shall be carried out in the form of an injection-moulded, or extruded sample in solid-wall pipe form made from the relevant material. ^c This requirement is only valid for pipes and fittings intended to be jointed in the field by fusing or welding.				

PP material of MRS 1700Mpa is advisable, and should have a minimum carbon content (for outer layer) of 2% to achieve UV resistant characteristics

PE (Polyethylene) material characteristics described in the table below:

Characteristic	Requirements	Test parameters		Test method
Resistance to internal pressure 165 h ^{a, b}	No failure during the test period	End caps	Type A or B	ISO 1167-1
		Test temperature	80 °C	ISO 1167-2
		Orientation	Free	
		Number of test pieces	3	
		Circumferential stress	4,0 MPa	
		Conditioning period	In accordance with ISO 1167-1	
		Type of test	Water-in-water	
		Test period	165 h	
Resistance to internal pressure 1 000 h ^{a, b}	No failure during the test period	End caps	Type A or B	ISO 1167-1
		Test temperature	80 °C	ISO 1167-2
		Orientation	Free	
		Number of test pieces	3	
		Circumferential stress	2,8 MPa	
		Conditioning period	In accordance with ISO 1167-1	
		Type of test	Water-in-water	
		Test period	1 000 h	
Melt mass-flow rate	≤ 1,6 g/10 min	Temperature	190 °C	ISO 1133:2005
		Loading mass	5 kg	Condition T
Thermal stability, OIT ^c	≥ 20 min	Temperature	200 °C	ISO 11357-6
Reference density	≥ 930 kg/m ³	In accordance with ISO 1183-1		ISO 1183-1

^a This test shall be carried out in the form of a solid-wall pipe made from the relevant extrusion material.

^b For injection-moulding compounds this test shall be carried out in the form of an injection-moulded or extruded sample in solid-wall pipe form made from the relevant material.

^c This requirement is only valid for pipes and fittings intended to be jointed in field by fusing or welding.

PE material of MRS 1000Mpa is advisable, and should have a minimum carbon content (for outer layer) of 2% to achieve UV resistant characteristics

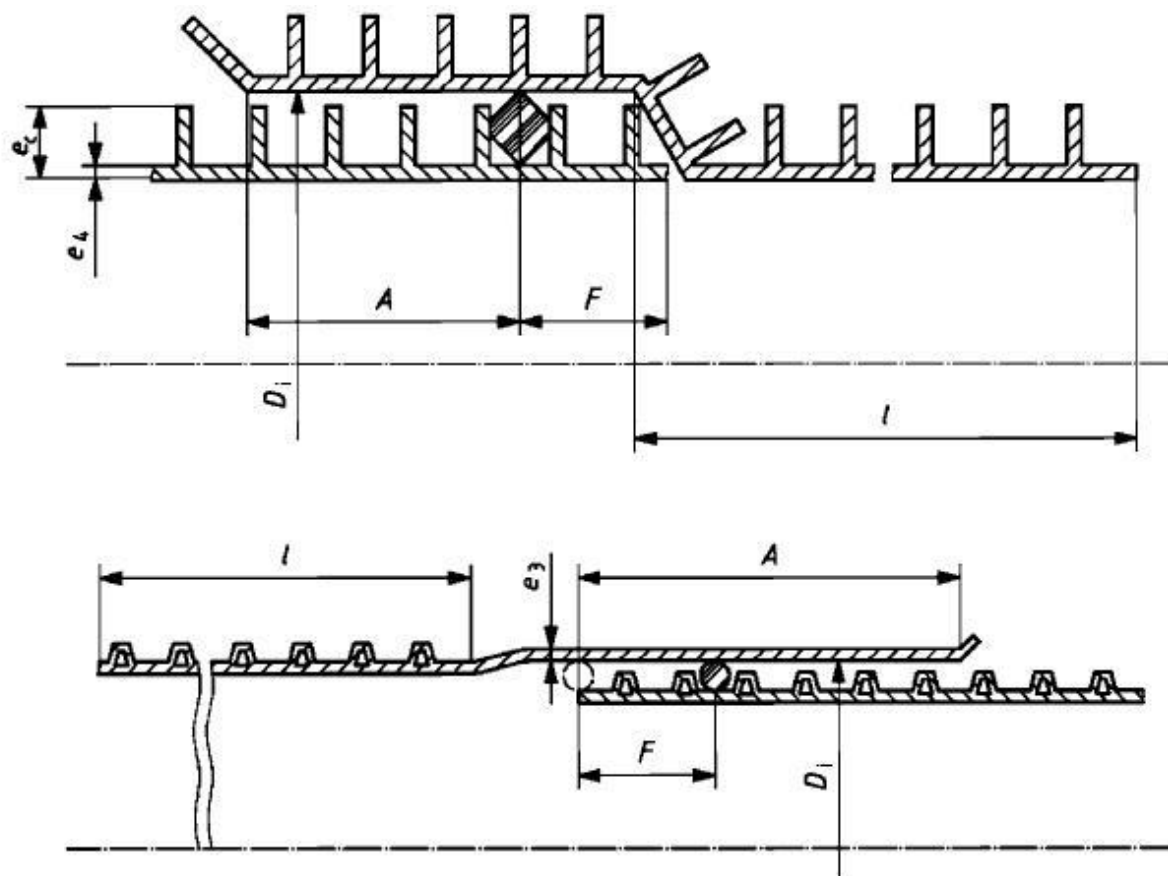
Typical spigot & socket joint

Figure 2 – examples of sealing ring joints

Above are typical examples of elastomeric sealing ring joints, with the sealing ring located on the spigot.

Below is a table showing the following: Nominal sizes, minimum internal diameters, thickness of inside layers and socket length. These must be strictly adhered to or exceeded under the ISO 21138 standard for structured wall pipes.

The indications for e4, e5 and A(min) can be seen on figure 1 above as a reference diagram.

Internal Diameter (mm)	Minimum wall thickness		A (min) (mm)
	e4 (min) (mm)	e5 (min) (mm)	
100	1.00	1.00	32.00
150	1.30	1.00	43.00
200	1.50	1.10	54.00
250	1.80	1.50	59.00
300	2.00	1.70	64.00
400	2.50	2.30	74.00
500	3.00	3.00	85.00
600	3.50	3.50	96.00
800	4.50	4.50	110.00
1000	5.00	5.00	140.00
1200	5.00	5.00	162.00

Please note that the minimum inner skin thickness (e4) is the minimum requirement for survivability for hard sewage mediums, and integrity for the lifespan of the pipe.

In addition to the minimum required wall thickness of sockets and spigots, their ring stiffness, when determined in accordance with ISO 9969, shall conform to the following equation:

$$S_{so} + S_{sp} \geq SN_{pipe}$$

For the test, it is permitted to use cut-off straight spigot and socket parts even if they do not conform to the length requirement specified in ISO 9969.

Mechanical characteristics

When tested in methods specified in the table below, using the indicated parameters, the pipe shall have the mechanical characteristics conforming to the requirements given in the table below.

The pipes shall be designated in one of the following nominal ring stiffness classes (SN):

DN ≤ 500: SN4, SN8 or SN16 DN > 500: SN2, SN4, SN8 or SN16

Characteristic	Requirements	Test parameters		Test method
Ring stiffness	≥ relevant SN	In accordance with ISO 9969		ISO 9969
Impact strength	TIR ≤ 10 %	Test temperature Conditioning medium Type of striker Mass of striker for ^a : $d_{im,max} \leq 100$ $100 < d_{im,max} \leq 125$ $125 < d_{im,max} \leq 160$ $160 < d_{im,max} \leq 200$ $200 < d_{im,max} \leq 250$ $250 < d_{im,max} \leq 315$ $315 < d_{im,max}$ Fall height of striker for ^a : $d_{em,min} \leq 110$ $d_{em,min} > 110$	(0 ± 1) °C Water or air d90 0,5 kg 0,8 kg 1,0 kg 1,6 kg 2,0 kg 2,5 kg 3,2 kg 1 600 mm 2 000 mm	ISO 3127
Ring flexibility	In accordance with 9.1.2 at 30 % of d_{em}	Deflection Length of test piece Position of test piece	30 % Shall incorporate at least 5 ribs/spirals ^b Mould split line, when applicable, at 0°, 45° and 90° from the upper plate	EN 1446
Creep ratio	PVC-U: ≤ 2,5 at 2 year extrapolation PP and PE: ≤ 4 at 2 year extrapolation	In accordance with ISO 9967		ISO 9967
Tensile strength of seam ^b	In accordance with 9.1.3	Rate of movement	15 mm/min	EN 1979
^a Refer to the specified $d_{em,min}$. ^b Only applicable to spirally formed pipes.				

Ring flexibility

When tested in accordance with the test methods described in the previous table, and visually inspected without magnification

- a. There shall be no decrease of the measured force
- b. There shall be no cracking in any part of the wall structure
- c. There shall be no wall delamination except possible delamination between the outside and inside wall of double layer pipes
- d. There shall be no other types of rupture in the test piece
- e. Permanent buckling in any part of the structure of the pipe wall including depressions and craters shall not occur in any direction

Tensile strength

When tested in accordance with the test methods highlighted above, the minimum required tensile strength of the seam shall conform to the table below:

Nominal size DN/ID or DN/OD	Minimum tensile force N
$DN \leq 375$	380
$400 \leq DN \leq 560$	510
$600 \leq DN \leq 710$	760
$DN \geq 800$	1 020

The pipe should have an allowable deflection of up to 30% without any signs of cracks, or ovality during the process.

Performance requirements

When tested in accordance with the test methods below, the joints and system shall have the characteristics conforming to the requirements given in the table below

Characteristic	Requirements	Test parameters		Test method
Tightness of elastomeric ring seal joint		Temperature	(23 ± 2) °C	EN 1277:2003, Condition B
		Spigot deflection	10 %	
		Socket deflection	5 %	
	No leakage	Water pressure	5 kPa (0,05 bar)	
	No leakage	Water pressure	50 kPa (0,5 bar)	
	≤ -27 kPa (-0,27 bar)	Air pressure	-30 kPa (-0,3 bar)	
Tightness of elastomeric ring seal joint		Temperature	(23 ± 2) °C	EN 1277:2003, Condition C
		Joint deflection for: $d_e \leq 315$ mm	2°	
		315 mm < $d_e \leq 630$ mm	1,5°	
		630 mm < d_e	1°	
	No leakage	Water pressure	5 kPa (0,05 bar)	
	No leakage	Water pressure	50 kPa (0,5 bar)	
	≤ -27 kPa (-0,27 bar)	Air pressure	-30 kPa (-0,3 bar)	
Resistance to combined temperature cycling and external loading ^b	^a	For $d_{im} \leq 160$ mm: In accordance with EN 1437:2002, Method A		EN 1437:2002 Method A, hot and cold water
		For $d_{im} > 160$ mm: In accordance with EN 1437:2002, Method B		EN 1437:2002 Method B, hot water
Long-term performance of TPE seals	Tube pressure: -100 years extrapolated: ≥ 150 kPa (1,5 bar)	Test temperature	(23 ± 2) °C	EN 14741
Watertightness ^c	No leakage	Water pressure Duration	50 kPa (0,5 bar) 1 min	EN 1053
Tensile test of welded or fused joints	No break in the joint	Minimum tensile force	In accordance with Table 15	EN 1979 ^d

^a The following requirements apply:

- vertical deformation: ≤ 9 %
- deviation from surface evenness in bottom: ≤ 3 mm
- radius of bottom: ≥ 80 % of original
- opening of weld line: ≤ 20 % of wall thickness
- tightness at 35 kPa (0,35 bar)/15 min: no leakage allowed.

^b Only for components in accordance with this part of ISO 21138 with DN/OD ≤ 335 and DN/ID ≤ 300.

^c Only for fabricated fittings made from more than one piece. A sealing ring retaining component is not considered as a piece.

^d This test is applicable for all pipe and fitting constructions when jointed by fusion or welding. The test pieces shall be cut longitudinally in the fusion area. The length of the test piece shall include the joint plus a length at each end sufficient to ensure a proper grip in the tensile testing machine.

Marking

<u>Aspect</u>	<u>Marking</u>
Standard Number	ISO 21138
Manufacturer's identification	Name or symbol
Dimensions DN/ID series	ID 200MM
Stiffness class	e.g. SN 4
Material	PE or PP
Production period (date or code)	e.g. 0204a
Country of Production	Kenya

Internal Diameter:

INTERNAL DIAMETER (ID)	RING STIFFNESS
ID150	SN4 Or SN8
ID200	
ID250	
ID300	
ID400	
ID500	
ID600	
ID800	

4.11 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.

4.12 Polyethylene Pipes and Fittings

4.12.1 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 14 bar.

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.

4.12.2 Joints

Unless otherwise specified or approved by the Project Manager polyethylene pipes shall be electrofusion welded. Joints between polyethylene pipes supplied from different manufactures or not manufactured from the same grade of polymer shall only be jointed by electrofusion 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.

4.13 Gate Valves

4.13.1 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.

4.13.2 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. Handwheels 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 handwheels. 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.

4.14 Butterfly Valves

4.14.1 General

Butterfly valves shall conform to BS EN 593. All Butterfly Valves shall be supplied with a 10-year manufacturer's warranty.

4.14.2 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 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.

4.14.3 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.

4.14.4 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.

4.15 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 tappings 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.

4.16 Non-Return Valves

4.16.1 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.

4.16.2 Nozzle Check Valves

Nozzle check valves shall be slam free closing with a streamlined cross section as manufactured by Mannesmann Demag or similar.

4.17 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.

4.18 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.

4.19 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 bell mouth 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.

4.20 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.

4.21 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.

4.22 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.

4.23 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.

4.24 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.

4.25 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

4.26 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.

4.27 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.

Line and level surveys shall comprise a traverse line along the centre line of the pipeline as established by the Project Manager.

4.28 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.

4.29 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.

4.30 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.

4.30.1 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.

4.30.2 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.

4.30.3 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.

4.30.4 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.

4.31 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.

4.32 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.

4.33 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 an 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.

4.34 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.

4.35 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.

4.36 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.

4.37 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.

4.38 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.

4.39 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.

4.40 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 kilometer 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.

4.41 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.

4.42 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.

4.43 Connections to and Diversions to Existing Pipework

4.43.1 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.

4.43.2 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.

4.43.3 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.

4.43.4 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.
- 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.

4.43.5 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.

4.43.6 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 5. Building and Structures

5.1 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.

5.2 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 clean 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.

5.3 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.

5.4 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.

5.5 Screen Walling

Screen walling shall consist of perforated precast concrete blocks 100mm thick of approved shape, design and manufacture laid to an approved pattern in cement mortar with perfectly even joints which shall be neatly flush or recess pointed as directed.

5.6 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.

5.7 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.

5.8 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.

5.9 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.

5.10 Cement Rendering

Rendering shall be in a 50 kg: 017-2-.20m³ 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.

5.11 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.

5.12 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.

5.13 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.

5.14 Cable Duct Covers and Frames

5.14.1 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.

5.14.2 Checker Plate Covers

Checker plate covers shall be hot dipped galvanized mild steel fitted flush with the floor surface and fully supported.

5.15 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.

5.16 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.

5.17 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.

5.18 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.

5.19 Open Mesh Walkways and Covers

Open mesh type walkways, platforms and covers shall be of aluminum 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.

5.20 Handrailing

Hand railing shall be approximately 1200mm 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 aluminum 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.

5.21 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.

5.22 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.

5.23 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.

5.24 Isolation of Aluminum

All items of aluminum construction shall be isolated from concrete by the use of bituminous felt or DPC material or two coats of bituminous paint. The aluminum shall be isolated from dissimilar metal by the use of fibre washers and spacers.

5.25 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.

5.26 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**6.1 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 tuning circle radius measured to track centre line shall not be less than 15.0m.

6.2 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.

6.2.1 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-leveled 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.

6.2.2 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).

6.2.3 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.

6.3 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.

6.4 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.

6.5 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.

6.6 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****7.1 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.

7.2 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.

7.3 Failure to Comply with Specifications

7.3.1 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 7.3.1.1 (b) shall be deducted from the amounts otherwise due to the Contractor.

7.4 General Requirements

7.4.1 Preamble

All references to safety shall be deemed to include health and the environment.

7.4.2 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.

7.4.3 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.

7.4.4 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.

7.4.5 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.

7.4.6 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.

7.4.7 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.

7.4.8 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.

7.4.9 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.

7.4.10 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.

7.4.11 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.

7.5 Safety Requirements

7.5.1 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 Contactor shall encourage employees to wear substantial work gloves whenever practical and safe to do so.

7.5.2 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.

7.5.3 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.

7.5.4 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.

7.5.5 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.

7.5.6 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.

7.5.7 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.

7.5.7.1 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.

7.5.7.2 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.

7.5.7.3 Mobile Elevating Work Platforms

Operators shall be trained in the safe use of such platforms and hold a current Certificate of Competence.

7.5.7.4 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.

7.5.7.5 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.

7.5.8 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.

7.5.9 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 702.5) 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.

7.5.10 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.

7.5.11 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.

7.5.12 Laser Survey Instruments

Details of the types and use of laser instruments shall be submitted and agreed with the Project Manager.

7.5.13 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.

7.5.14 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.

7.5.15 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:

“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.

7.5.16 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 or night.

Excavated or other materials shall be stored at least 0.65 metres from the sides of excavations.

7.5.17 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.

7.6 Environmental and Health Requirements

7.6.1 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.

7.6.2 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 wind blown 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.

7.6.3 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.

7.6.4 Solid Waste

7.6.4.1 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.
- (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.

7.6.4.2 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.

7.6.4.3 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.

7.6.4.4 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.

7.6.5 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 use 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.

7.7 Additional Requirements for Work in Public Areas

7.7.1 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.

7.7.2 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.

7.7.3 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.

7.7.4 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.

7.7.5 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, drawpits 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.

7.8 Contractor's Site Check List

A sample Contractor's Site Check List is included in Annex 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.

Annex 1**Sample Excavation Permit**

To: (Project Manager)

From: (Contractor)

Date:

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):

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:

Annex 2
Sample Street Closure Permit

To: (Project Manager)

From: (Contractor)

Date:

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):

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:

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

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

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

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

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

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

Machinery and Equipment:

- adequate secured guards in good repair to dangerous parts, e.g. exposed gears, chain drives, projecting engine shafts

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

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

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

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

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

Fire – General:

- sufficient number and types of fire extinguishers
- adequate escape routes, kept clear
- worker awareness of what to do in an emergency

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

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

Fire – Other Combustible Materials:

- minimum amount kept on site
- proper waste bins
- regular removal of waste material

Noise:

- assessment of noise risks
- noisy plant and machinery fitted with silencers/muffs
- ear protection for workers if they work in very noisy surroundings

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

Manual Handling:

- avoid where risk of injury
- if unavoidable, assess and reduce risks

Protective Clothing:

- suitable equipment to protect head, eyes, hands and feet where appropriate
- enforce wearing of protective equipment

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

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.

SECTION 8. ENVIRONMENTAL IMPACT MITIGATION

8.1 General

All construction related environmental impacts can be mitigated with the observation of good construction practice and careful on site monitoring. The Contractor shall abide by all the provisions of the Project Environmental Management Plan (hereinafter referred to as the EMP), Environmental Impact Assessments (EIAs), NEMA Environmental Permit, all related laws, standards and directives in force in Kenya, and with any amendment thereof introduced during the execution of his Contract.

The Clauses should be read in conjunction with those in the General Specification. In the event of any ambiguity or discrepancy this specification shall take precedence.

8.2 Methods Statements

The Contractor shall provide in a timely manner a Method Statement for any mitigation measures in the EMP, EIAs, and NEMA Permit for which the Project Manager requests a separate Method Statement. Should the method of work proposed by the Contractor be unacceptable to the Project Manager, the Contractor shall provide a revised Method Statement. The work will not be allowed to proceed until a Method Statement has been approved by the Project Manager. Method Statements to be provided should include, but not be limited to the following:

- Site Clearance;
- Landscape Planting and Site Rehabilitation;
- Traffic Management Plan;
- Environmental Monitoring (Air, Water and Noise);
- Health and Safety Plan;
- Emergency Management and Disaster Preparedness Plan (to include hurricanes, earthquakes, flooding, fire, oil spills, etc.);
- Traffic Management Plan

8.3 QSE Reporting, Inspections and Audits

The Contractor shall provide the Project Manager with a monthly Quality, Safety and Environment (QSE) report no later than 7 days after the end of the reporting month and be subject to regular QSE system inspections and audits by the Project Manager.

8.4 Environmental Monitoring and Reporting

The Contractor is required to put in place a programme of regular environmental monitoring for air quality, water quality and noise to meet the requirements and conditions of the EMP, EIAs, and NEMA Permit. The monitoring programme should be conducted in accordance with a Method Statement which has been approved by the Project Manager and the appropriate regulatory agency.

Reports on the monitoring programme should be submitted to the Project Manager and the relevant regulatory agency.

8.5 Access Requirements for Supervision

Any Officer or Agent authorised in writing by the AWWDA, NEMA, their agents or other organisation for which from time to time it may be necessary, may at any time enter any premises whether prescribed or otherwise and may:

- Examine and inspect equipment, control apparatus, monitoring instruments or plant;
- Take samples of any material that is emitted, discharged or deposited, or is likely to be, from such premises;
- Examine any books, records or documents relating to the performance or use of such equipment, apparatus, instruments or plant, or relating to the emission, discharge or deposit from such premises; and
- Photograph such premises as is considered necessary or make copies of any book, records or documents seen in the course of examination.

8.6 Conditions of Site

Before carrying out any 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 where in the opinion of the Project Manager it is deemed necessary, by means of photography.

8.7 Adjoining Property

The Contractor shall advise owners, occupiers and users of the dates on which work is to be executed on adjacent property not less than 48 hours prior to commencement, and take all reasonable precautions to prevent collateral damage and, if any damage is caused, make good to the satisfaction of the owner at the Contractor's expense.

8.8 Landscape

The Contractor shall exercise care to preserve the natural landscape and shall conduct his operations so as to prevent any unnecessary destruction, scarring or defacing of the natural surroundings in the vicinity of the work.

Except where clearing is required for permanent works, all trees, native shrubbery and vegetation shall be preserved and shall be protected from damage that may be caused by the Contractor's equipment and operations. No trees shall be cut down outside defined work site boundaries without the specific approval of the Project Manager. The trees identified for preservation should be flagged prior to the commencement of clearing activities.

Where unnecessary destruction or defacing of landscape or natural vegetation, has occurred the Contractor shall be responsible for repairing, replanting or otherwise correcting the damage at his own expense.

8.9 Site Clearance

Materials other than topsoil arising out of site clearance shall be disposed by the Contractor off the Site, or where approved by the Project Manager, on the site in a manner and place approved by the Project Manager.

The extent and depth of topsoil to be removed shall be agreed with the Project Manager. Topsoil shall be set aside for subsequent re-use or disposal as directed by the Project Manager, and will be stored in such a manner as will preserve its fertility until such time as re-use or disposal is directed.

8.10 Ecosystems and Wildlife

The Contractor shall institute penalties for construction workers, including those of sub-contractors, who unnecessarily damage or destroy wildlife and other features of the natural ecosystem. Summary dismissal shall be the penalty for workers found collecting eggs or illegally partaking in the trading of species or any activity involving the unwarranted disturbance of any protected species, on or off construction sites.

8.11 Access to Work Sites

The mitigation of the impacts from construction traffic can take three forms; access control, road cleaning and definition of approved routes.

For access control, the Contractor shall restrict turning movements to approved access points to and from existing highways and, if necessary, improve existing junction layouts to reduce the potential for accidents. Restrictions on the timing of use, with construction traffic prohibited outside of specified, supervised hours, may also be required.

Road cleaning measures will be required to ensure roads are kept in a safe condition, that surplus oil, mud and other materials are removed on a regular basis.

Prior to commencement of the Contract, the Contractor shall submit for the approval of the Project Manager a Traffic Management Plan outlining points of access to the primary road network, additional traffic control measures to be implemented, proposals for signage and road cleaning together with a programme for these activities.

Wide or abnormal load movements shall wherever possible be transported during the early hours of the morning. Appropriate times of operation would be between 2300 and 0500 hours. Such loads will require specific obstruction-free routes to be defined in consultation with the Kenyan Constabulary. These details, together with the proposed timings of the movement shall be submitted to the relevant authorities and the Project Manager for approval.

Garage and maintenance areas for vehicles should have oil and grease interceptors for wash water.

8.12 Dislocation of Existing Access

On the basis of the information contained in his Programme of Works, the Contractor shall prepare a plan of diversions and temporary works for approval by the Project Manager. The plan shall include details of to the proposed works, arrangements for signage, the timing of the proposed closure and works with start date, reopening date and the hours of closure, and the programme of making good.

8.13 Public Utilities

At the commencement of the Contract, the Contractor shall examine the site and identify/verify all utilities above or below ground, and shall record all such information on suitable Site Drawings, which shall be submitted to the Project Manager within one month of commencement of the Works. The Contractor shall for this purpose excavate trial pits or take any other measures needed as may be necessary for identification and verification of existing utilities. The Contractor shall request of the utility agencies confirmation and definition of all utilities sites in and adjacent to all construction sites.

The Contractor shall liaise with the agencies responsible for the maintenance of utilities that may be crossed, temporarily diverted or in any other way affected by construction works as to the timing and nature of the works proposed. Any curtailment of a utility service shall only be undertaken with the prior approval of the service provider and the Project Manager.

Damage to any utility will be made good to the satisfaction of the utility agency at the Contractor's cost. Such repair work shall be treated as an emergency and undertaken without undue delay, notwithstanding that

the Project Manager may not be immediately available. All such damage shall be reported in writing to the Project Manager with details of the remedial action undertaken.

8.14 Wastewater Disposal

The Contractor shall submit a proposed plan for the disposal of wastewater from the construction camp and all other sites at which it will be generated to the Project Manager for approval. Prior to installation, the Contractor shall obtain approval for proposed disposal system from all appropriate agencies and from the Project Manager.

8.15 Solid Waste Disposal

Where possible, all on and off site facilities shall be included in the existing municipal solid waste collection and disposal process. The Contractor shall provide any necessary special handling and treatment of any generated solid waste and separate such materials from other waste for collection and disposal.

If it is not considered feasible or desirable to incorporate sites into established municipal waste collection systems, the Contractor shall collect and transport materials to an approved landfill site.

The normal manner of disposal shall include all necessary precautions to prevent air, soil and water air pollution, drainage impedance, fire hazard and damage to ecosystems.

8.16 Soil Pollution

The Contractor shall be required to perform all construction activities by methods that will prevent pollution of the soil by accidental spillage of solid or liquid contaminants.

If a significant spillage does occur the Contractor shall remove all contaminated soil in a manner and to a site specified by the Project Manager. Where necessary, appropriate replacement material shall be laid. The costs of these actions and related materials shall be borne by the Contractor.

8.17 Surface Watercourses

Work adjacent to or in surface watercourses and drainage channels shall allow for the maintenance of flow and avoid discolouration.

8.18 Water Pollution

The Contractor shall comply with all applicable regulations concerning the control and abatement of water pollution in Kenya.

The Contractor's construction activities shall be performed by methods that will prevent the entrance or accidental spillage of solid matter or liquid contaminants, debris and wastes to watercourses, drainage ditches and ground water aquifers.

In the event of a serious spill, and contamination, the Contractor shall notify relevant authorities and the Project Manager immediately. Any remedial works instructed, shall be undertaken by the Contractor or any other specified body at the Contractor's expense. Such work shall be undertaken as a matter of urgency. Intentional failure or delay in issuing notification of such spills, or to implement remedial works, shall be considered a Breach of Contract.

8.19 Erosion

The Contractor shall at all times take care to prevent erosion of areas which may be affected by his operations and the Project Manager may impose such reasonable limitations and restrictions upon the method and timing of work as the circumstances warrant.

All temporary discharge points shall be located, designed and constructed in a manner that will minimize the potential threat of erosion in the receiving channels.

The Method Statements for Site Clearance and for Landscaping and Site Rehabilitation should address the issue of soil erosion and sediment discharge.

8.20 Risk of Flooding

The Contractor's attention is drawn to the risk of flooding during storms and shall take appropriate precautions to ensure surface water is free to flow naturally and shall not cause obstructions liable to increase the risk of flooding. Watercourses upstream of the road shall not be interfered with, altered or diverted, and materials shall not be stored or deposited across a watercourse, culvert or drain entry so as to obstruct any natural flow of surface water. All works shall be adequately protected and marked so as not to increase the risk of injury or damage to the works, persons, vehicles, etc. in the event of flooding.

The Contractor should take steps to ensure that storm water entering watercourses should be free from silt and suspended materials.

The Contractor shall bear all costs and expenses for protection works which he executes including construction of temporary diversion banks and channels and all necessary works against flooding.

8.21 Aggregate. Fill and Spoil Heaps

The contractor shall ensure that all such heaps are located at sites that are generally on land, with slopes of less than 1.5% and that do not permit direct run off to water courses. Aggregate stockpiles shall not exceed their natural angle of repose unless structurally supported. The on site storage of excessive quantities materials shall be avoided.

All such heaps shall be of a size and stability to ensure the risk of mass movement during periods of intense rainfall is minimised. Where necessary a shed or tarpaulin cover may need to be provided to prevent erosion from wind and rain.

8.22 Noise

The Contractor shall ensure that all the equipment utilised in the construction of the project is fitted with appropriate noise muffling devices that conforms to the following sound level emissions:

Construction Equipment Noise Limits

Activity	Source	Day	Night
Earthworks	Surfacing Bulldozer/excavator	75 dB(A)	55 dB(A)
Piling	Piling machine	85 dB(A)	None
Structural	Concrete mixer/concrete pump	70 dB(A)	55 dB(A)
	Roller	70 dB(A)	55 dB(A)

Equipment not covered under these regulations should be fitted with muffling devices in accordance with manufacturers' recommendations.

Equipment and vehicles that are excessively noisy due to poor engine adjustment, damaged noise amelioration equipment, or other inefficient operating conditions shall not be operated until corrective measures are taken.

The Contractor shall ensure plant operated intermittently is shut down, or at a minimum throttled down during idle periods.

In general, noisy operations shall be restricted to between 7 am and 9 pm, and not undertaken on public, religious or other holidays. The public shall be informed of the expected time and duration of works that may emit significant noise levels.

Noise sensitive areas should be identified by the Contractor and a programme of regular monitoring designed and implemented by the Contractor.

Piling operations should be restricted to the hours of 9 am and 4 pm. Advance notice by the Contractor of work starts of at least 5 days shall be given to residents or users of properties within 50 m of a piling site. Such notice shall take the form of public notices displayed within affected neighbourhood.

Approval to extend periods of operation may be given by the Project Manager in consultation with the relevant municipality authority but only where it is necessary to maintain the stability of the Works or for the maintenance of workers and public safety. Extended periods of overtime working shall not be permitted except in the most exceptional cases. Persons living within 50m of the works area designated for extended hours of operation should be informed in writing at least 48 hours before the change in operating hours.

8.23 Air Pollution excluding Dust

In the conduct of general construction activities and the operation of equipment, the Contractor shall utilize all practical methods and devices as are reasonably available to control, prevent and otherwise minimize atmospheric emissions or the discharge of air contaminants. This will include:

- Equipment and vehicles that show excessive emissions of exhaust gases due to poor engine adjustment or other inefficient operating conditions should not be operated unless corrective measures are taken;
- Burning of materials resulting from the clearance of trees, bushes and combustible materials shall not be permitted.

8.24 Dust

The Contractor shall take all necessary measures to limit pollution from dust and any wind blown materials during the works, including damping down with water on a regular basis during dry and windy climatic conditions. All trucks using public roads shall be properly covered to prevent discharge of dust, rock and sand.

During the performance of the Works required the Contractor should be responsible for all labour, equipment, materials and the means required to carry out efficient control, wherever and as often as necessary, to prevent dust from his operations from damaging dwellings, crops, or causing a nuisance or health hazard to persons.

Specific dust suppression measures may include:

- The provision of water troughs at entry and exit points to prevent the carry over, beyond the construction site, of dust emissions;
- Use of appropriate hoardings;
- Using coverings for all vehicles transporting materials likely to give off excessive dust emissions.
- Vehicles should not be overloaded above the freeboard.

The Contractor will be held liable for any damage resulting from dust originating from his operations.

8.25 Storage of Fuel

All fuel storage tanks shall be located on hard standing and bunded to prevent the outflow of any spilt fuel. The capacity of the bunded area shall be 110% of the volume of the fuel storage. Each installation shall be complete with all protective guards and warning signs as approved by the Project Manager.

8.26 Oil and Grease

All oils and greases shall be kept secure under cover and where it will not normally come in contact with drainage channels or watercourses.

The disposal of waste oil, grease and other hydrocarbon products shall be to a disposal facility licensed to take such materials, and to the approval of the Project Manager.

8.27 Hazardous Materials

The Contractor shall submit to the Project Manager an inventory of all potentially hazardous materials to be stored on site, together with a preliminary indication of the quantities of material that may be present at any one time. A Materials Safety Data Sheet (MSDS) should be kept on file for every chemical in the inventory and be available on site.

Facilities for the storage, handling and use of such materials shall be in accordance with manufactures' recommendations, MSDS, and to the approval of the Project Manager.

Facilities for the storage of classified hazardous materials, whether the buildings in which containers are stored or the containers themselves, shall be clearly identified with the standard HAZCHEM markings, and access to them permitted only to authorized personnel.

No waste or surplus hazardous chemical shall be disposed of unless approval is obtained in writing from the Project Manager, identifying the nature of the material, the amount, details of origin and any batch reference, and the location and method of disposal.

Staff and sub-contractors staff should be trained in the proper storage, use and disposal of these hazardous materials and provided with the appropriate Personal Protective Equipment (PPE).

8.28 Landscape Planting

Areas to be planted shall be soiled with good quality fertile soil not less than 300 mm compacted thickness, which shall be raked and brought to a fine tilth.

Species to be planted and their spacing shall be approved by the Project Manager and the areas shall be watered and attended until the plants have become well established. The Contractor shall supply attendance during the Defects Liability Period to ensure that all planted areas are kept weeded and watered, with die back removed and replaced as necessary.

A Method statement for Landscaping is required.

8.29 Operations and Maintenance (O&M) Manuals

O&M Manuals developed by the Contractor should address all issues contained within the EMP, EIAs and the NEMA permit in respect of Operational Monitoring.

Part 2 Mechanical & Electrical Works

Section 1 Scope of Works

Section 2 General Specification - General

Section 3 General Specification - Electrical Works

Section 4 General Specification - Mechanical Works

Section 5 General Specification - Instrumentation and Control

Scope of Works

Section 1 Description of the Works

General Description

This section covers the design, supply, installation, delivery, installation, testing, commissioning and upholding during the operational acceptance and maintenance periods of the mechanical installations for rehabilitation and extension of sub Trunk Sewer.

Extent of the Works

The work under this contract consists of the following items of work as shown on the Drawings or as directed by the Project Manager:

- ✓ Desilting and Rehabilitation of all Sub trunk sewers pipelines lines with their won-out manholes by raising them above flood levels.
- ✓ Laying of 300 mm dia DWC pipes Arterials connecting to Motoini sewer as per the drawings.
- ✓ Provision of ablution blocks as specified by client and location to be provided by the community.
- ✓ Laying of 300 mm dia DWC pipeline Extension to Kenya science and Nairobi trade fair sewer as per the drawings.
- ✓ Provision of 10 solid waste collection points generated.
- ✓ Provision of pedestrian 1 access bridges as per the design.
- ✓ Construction of 1 water kiosk as per the drawings and specifications.
- ✓ Laying of HDPE DN 50mm dia PN 6 water reticulation pipeline as per the drawings and specifications.

Location of the Works and Access

The works will be located in Nairobi County,.

Construction

General

The mechanical and electrical equipment is to be installed on new sites which are to be constructed as part of these works. The Contractor shall be responsible for protecting all new plant, building work and services. Any damage caused by the Contractor to any new structures or services shall be repaired to the satisfaction of the Project Manager. The Contractor shall immediately carry out essential repairs to any buildings, structures or services damaged by him during the execution of the Works and shall maintain them until such time as final reinstatement and repairs are completed.

Prior to commencing work, the Contractor shall submit to the Project Manager his proposals for executing works .No work shall commence until the Project Manager has provided his approval in writing of the Contractor's proposals in this regard.

The Operator

The person(s) who shall operate the works shall have no have no authority to issue instructions under the contract and all formal contract correspondence shall be with the Project Manager.

Management**Contractor's Superintendence of Site Work**

The Contractor shall have available at all times an approved representative for the purpose of attending, site meetings and other meetings deemed necessary by the Project Manager for the proper programming and execution of the Works during the currency of the Contract.

It is a specific requirement of this contract that the Contractor shall nominate a Project Manager, who has proven experience in managing projects involving equipment similar to the Works specified and the controls thereof. This Project Manager shall co-ordinate all suppliers and sub-contractors and shall be fully responsible for the complete Contract.

Workmanship, Quality Control and Testing

The Contractor shall at his own expense institute a quality control system and shall employ experienced engineers, foremen and other staff to ensure proper supervision and control of the work at all times and shall at his own cost carry out all necessary testing to ensure that materials and workmanship comply with specified requirements.

The Contractor shall be deemed to have allowed in his tender for the costs of all testing of materials and completed work as are required to be rendered by him in terms of the contract. It is the Contractor's sole responsibility at his own cost and by means of any necessary tests to demonstrate to the Project Manager that all materials and completed work comply with all specified requirements.

Spare Parts and Tools

The Contractor shall supply sufficient spare parts and tools for five years operation in accordance with the requirements listed in these Specifications.

General Specification

Section 11 General

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 as specified in the Particular Specification.

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 Project Manager.

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 Project Manager's approval before any item of Plant for that installation is ordered.

Drawings of new raw water pumping station and other new installations indicate the design arrangement of the plant and equipment. The Contractor shall using this design arrangement drawings, detail the arrangement of the Plant to be installed and shall collect all information, data, dimensions and details as necessary for the detailed design, and for the supply and installation of the Plant and equipment. Where new installations are equipped with plant and/or equipment of Imperial or non standard dimensions the Contractor shall supply any special fittings required to interface between the non standard or imperial and other new plant and equipment.

Drawings for new installations 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.

Where new boreholes are drilled or existing boreholes are rehabilitated under this Contract, they will be subject to test pumping by the Contractor, as specified elsewhere, to determine draw down level, appropriate pump setting depth, sustainable yield and pump duty points.

Where existing boreholes have been rehabilitated under another contract the test pumping results will be made available to the Contractor. Where no records are available the Contractor will be instructed to undertake test pumping of the existing borehole.

Information to be Supplied by the Contractor

In accordance with the requirements of the Conditions of Contract the Contractor shall submit to the Project Manager for approval detailed Construction Documents giving information for all items of Plant. The information shall include, but not by way of limitation, 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 Project Manager to check that the materials of construction and performance of the Plant are in accordance with the Specifications and suitable for the purpose intended. In the case of installation for rehabilitation the information shall clearly indicate those items of the existing plant which are to be retained. The Contractor shall furnish additional

information and calculations if requested by the Project Manager. The Contractor shall allow 21 days for the Project Manager to check the details, from the receipt by the Project Manager of complete information. No Plant shall be manufactured or ordered from suppliers for a particular installation until the Project Manager has given approval of the information.

At least 6 weeks prior to delivery of the Plant to Site, the Contractor shall submit to the Project Manager 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 Project Manager. Drawings and Documents which have been approved by the Project Manager shall not be departed from without the approval of the Project Manager.

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 Project Manager 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 Project Manager.

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 Project Manager. Additional tests shall be performed on borehole pumpsets to include the incorporation of any stage spacer pieces. 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 9906. The following tolerance values shall be used:

$$X^{QV} = \pm 0.04$$

$$X^H = \pm 0.02$$

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 10826-1; 1995. The maximum rms vibration velocity acceptable for factory testing shall not exceed the limits set out in ISO 10826-1; 1995 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 Project Manager.

Test certificates in triplicate shall be submitted by the Contractor to the Project Manager 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.

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, in compliance with the Conditions of Contract, 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 Project Manager.

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 Project Manager.

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;
- g) 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;
- h) Calibration tests shall be carried out in all instrumentation;
- i) Greasing and lubricating systems shall be tested on all plant;
- j) Test of all alarm systems, overloads and safety equipment;
- k) Any other test requested by the Project Manager.

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. 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 start up 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.

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 Project Manager 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 Project Manager.

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 Project Manager when tests are being carried out. The Contractor will receive notice in advance of the timing of such tests.

Spare Parts and Stores

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.

Where the Contractor includes the provision of a Spare Parts Store the Contractor shall instruct the Project Manager's storemen in the placing of the parts and tools into store and shall familiarise the staff with the proposed inventory system. He shall also instruct the Employer's staff in the operation of the stores including the correct identification of parts and tools by reference to drawings and maintenance manuals, analyzing rate of parts usage and identification of ordering intervals.

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 shall remain the property of the Contractor unless specified otherwise.

Operating and Maintenance Manuals

At least two weeks before commencement of the Tests on Completion the Contractor shall submit to the Project Manager four 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. A separate set of manuals shall be provided for each installation.

Two copies of the draft O & M Manuals for each installation shall be available on site at all times during the testing and commissioning of the Plant for the instructions to be verified. Any modifications found necessary shall be incorporated in the final version.

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 labeled.

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.

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.

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 Project Manager.

All switchboard cubicles shall be clearly labelled 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 Project Manager.

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.

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 Project Manager 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 Project Manager for approval.

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 Project Manager.

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 Project Manager'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.

Standards

All plant and equipment shall comply with the latest additions of appropriate international standards quoted in this specification or near equivalent. Any deviation from quoted standards shall be subject to the written approval of the Project Manager.

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
l/head/day	litres per head per day
kW	kilowatts
kVa	kilovolt-ampere
kWh	kilowatt hour
ISO	International Standards Organisation
CFM	cubic feet per minute
AOD	Above ordnance datum
SWL	Static water level
PWL	Pumping water level
GL	Ground level
EOH	End of hole
KP&L	Kenya Power and Lighting Company
NEC	National Electrical Code
IEE	Institute of Electrical Engineers
ICE	International Electrotechnical Commission

Section 12 General Specification - 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 equipments shall be separately identified in the Bill of Quantities.

Power Supplies

The sites for work under this contract have no existing power supplies. Prior to the installation of plant the Contractor shall assess the revised electrical loads of the new plant and advise the Project Manager of any upgrading and provision required.

The Contractor shall provide, where necessary, any temporary power supplies needed for the execution of the works.

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 supply requirements in kVA for the installation(s) shall be given to the KP&L prior to installation.

The Contractor shall provide a certificate of completion from KP&L prior to installing any 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.

Supply Interruption

To ensure that the effects of incoming electricity supply disruptions have minimal effects on pumping capacity, main switchgear shall be fitted with overload, overcurrent and closing after a supply interruption. The switchgear shall not require manual resetting or closing after a supply interruption. Where contactor controls are used for main and auxiliary transformer circuits, these shall be latched so that they are re-energised when the supply is restored.

Re-starting of main motor circuits under automatic control shall be staggered to reduce system disturbance. (See Pump Duty Control).

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 e.g. ball valves, check valves or gate valves closed by gravity or stored energy systems in exceptional circumstances.

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 required 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.

Normal starting sequence will therefore cause the pump to run-up to operating speed then initiate opening of the delivery valve. Normal stopping sequence will first initiate delivery valve closure, after the valve has closed then pump motor will be de-energised.

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 (3 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 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.

On restoration of mains supply, a minimum period of 10 seconds shall elapse before a signal is given to stop the generator. Delayed stop timer setting to be adjustable 0.3 min.

Generator Supply – After the generator has been initiated, the monitor relays shall control the closing for the generator supply contactor to the load. The generator shall continue to run until signaled to stop by the restored Mains supply. A timer provided by others in the generator control panel shall ensure that the

generator shall run for a minimum run on time, (adjustable 0 – 60 min). All timers shall be set to suit operations requirements.

Manual Operation

If the generator is to be connected to both halves of the switchboard (bus-section closed) whilst the Mains supply is still available, the Mains supply switch shall be opened and the generator will receive its automatic start signal due to apparent loss of Mains supply. The generator will start and take on load automatically as if for a normal mains failure. The generator will continue to run until the Mains switch is closed, generator shutdown will then occur as defined for automatic mode.

If the generator is to be connected to its own half of the switchboard only, with the other half still fed from a healthy Mains supply, the opening bus-section switch will allow both contactors to be closed. The generator must then be manually started from the 'Generator Run-up' button as mains failure will not be detected. When the generator is running and ready to take load, the generator supply contactor will automatically close and the drives may be started in sequence as required. The generator will immediately stop and de-energise its supply contactor, allowing the Mains supply contactor to be restored after the bus-section switch has been closed. The generator minimum run timer being over ridden for the manual facility.

If the generator is to be run off-load only, then its incoming supply switch may be opened, alternatively the bus-section may be left closed, thus preventing the generator contactor from closing whilst the Mains supply is in use. The 'Generator Run-up/Run-Down' buttons or the Start/Stop buttons on the local generator panel shall be used.

Restoration of Loads

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 fusegear and circuit breakers, to deal with prospective fault currents.

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 hose proof (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 7498-1; 1991 or equivalent for draw out 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 Project Manager.

The system proposed shall conform to the following minimum requirements.

- 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 Project Manager			
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 Project Manager.

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 95mm^2 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 Project Manager.

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 1.0mm^2 (32/0.2) PVC insulated 600V grade, except wiring to PLC or other light current equipment which shall be not less than 0.5mm^2 (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 Project Manager.

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 Project Manager.

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 by 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 Project Manager. 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, synchrosopes) 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 Project Manager'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 Project Manager.

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.

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.

Provision shall **Provisions for Earthing**

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 and 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.

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 Project Manager 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 be provided with 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 Project Manager. 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 be submitted for the approval of The Project Manager. 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.

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:

$$\frac{I_S}{I_N} = 6 \quad \text{when the nominal current of the motor is between 15 and 40 A;} \\ \text{and if the starting current lasts less than 1 second;}$$

$$\frac{I_S}{I_N} = 3 \quad \text{when nominal current if the motor is between 40 and 125 A;}$$

$$\frac{I_S}{I_N} = 2.5 \quad \text{when the nominal current of the motor exceed 125 A.}$$

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 contactor.

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.

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 rates 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 p 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-energised 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°C/+40°C shall be connected 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:

**“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.

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 Project Manager.

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 Project Manager. 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 Project Manager 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 Project Manager 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 Project Manager.

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/SWA/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 installation, PVC sheathed, steel wire armored 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).

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 Project Manager.

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 Project Manager.

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	900
Over 60	1100	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 these 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

CATEGORY 1

Instrument power & Control
(over 50V, under 10A, AC or DC)

CATEGORY 2

High level signals
(5V to 50V DC)

CATEGORY 3

Low level signals
(Less than 5V DC)

Cat 1

Cat 2

200 mm

Cat 3

300 mm

200 mm

300 mm

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 Project Manager.

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 Project Manager'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 Project Manager. 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 of 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 are 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 try.

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 Project Manager.

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 Cable	To HC Cable	To LV Cable	To Other Pipes	To Gas/Water etc.
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 Project Manager. 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 Project Manager'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 excavate, 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 Project Manager.

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 Project Manager.

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 Project Manager 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 aluminium 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 labelled 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 Project Manager.

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 Project Manager 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 Project Manager.

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 Project Manager.

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 Project Manager.

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 Project Manager. 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 Project Manager 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 aluminium 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 aluminium 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 Project Manager 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 Project Manager 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 Project Manager.

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 aluminium 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 over sheath 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 Project Manager 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 joined 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 Project Manager. 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.

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 Project Manager.

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 Project Manager 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 Pipes	To Gas/Water etc.
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 Project Manager'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 Project Manager for subsequent reinstatement in their original position.

Broken land drains and damage to other services shall be reported to the Project Manager 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 Project Manager 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 Project Manager.

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 Project Manager 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 radiused (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 aluminium 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 partitioned 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.

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 labelled 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).

Miscellaneous Equipment

Battery Charger

The battery charger shall operate from the mains supply and be suitable for the battery provided and shall include overcurrent protection and automatic voltage regulation irrespective of the load on the battery. Where permanent loads are connected, the charger shall be capable of supplying a normal float charge designed to meet the standing loads and maintain the battery in a fully charged condition. Provision shall be made for a boost charge, selected by means of a Normal/Boost switch mounted within the panel with a label adjacent giving instruction on the use of the boost control.

The charger shall incorporate a provision for adjustment of the charging voltage and have protective devices to initiate the "Battery Fault" indication on the specified panel in the event of charge failure and low battery voltage. Mounted on the front panel shall be a mains supply indication lamp and meters showing the charging voltage and current.

When associated with engine starting duties, the charger shall be automatically isolated during the engine starting procedure. During engine operations, battery charging shall be automatically maintained by an engine driven generator working through a regulator and cut-out.

Starter Battery

The battery shall be a 24V lead acid, stationary, high performance, low maintenance Plant type suitable for standby engine starting duty and continuous normal charging.

Its capacity shall be sufficient to provide at least three successive 10 second attempts to start within a period of 2 minutes at 0°C.

The battery shall be accommodated securely in a wooden stand supporting a protecting cover, all finished with 2 coats of black chlorinated rubber paint.

Battery Supplies

Batteries for switchgear, control and alarm duties shall be of pocket plate nickel cadmium structure with an alkaline electrolyte and shall be suitable for constant trickle charging.

Each trip battery shall be rated for performing three successive tripping duties and for alarm relay circuits required for the associated circuit breakers. The trip battery shall not be used for other than these purposes.

Closing and general control or alarm circuit batteries, where required, shall be rated as detailed in the specific requirements.

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:

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, aluminium 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 Project Manager.

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, deed-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 switched 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 $\frac{3}{4}$ " 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.

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.

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/m²°C. 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 aluminium 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.

Road Lighting

Luminaires

The luminaires shall be weatherproof to at least IP55 or as otherwise specified. The output and spectral distribution characteristics shall be as detailed in the Specific Requirements.

Location of Luminaires

The position of all luminaires/columns shall be as indicated in the drawings and as agreed with the Project Manager. These positions shall be clearly marked on site to prevent obliteration before the work is started.

Electrical Equipment

Lanterns, switches, control gear and accessories shall be fitted, wired and connected in accordance with the IEE Wiring Regulations for Electrical Installations and the work shall be done by a qualified electrician.

Fuse cut boxes shall be made of flame retardant, resin moulded materials incorporating fuseways, looping terminals and earthing connections to suit the application. Fuse covers and other access to live parts shall be accessible only by the use of tools.

Metal columns, lanterns and the external metal work of switches and control equipment shall be electrically bonded and unless otherwise specified, connected to earth by one of the following methods:-

In installations served by an underground supply, by a conductor connected to the metal sheath of the supply cable

In any section of an installation served by an overhead wiring system, if a continuous earth wire is available along the entire length of the system, by a conductor suitable for connection to this wire; if no continuous earth wire is available, by individual earthing to each column in a manner to be specified by the Project Manager.

Lanterns shall be attached to the columns only after the columns have been securely fixed in their agreed vertical and horizontal alignment. Together with any optical components, they shall be correctly orientated with the road in accordance with the manufacturer's instructions. Leveling devices shall be used as supplied and as recommended by the manufacturer.

The lamps shall be clearly inserted in the lanterns without subjecting them to undue mechanical shock or vibration. Care shall be taken to ensure that lamps operate in the correct burning position, in accordance with the lamp manufacturer's instructions. Lamps, reflectors, bowls and refractors shall be clean and free from dust or obscuring films after assembly.

Wall and Bracket Mounting

In the absence of detailed instructions, the erector shall ensure that wall brackets and wall mounted lanterns are securely fixed to structurally-sound parts of the wall. The dimensions of fixing screws and wall plugs should be adequate for the loads to be carried. Where lanterns are mounted on long outreach brackets or where large surface areas are involved, the lanterns or brackets should be fixed to solid brick or stone wall by means of thoroughly caulked or grouted rag-bolts of adequate dimensions. The method of attachment to timbered buildings or other forms of construction should be the subject of agreement with the Project Manager.

Control gear not located inside the lantern should be housed in robust waterproof and tamperproof containers, securely fixed to the wall if appropriate. Surface wiring between the lantern and control gear compartments should be protected mechanically by means of heavy gauge welded steel conduit or steel wire armoured cables.

The requirements of the statutory authority should be complied with where street lighting lanterns and accessories are mounted on poles owned by statutory authorities.

Domestic Electrical Installation for Buildings

General

Electrical installations for buildings shall comply with the British or Kenyan Standards as normally applicable.

Materials and works for building electrical installation shall comply with:

- D.T.U. (United Technical Document) No. 70.1 published in December 1971 and
- completed by erratum July 1981

- D.T.U. published in April 1973
- N.F.C. 15-100: Electrical installations
- N.F.C. 71-800: Security blocks
- N.F.C. 13-200: High voltage electrical installations – Regulations
- N.F.C. 14-100: Sub-circuits installations- Regulations
- N.F.C. 15-150: High voltage gas discharge lamps installations.

The works which are the subject of this specification are for the installation of the electrical power supply network in the pumping stations and related buildings.

All equipment shall be to class of protection IP55 as a minimum.

The works include:

- Main distribution boards;
- Secondary distribution boards;
- Cabling and wiring;
- Installation of wiring in conduits for lighting, sockets-outlets and outlet boxes;
- starting from secondary panels, as well as the lighting points, socket outlets, and outlet boxes;
- Internal and external lighting luminaries;
- Earthing systems.

Electrical Distribution

A main distribution board to be installed near the entrance to the building.

A cable shall supply the power to this panel from the pumping station main panel or as otherwise stated in the Particular Specification. The main domestic distribution board shall comprise:

- A cabinet made of 2mm (minimum) thickness sheet steel treated against corrosion and protected by a textured paint: Finished colour shade RAL 7032 or RAL 7035).
- A frame, bus-bars, analytical instruments, ammeters, voltmeters with selector switches, four pole circuit-breakers with instantaneous electromagnetic trip release.
- One or more secondary distribution boards shall be installed according to the specification and the electrical installation drawings. These boards shall comprise:
- A cabinet made of 2mm (minimum) thickness sheet steel treated against corrosion and protected by a textured paint finished colour shade RAL 7032 or RAL 7035.

The enclosure shall be designed for built-in or surface mounting as specified. The cabinet shall include:

- An enclosure having a lockable door and key.
- A frame fitted with prefabricated bus-bars, the nominal rating to be determined according to the application.

- The cabling for the equipment, inside the board and the fixing items necessary for the mounting of the board.

Socket-Outlets and Plugs

Socket-outlets and plugs and junction boxes shall be provided as shown on the drawings and/or described in the particular specification, and in accordance with this technical specification.

Lighting

The installation of the lighting system shall be consistent with the technical specifications generally, and particular attention shall be given to those related to humid and corrosive situations (chlorine).

Electricity Supply

The electrical supply has the following features:

- Three-phase
- 415 V between phases
- 240 V between phase and neutral
- Frequency 50 Hz

Note: Voltage may vary +15%, -15% from the nominal value.

Nature and Origin of Materials

General

All materials intended for incorporation in the works shall comply with the D.T.U. in force and the regulations for construction, and the recommendations of the International Electrotechnical Commission.

Any approval of the Project Manager on the origin of materials does not release the Contractor from his responsibility in respect of the quality and the reliability of the materials supplied to the site, which must always be consistent with the relevant specifications. Any change of the origin of materials previously approved shall be submitted for approval.

Distribution Boards

All distribution boards shall be metallic construction, they shall be monocellular, rectangular and have a plane front face.

They shall have a class of protection IP55 and be finished with textured paint RAL 7032 or RAL 7035 (see paragraph 19.1).

Distribution boards shall be supplied with all the wiring, bus-bars, equipment, accessories, cables, junction boxes, and installation material ready for installation directly on arrival at site.

The boards shall be designed to facilitate inspection, maintenance and repair and all articles having the same characteristics and dimensions shall be entirely interchangeable.

Distribution boards must not show any deformation or welding effect. They shall be rigid enough to support the equipment without deformation both during normal operation and under short circuit condition. They shall be fitted with reinforcement especially against the effect of short-circuits.

All bus-bars, equipment and connections shall withstand the nominal rated current continuously without heating beyond admissible values.

The design of distribution boards shall take into consideration every change of rating of the equipment to suit the climatic conditions specific to the site. All live terminals and parts shall be adequately insulated from the frame of the panel board. The frame shall be earthed.

Bus-bars shall be so protected as to exclude the possibility of contact with them or any live part when closing or releasing circuit breakers.

Boards comprising several cells, shall be protected with an earthing bar covering the entire length of the board.

Frames and the metallic enclosures of equipment shall be connected to the earthing bar by means of approved accessories.

Each single phase distribution board shall have one bus-bar and one neutral bar. The section of the bars shall be sufficient to allow the passage of the nominal current without leading to excessive heating, the rating shall be equivalent to at least the total nominal current incoming circuit breakers in the board.

Bus-bars shall be made of electrolytic copper. The Contractor may offer variants made of another material, but in this case, he shall submit for the Project Manager's approval all the details concerning the accessories required for the connection of cables and equipment to bus-bars.

The frames of distribution boards shall be treated against corrosion. They shall be painted internally and externally with one coat of primer and two grey finishing coats.

All circuits fed from the panel board shall be labeled.

Distribution boards shall have at each feeder, a chart or diagram describing, according to the distribution scheme, the circuits connected to this feeder. The boards shall be of fixed, non removable type. Circuit breakers shall be of a miniature type.

Connections to all equipment shall be easily reached and made from the front without having to dismantle the board.

Ammeters shall be fitted at each incoming feeder.

Circuit Breakers

All circuit breakers shall meet the following conditions:

- They shall be designed to function under the electrical current supplied to the station;
- Each phase pole shall be fitted with an instantaneous action thermo-magnetic type over current trip. The trip shall act on a common tripping of all poles;
- Circuit breakers shall be of automatic trip type;
- Each pole shall be fitted with an arc extinguishing mechanism;
- Circuit breakers shall be compensated for ambient temperature. All thermal relays shall be compensated in order to function correctly in the ambient temperature of the site.

Three-phase circuit breakers shall also meet the following conditions:

- Incoming circuit breakers from the main panel board, connected directly to the transformer station shall be four pole. All other circuit breakers shall be three pole. All the pole of three-phase circuit breakers should trip simultaneously with one control mechanism.

Circuit breakers installed in secondary panel boards may be moulded case miniature type.

All circuit breakers shall have sufficient rupturing capacity to switch off the highest short-circuit currents.

Circuit breakers shall have the rating indicated on the drawings.

The minimum rupturing capacities shall be as tabulated hereunder and consistent with the D.T.U.

Rating A	Voltage Volts	Rupturing Capacity KA
32	240-380	6000
70	240-380	6000
100	380	14000
125	380	14000
150	380	22000
500	380	30000

Contactors

Contactors used in the installation shall be three-pole, mounted in screened boxes, protected to Class IP55. They shall be designed to function under the nominal working voltage and current corresponding to the circuit breakers protecting the circuits they control.

The mechanical and electrical resistance of the contactors shall be high and they shall be protected against dust or any other factor that might harm their proper functioning.

“On” and “Off” push-buttons shall be mounted on the cover of the box.

Electric Cables

The cables to be installed include the following:

- Main distribution board power supply cables;
- Connection cables between the main and secondary distribution boards;
- Power supply cabling to metering;
- Connection cables between meters and secondary boards;
- Cables used for the power supply of low power motors.

Multicore cables shall be protected with an external sheath made of thermoplastic material of NYA type consistent with the most recent VDE standards or of an equivalent type consistent with other recognized standards.

All cables shall be of 1000 volts rating.

Cores shall be made of pure electrolytic copper; resistivity = $0.01724 \text{ Ohm/mm}^2/\text{m}$ at a temperature of 20°C . They shall be multi stranded for sections exceeding 6mm^2 .

The insulation of the cores shall be colour coded as specified.

Insulated Conductors

Conductors laid in polyethylene tube shall be made of copper insulated with thermoplastic materials. They shall be of NYA type consistent with most recent VDE standards or of an equivalent type consistent with other recognized standards. They shall be of 600 volts rating.

Conductors shall be made of pure electrolytic copper, resistivity = $0.01724 \text{ Ohm/mm}^2/\text{m}$.

The minimum section of conductors shall not be less than 1.5mm^2 . Conductors having sections exceeding 2.5mm^2 shall be multi-stranded.

In single-phase circuits, the section of neutral conductors shall always be equal to that of the phase conductor. Each circuit shall have an independent neutral from the secondary panel board.

All phase conductor, neutral conductor and earth conductor on the installation shall be differentiated, one from the other, by the colour of the insulation.

Each phase conductor shall have a colour different from those of the others, changing the colour for a phase conductor along the same circuit is absolutely forbidden.

The neutral conductor shall be grey throughout the installation.

Earthing conductors shall be yellow-green throughout the installation.

The connection of conductors shall be carried out exclusively inside enclosures, by mean of clamping screws in order to prevent the scattering of strands.

The use of an insulating adhesive tape is forbidden.

Maximum voltage drop in comparison with the available voltage in the main panel board: 3%.

Maximum density of current: 3A/mm^2 for 2.5mm^2 cables and 2A/mm^2 for larger cables.

Conduits

Where electrical wires and cables, including very low voltage wiring, are installed in plastic conduit, the conduit shall be consistent with the DTU and its addenda (class of protection IP55).

The connection of conduits shall be carried out by means of accessories of the same type, using materials specified in the catalogues of the conduit manufacturer (class of protection IP55).

Adequate flexible accessories shall be used for electric lines crossing expansion joints or fixed to different structure units.

Generally, all accessories used with electrical networks shall be of the same type and shall have the same characteristics.

Conduit fixing clamps shall be made of hot galvanized steel. Screws and nuts together with the number and section of conductors that may be installed therein. The numbers stated in the table represent in millimeters the minimum internal diameters. The Contractor shall supply conduits having a diameter equal to at least that specified.

Section of Conductors (mm ²)	Numbers of Conductor in Conduit			
	3	4	5	6
2.5	16	16	16	16
4	16	16	16	26
6	16	16	16	23
10	21	21	21	29
16	21	29	36	36
25	36	36	36	48
35	36	58	48	48

No more than 6 conductors may be installed in one conduit unless the seventh is an earthing conductor.

Boxes

Boxes used for connections and sub circuits, as well as those installed at each feeder, shall be supplied with appropriate covers (class of protection IP55).

They shall have knockouts for conduit connections.

Switch and socket boxes shall be provided for the switches and sockets to be installed, in conformity with the recommendation of the supplier of these items.

Surface mounted boxes shall be watertight to IP55, of moulded construction with inlets fitted with glands.

Junction boxes installed outdoors or inside humid locations shall be watertight weatherproof type (class of protection IP55).

Switches

Lighting circuit switches shall be single or two-way rated for 16 Amp, 250V. They shall be silent toggle switches.

The switch and cover plate shall be fixed to the box with stainless steel or chromium-plated screws. Hook fixings are forbidden.

Flush switches shall have their covers made of an insulating material (class of protection IP55).

Surface mounted switches shall have the same mechanism as flush switches, but shall be installed inside dust proof boxes, having inlets fitted with glands (class of protection IP55).

Socket Outlets and Plugs

Single Phase

Each single-phase socket-outlet and plug shall have 2 terminals and one earthing contact. They shall be rated for 13/15 Amp and 20 Amp-240V.

Fixing switch and cover plate to the box shall be done with stainless steel or chromium plated screws. Hook fixings are forbidden.

Switches used with built-in installations shall be of flush type and fitted with square or rectangular covers made of an insulating material.

Surface mounted switches shall be installed inside water proof boxes (class of protection IP55). These boxes shall have inlets fitted with glands and shall be provided with knockouts.

Three-phase Socket Outlets and Plugs

Three-phase socket outlets and plugs shall be rated for 32 Amp, 380/415V and shall have earthing terminals. Surface mounted socket-outlets and plugs shall be installed inside weather proof boxes (class of protection IP55).

These boxes shall have inlets fitted with glands and shall be provided with knockouts.

It shall not be possible to insert telephone plugs into sockets.

Junction Boxes

Power supply circuits of low power equipment such as fans and air convectors shall be linked to junction boxes with fixed connections for the corresponding equipment.

Junction boxes shall be either single-phase or three-phase.

Earthing Systems

Resistance of Earthing Systems

The following independent earthing systems may be utilised.

- Earthing systems of the neutral point of the standby generating set alternator.
- Earthing system of the metallic frame of the main panel board.
- Earthing system of the building or metering system.

These systems shall have a resistance of less than 5 Ohms.

Earthing

Each earthing system shall be achieved by one or several rods.

The resistance of the earthing shall not exceed the value stated in the previous paragraph.

The Contractor shall install a sufficient number of rods to achieve this resistance value.

Earthing rods shall consist of a steel core covered with a copper coat.

The heads of the earthing rod shall be buried 500mm deep in the ground. A concrete manhole having a 500mm side shall be prepared for each earth terminal in order to facilitate maintenance operations and later reinforcement works utilizing additional elements if required to increase the earthing installation.

The manhole shall have a cast iron or concrete cover allowing permanent access.

The head of each earthing terminal shall be fitted with a sectioning bar allowing the isolation of this earthing element from the installation and, hence, the measurement of the earth resistance.

The connection of earthing cables to the earthing system shall be carried out by means of sockets ensuring very good contact.

Earthing Conductors

The sections of earthing conductors of the various terminal circuits or power supply circuits of a panel shall be the same as those of the neutral conductor of the corresponding circuit, in such a way that they are not less than 2.5mm² nor more than 70mm².

Connections shall be carried out by permanent weld or by screw clamping.

Connections between earthing network and equipment subject to movement shall be carried out by means of copper braids having the same section as earthing conductors.

Series earthing is prohibited.

All insulated earthing conductors shall be yellow-green (external colour). This colour shall not be used for any other part of the installation.

Lighting Fixtures

General Conditions

Lighting installation shall be complete and shall include all necessary accessories, whether the accessories are described hereunder with the description of the lighting installation or not.

The body of the lighting fixture, its base, or support shall entirely cover the corresponding box.

External devices shall be mounted with non-ferrous accessories.

The frame of lighting devices inserted in a false-ceiling shall not allow light to infiltrate between the frame and the false-ceiling.

Lighting devices fixed directly to a centre box shall be solidly held by a peg and a cramping block.

Characteristics of Materials

General

Unless otherwise stated on the drawings lighting devices shall, wherever applicable, comply with all conditions stated below.

The name of a supplier and catalogue number are stated for reference only as a description of type and standard. The equipment supplied shall be consistent with the specifications and, if necessary, standard equipment shall be modified accordingly.

Wiring

Wiring inside lighting devices shall have a section equal to or exceeding 2mm², and shall be insulated for a nominal voltage of 500V.

Sheets

The minimum thickness of sheet used in lighting devices shall be 1mm.

Metallic parts of lighting devices shall be free from any scratch.

Treatment and Painting of Sheets

All sheets shall receive the following treatment:

Prewashing, grease removal, rinsing, passivation, drying.

Unless otherwise specified, all non reflecting surfaces, such as the frames of lighting devices, bases, etc. shall be coated with an enamel finish. The colour of the paint shall comply with the specifications unless specified otherwise by the Project Manager.

All reflecting surfaces shall be coated with white enamel having a minimum reflection coefficient of 80%.

Fluorescent Luminaires

General

Flush luminaires shall be so dimensioned as to allow the replacement of one or more sections of the false-ceiling without requiring any cutting.

Bushes

Lighting devices shall be equipped with clip-on bushes.

Ballasts

Ballasts shall be consistent with the standards of the D.T.U. and designed for 45°C ambient temperature. Only one or two-lamp ballasts shall be used.

Ballasts shall be completely enclosed inside a metallic casing and shall have a corrosion-resistant finish.

Windings shall be impregnated with a polyester resin suppressing every risk of softening and melting and ensuring excellent heat dissipation.

Ballasts shall be corrected to give a power factor better than 0.9.

Ballasts shall be of silent-type operation and unless otherwise provided for, shall be rapid start type.

Two series-lamp ballasts shall be lead-lag type or equivalent.

Incandescent Luminaires

Incandescent luminaires shall be fitted with porcelain-base bushes having an Edison screw E27 for lamps up to 200W, and Goliath screw E40 for lamps of 300W or more.

It shall be possible to place and remove lamps without dismantling the system.

The various types of incandescent luminaires shall comply with the detailed description given by the manufacturer.

Lamps

General

Lamps shall be supplied and placed in all the lighting fixtures as specified.

Prior to the final commissioning of electrical installations, lamps used throughout the works shall be replaced by new ones.

Incandescent Lamps

Incandescent lamps shall be of the internal satin type with screw bases.

Lamps shall be designed to work at 240V (or 24V) voltage, they shall have a lifetime of a minimum 1000 hours.

Fluorescent Lamps

Unless otherwise specified, fluorescent lamps shall be rapid start type. They shall have a high luminous efficiency.

Halogen Lamps

Halogen lamps shall be tubular type, having a lifetime of at least 4000 hours and operating in all directions and positions.

The colour temperature shall be 2850°C, the fuse shall be incorporated and the flux value is 5000 lumen.

Particular Cases: Lighting of Humid Buildings

Given the humid atmosphere inside pumping, treatment and other similar areas, 200 Volts should not be used for the lighting system without a security mechanism.

The Contractor shall install a special security mechanism in the following manner:

The outgoing supply cable shall be equipped with an isolating transformer and a power circuit breaker fitted with differential protecting devices of adjustable sensitivity and delays: 0.3A, 1A, 3A up to one second.

The rupturing capacity shall be 20KA in accordance with D.T.U.

N.B. All equipment used in the buildings shall be standard and shall comply with international technical regulations relating to humid and corrosive buildings. (Class of protection IP55 minimum).

Execution of the Works

Locations for Installation of Equipment

The locations for the installation of materials shall be agreed on site between the Contractor and the Project Manager or his representative.

Secondary Distribution Panel Boards

Unless otherwise directed, secondary panel boards shall be centered 1.50m above finished floor level.

Distribution boards shall be totally protected and fitted with circuit breakers. In three-phase panel boards, the numbering of circuits indicated on the drawings is based on a three-phase separation where circuits are connected respectively to the red, yellow and blue phase.

Internal equipment of panel boards (bus bars, circuit breakers) shall only be installed in the enclosure after installation, fixing and connecting conduits.

All opening left in the panel shall be properly sealed.

Distribution panels shall be installed vertically; under no circumstances shall the conduits serve as supports to the panel.

The sides of panels to be embedded shall be covered before installation with a thick coat of emulsified tar.

The frames of built-in panel boards shall be installed squarely and in alignment with the walls.

Each distribution panel shall have at the front side an engraved plate stating the name and reference letters of the panel board. On the inside of each panel board door, there shall be a list stating the reference number for each circuit connected to the panel board and the reference number of the locations supplied with power by the circuit.

General Conditions

Cable installations shall conform to the following:

The methods used for installation of cables shall not damage the conductors and the insulators;

The pull utilized for installation of cable shall be kept to the minimum necessary for installation and shall not permanently strain the conductors;

The connection wires to equipment shall not be subject to any strain;

The radius of curvature of cables shall, at no point, be less than 10 times the outside diameter;

Between any two sub circuit boxes, cables shall be continuous, no junctions shall be allowed;

The use of wooden pins for sealing is forbidden;

Cables shall be marked every 10 metres in order to facilitate identification.

Installation of Visible Cables

All visible cables shall be mounted as follows:

Cables shall be installed in cable tray in one layer and shall in no case be superimposed. Each cable tray shall have a 25% reserve in order to allow for the installation of future cables. Vertical sections shall be fitted with cable fixing devices;

Cables shall be fixed on masonry along walls by means of galvanized steel brackets or other means proposed by the Contractor and approved by the Project Manager;

Beneath ceilings, cables shall be held by substantial supports. The supports shall be sufficiently close to avoid droop of the cables.

Other Conditions

Lengths of cables mounted between ground and a height of 2.50m and those crossing masonry shall be installed inside galvanized steel tube.

Insulated Wires

All wires and connection devices shall be accessible for inspection and replacement as required. They shall be so set out and installed as to allow handling without causing any mechanical deterioration.

All wires shall be installed entirely outside conduits.

The connection of wires shall be carried out exclusively inside enclosures by clamping in order to prevent the scattering of strands.

The use of adhesive insulating tape is forbidden.

The pulling of wires in conduits shall be carried out carefully in order not to damage the insulator. It is forbidden to use oils, grease or any other fluid for facilitating the pulling of wires, the Contractor can however use powder of an approved type.

Switches shall be installed on phase wires and in no case on neutral wires.

Phase wires, neutral wires and earthing conductors of the installation shall be differentiated from each other by the colour of the insulator.

Each phase wire shall have its own specific colour, different from any other.

The mixing of colours for a phase wire, from point of installation to another point along the same circuit is strictly forbidden.

The colour of neutral wires shall be grey, and shall remain unchanged throughout the installation.

The colour of the earthing conductor shall be yellow-green, and shall remain unchanged throughout the installation.

Conduits

Conduits shall be so installed that the junction, sub-circuit, and wiring draw boxes are always accessible for maintenance and repair. The connection of conduits or of conduits and other accessories shall be carried out according to instructions of the conduit manufacturer.

Surface mounted conduits shall be fixed by means of galvanized steel brackets, sufficiently close to each other to ensure a solid fixing.

After laying the conduits, they shall be fixed in cement mortar.

The Contractor shall make grooves in the walls for built-in conduits; in all cases he shall fix the conduits in such a way as not to damage the finish of the structure.

The use of wooden pegs for sealing is strictly forbidden.

No 90° bends shall be permitted throughout the run of a conduit between two junction boxes. Should more than two bends be required, the Contractor shall install additional junction boxes in order to facilitate the laying and removal of wires.

In the event of the electrical conduits crossing other pipes, electrical conduits shall be so installed as to keep a free space between conduits and pipes.

A minimum clearance of 200mm shall be maintained between electrical conduits and heating or steam pipes. If this 200mm clearance cannot be achieved electrical conduits shall be externally insulated.

Conduits embedded in walls shall be vertical or horizontal. Installation of diagonal conduits inside walls is not permitted.

Surface mounted conduits shall run parallel or perpendicular to walls.

Note: All low voltage cables shall be installed in separate conduits.

Switches

Switches shall be flush or surface mounted according to the type of installation.

Switches shall be connected to phase wires and never to neutral wires.

Switches shall, in general, be installed 1100mm above the finished level of the floor, except in particular cases where their installation shall be submitted for the Project Manager's approval.

Switches intended for the same duty in different locations shall be installed at the same heights. Switches shall always be installed in the most suitable places for their operation.

Socket-Outlets and Plugs

The exact locations of socket-outlet and plugs shall be determined according to the construction details of the building. These locations shall be submitted for the Project Manager's approval.

Socket outlets shall be flush or surface mounted according to the type of the installation.

Flush mounted socket outlets shall be installed in their boxes with screws.

All single-phase socket-outlets and plugs shall have earthing contacts or terminals to be connected to the earthing system.

Three-phase socket-outlets shall be installed at heights which suit the equipment they supply with power.

Socket-outlets and plugs intended for the same duty in different locations shall be installed at the same heights.

Tests

General

Installation tests shall be carried out throughout the works, whenever it is necessary, and at the end of the works. Tests shall be consistent with the specifications of the Contract document and the standards in force.

The Contractor shall supply, without any additional payment, all equipment, analytical instruments, and labour necessary for conducting these tests. Analytical instruments shall be sealed and supplied with recent calibration certificates provided by an official laboratory.

All tests shall be carried out on the responsibility of the Contractor.

In the event of a failure of the tests, tests shall be repeated after the Contractor has carried out the necessary repairs or replacements.

The results of the tests shall be set out in a report signed by the Project Manager or his representative and by the Contractor.

Types of Tests

Tests shall comprise, but shall not be limited to, the following:

Visual Inspection

- Checking the state of the equipment and the quality of work;
- Checking levels and alignments;
- Verifying the effective characteristics of the equipment.

Measurement of the Insulation and Circuitry Continuity

This test shall be conducted on the various circuits after receivers have been removed.

Operation Tests

All electrical equipment shall be tested when operating in order to verify conformity with the specifications of the tender document and the installation regulations.

Performance Tests

These tests shall be conducted in order to verify the features of the installations and conformity with the standards in force.

The Contractor shall conduct any other test deemed necessary by the Project Manager in order to verify the condition and the functioning of the installations.

Section 4 General Specification - 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 stud bolts, 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.

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 Project Manager. 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 Project Manager.

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.

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.

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.

Provision for Handling

Suitable provision approved by the Project Manager 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.

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.

Balancing

All rotating parts of the machinery shall be statically and dynamically balanced unless otherwise agreed in writing by the Project Manager. The complete rotating assembly shall be designed such that any critical speeds are outside the duty running speed range of the machine.

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 Project Manager.

All bearing surfaces shall be properly charged with grease before the plant is operated.

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 Project Manager's approval.

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.

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 Project Manager'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.

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:

- Key number;
- Location of lock/Item of equipment.

Noise Level

All plant shall run without undue vibration and with the least practicable amount of noise.

Vibration levels shall not exceed these set cut 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).

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.

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 Project Manager.

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 Project Manager'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.

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 Project Manager. 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;

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 Project Manager's approval.

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.

The final colours and finish for the equipment's shall be as specified in Appendix 8 unless otherwise advised.

Pumps

Pump Duty

Pumps shall be of the type specified and arranged as indicated in the Specification Drawings. 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 Project Manager.

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 sewage pumps the ability to operate with the maximum reliability is of prime importance, with efficiency being a secondary 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 sewage pumps, due to the presence of grit in the sewage 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 sewage 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 rages and fibrous matter within the pumps.

Impellers for both sewage 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 o 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 s 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 house 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.

Intermediate Shafts

Intermediate shafts between the pump and drive shall include universal couplings at each end allowing free axial movement to avoid end thrust being transmitted. The shaft and coupling shall be fitted with a full length guard manufactured from mild steel mesh on a mild steel framework, easily removable for maintenance purposes.

The frame and mesh shall be hot dip galvanized.

Gear Unit

Each unit shall be continuously rated to transmit the full power of the drive either directly in line or through a right angled, helical gear system, having an input/output speed ratio to suit the duty.

The gear case shall be made of substantially ribbed cast iron with machined mounting feet and shall form a totally enclosed, oil tight casing.

The gear unit case and bearings shall be designed to accommodate the total weight of any suspended drive shafting and couplings in addition to any dynamic load imparted during service, and run for a minimum of 10,000 hours before a major overhaul is required.

Where specified, an electric tachometer shall be fitted to indicate the output shaft speed.

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.

Submersible Sewage Pumps

The pumps shall be fully submersible and of the unchokeable type, capable of passing raw unscreened sewage. They shall have non-over-loading characteristics and incorporate bearings sealed for life.

The sealing arrangements between pump and motor shall be by means of mechanical seals running in an oil bath which serves to lubricate and cool the interfaces of the seals.

The pump shall include renewable and easily replaceable wear rings.

Robustness of construction and the ability to operate automatically with a minimum of attention for long periods is essential.

The pumps shall be supplied with guide rails unless otherwise stated, and particular attention shall be given to the free passage of the pumps up and down the rails without jamming. The pump outlet flange, unless otherwise stated, shall have a boltless coupling on to the flange of the fixed delivery pipework and shall have positive location so as to provide an automatic coupling with a good seal when the pump is lowered into position.

The pump casing shall incorporate a lifting eye of not less than 80mm internal diameter suitable for the attachment of heavily galvanized lifting chains which shall be brought out of the wet well to a conveniently sited fastening.

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 Borehole 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/m^3 .

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.

Borehole 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 borehole 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 2 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.

Borehole Pumps Headworks

A fabricated steel discharge head piece shall be provided at the top of the borehole 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.

Borehole 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).

Vertical Turbine Pumpsets

The pumps shall be of the vertical line shaft type. The discharge head shall be bolted onto a substantial steel bedplate or frame which shall in turn be bolted to the pump room floor. The discharge head shall have a flanged discharge. The suction casing and impeller bowls shall be of cast iron. Replaceable seal rings shall be fitted on to the impeller suction side if required to maintain pump hydraulic efficiency.

The impeller shall be bronze or other material to suit the characteristics of the water to be pumped. The pump shaft shall be of stainless steel supported by bearings above and below each stage. Protection shall be given against the effects of entrained solids in the water being pumped intermediate bearings shall be lubricated by the liquid being pumped.

The line shaft shall be machined and ground carbon steel supplied in lengths not exceeding 3.0m, with screwed couplings. The line shaft bearings shall be spider type to locate the shaft in the tube and may also double up as line shaft tube couplers. Lubrication shall be provided to the bearings.

The pump suction shall be of at least equal diameter to the pump and shall be fitted with a suction strainer.

Means shall be provided of adjusting the pump shaft tension and position.

Chemical Metering and Dosing Pumps

Chemical dosing shall be by means of electrically driven metering pumps unless otherwise particularly specified.

Metering pumps shall be of the plunger or progressive cavity type.

The effective range of the metering pumps shall be between zero and maximum with an overall repeatable accuracy within $\pm 3\%$. Output shall be adjustable through a stepless variable stroke mechanism in the case of plunger pumps and variable speed motor or gearbox in the case of progressive cavity pumps.

The metering pumps shall be manually adjusted, and shall be calibrated to allow setting at the required dosage. Dose adjustment shall be possible whilst the units are in operation. Accurate dosing shall be maintained down to 10% of the maximum dosing rate.

The Contractor shall consider the liquid to be pumped and select the materials of construction so as to avoid corrosion. Mechanical glands are generally undesirable but where unavoidable, shall be to the approval of the Project Manager.

For metering pumps of the plunger type the materials in contact with the liquid shall be polypropylene, stainless steel grade 316, uPVC or PTFE. Plungers shall be a high-alumina ceramic or stainless steel, grade 316.

Metering pumps shall be mounted on bed plates which shall be protected from gland dip. The pumps shall be driven by close coupled motors with reduction gears and have mechanisms housed in a totally enclosed oil bath. At least one standby pump, fully connected into the chemical dosing system, shall be provided for each chemical, with local manual selection of duty and standby units. When pump duty changeover is effected, the appropriate suction and delivery isolating valves shall be manually operated.

Stators and rotors for progressive cavity pumps shall be of materials selected having regard to the liquids being pumped.

The design and location of the metering pumps shall be such as to facilitate easy dismantling for the removal of any foreign matter.

Flushing facilities shall be provided for all chemical pipework at the inlet and outlet of each metering pump, together with drip trays to contain any spillage or leakage and piped to the nearest drain point. Provision shall be made for priming the system to eliminate any air.

Each chemical dosing pump shall be provided with suitable isolating valves, an inter-connecting manifold system and, where necessary, loading valves. A calibrated glass container shall be provided connected into the suction manifold of each chemical pump so that its output can be checked.

Calibration curves shall be provided by the Contractor for all chemical dosing pumps.

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;
- 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.

Valves and Penstocks

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 handwheel 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.

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. Handwheels 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 handwheels.

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 cold applied bitumen conforming to the requirements of BS 3416 (material Type II).

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.

All valves shall be open end tested in accordance with BS 5163, and pressure and materials test certificates shall be submitted to the Project Manager for Approval.

Telescopic Valves

All bellmouth telescopic valves shall have cast iron outer sleeves and bellmouths. The outer sleeves shall have machined labyrinth seals and the sliding tubes shall be manufactured from zinc free bronze.

A cast iron shall be stirrup shall be affixed over the top of each bellmouth and these shall be connected to the rising screw thread by means of a stainless steel 'Rose' type coupling. To minimize fouling by rags etc. the valves shall not be fitted with outer guide rods.

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 Project Manager. 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 Project Manager 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 tappings 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.

Extension Spindles

Extension spindles shall be adequately sized to prevent buckling and shall be attached to the valve/penstock stem by a suitable adaptor incorporating two muff couplings, scarf lap jointed and pinned with at least two coupling joints included. Universal joints and waterproof sleeves shall be provided where specified. Extension spindles shall be manufactured from 080M40 (EN 8) steel.

Intermediate bearing support or guide brackets of cast iron, with slotted holes for site adjustment, shall be fitted to long shafts where necessary. Bearings shall be of PTFE or similar approved type.

Pedestal and Spindle Covers

Penstock and valve pedestals shall be of cast iron or heavy duty, welded, mild steel construction with a substantial base and fixing provision. The base and top of the pedestals shall be machined normal to the axis of the drive shaft.

Where necessary, support guide bushes shall be fitted as the base of the pedestal.

The pedestal height shall be such that the handwheel is approximately 1 metre above the operator's floor level. Covers of an approved type shall be provided for all rising spindles to totally enclose them when in the fully raised position.

Penstocks

All penstocks shall be designed and installed so that the maximum working pressure acts in a seating direction on the gate.

Both gate and frames shall be sufficiently rigid to withstand twice the maximum working pressure and any eccentric pressures created by the tightening of the anchor bolts during installation. All penstock frames shall have a spigot back.

The frame shall be of the rising spindle type unless otherwise specified, and the spindles shall be of adequate size to avoid buckling under load.

All spindle nuts shall be self aligning and their length shall be not less than twice the spindle diameter.

The top part of the penstock frames shall be sufficiently robust and substantial to prevent the frames bowing and if necessary, additional holding down bolts shall be fitted. The penstocks shall be fitted with matching wedges on doors and guides, the wedges shall be fitted with renewable seatings of zinc free bronze. Under no circumstances shall wedges be fitted to the bottom or lower section of the penstock doors. The wedges shall be adjustable with stainless steel adjusting screws and shall be readily removable.

On rectangular penstocks the inverts shall be flush with renewable synthetic rubber seals on the bottom of the doors. The rubber shall be suitable for the application and of an approved type.

The doors shall have lifting eyes cast in, or eye bolts of sufficient size to permit the lifting of the door against seating pressure.

Penstock Materials

Penstock doors, wedge support beams, frames, guides, frame extensions, headstocks and bridge pieces shall be cast iron, of minimum grade 220 to BS 1452. Doors and frames shall be fitted with renewable seatings of zinc free bronze.

Spindles shall be manufactured from stainless steel 431s29 (EN 57) or similar approved material.

Templates

Simple templates shall be supplied as soon as possible after approval of drawings to enable the Civil Engineer to position the holes for holding down bolts for all penstocks over 1.0 m square.

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 tappings 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.

Pipework

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 Project Manager 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 sized such that the air flow velocity does not exceed 8m/sec. 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 14 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 epoxy resin 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 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.

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 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.

Air pipework. - As for general purpose pipework except where otherwise specified. Low pressure air pipework shall be cast iron to BS 2035 Class C, flanged to BS 10 Table E. Internal surfaces to be cleaned and treated suitable for passing clean, humid air.

Gas pipework. As for general purpose pipework unless otherwise specified.

Fuel oil pipework. As for general purpose pipework except that pipework fittings shall not be galvanized.

Exhaust pipework. As for general pipework except that pipework and fittings shall not be galvanised. Flanges shall be to BS 10 Table D.

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 Project Manager, 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 Project Manager'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

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).

Corrosion Protection

Pipes and fittings shall be protected externally with an extruded polyethylene or polyurethane coating complying with DIN 30674. 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.

Steel Pipe Work

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.

Each pipe shall be supplied complete with a coupling for jointing.

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. 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.

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.

Chemical Pipework

General

Each point of chemical application shall be fully piped from the appropriate tank or metering pump. Chlorine dosing pipes shall be run in rigid pipework.

All chemical pipes shall be colour banded to enable individual lines to be identified throughout their run.

The contract shall include for the provision of all necessary chemical suction, delivery, overflow and drain piping, fittings, support racks or trays and brackets for the plant supplied under the Contract.

The chemical hoses shall be provided with unions, as necessary, to provide for rapid dismantling and re-assembly in case of blockage and allow for easy cleaning. Drain cocks shall be provided at suitable points to allow for draining out of any chemical pipe before dismantling.

All pipework conveying chemical solutions or slurries shall be selected to suit the characteristics of the chemical being handled and also the environmental conditions in which they are installed.

Valves shall be of the diaphragm type, with bodies or linings suitable for the chemicals handled.

All chemical liquid wastes shall be conveyed to the nearest drain point.

Chemical Hose Trays

All chemical dosing hoses shall be run on cable trays of the heavy duty pattern constructed of mild steel and galvanised after manufacture. Trays shall have return flanges of minimum depth 25mm. Manufactured bends, fillers and tees shall be used throughout. Supporting steelwork shall be manufactured from a proprietary galvanised steel mechanical support system. The system shall comprise a U-section steel channel of minimum dimensions 40mm x 40mm and having an inner return flange. Fixing devices, support brackets etc., shall also be of proprietary make from the same manufacturer. Wherever horizontal tray runs are used, supporting brackets shall be cantilevered from vertical faces to facilitate the easy removal or addition of hoses.

Tray supports shall be arranged such that no perceptible sagging of trays is present when all hoses are in place. A minimum of 20% spare capacity shall be left on all trays.

Cut ends of trays and steelwork shall be painted with approved cold galvanizing paint before installation.

Hoses shall be laid flat on trays at a maximum of 2m intervals with adjustable self-tensioning nylon cable saddles. One bolt fixing saddle shall be used with two point fixings. The unbolted end shall employ a self-locking tongue slotted into the cable tray. All saddles shall be easily removable without cutting and be suitable for re-use. No more than 4 hoses shall be embrace with one saddle.

Stacking of hoses on trays shall not be permitted.

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/m^2 (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/m^2 (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 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.

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.

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 gravelling 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.

Compressors/Blowers

Air Compressor

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 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.

Diesel Engines

General

The engine shall be a cold starting 4 stroke water cooled, multi-cylinder in-line or “V” form, naturally aspirated or turbocharged and intercooled, totally enclosed industrial diesel of standard proven design, designed to run on liquid petroleum fuel to BS 2869 Class ‘A’ and incorporate all starting, lubricating, cooling, monitoring, alarm and shut-down systems suitable for automatic and continuous unattended operation.

The engine crankcase shall be fitted with a breather pipe and safety devices to provide protection in the event of an explosion.

Crankcase access panels shall be provided for maintenance/inspection where possible.

Duty and Rating

The engine shall be rated in accordance with BS 5514 to provide the necessary torque and power output at a rated speed not greater than 1500rpm, to drive the specified load under the given site conditions.

Flywheel

The engine crankshaft shall be fitted with a flywheel of suitable inertia to absorb speed variation to within the specified limits. The flywheel shall incorporate all necessary barring facilities and timing marks. Safety devices shall be fitted to prevent the engine starting when any barring gear is in use.

Torsional and Cyclic Characteristics

The rotating system of the engine and ancillaries shall be statically and dynamically balanced during manufacture. Detachable components, e.g. fans shall either be separately balanced or permanently marked in a manner that ensures correct angular positioning.

For alternator drives, the coupling between the engine and the alternator shall be a flexible type of the manufacturer’s standard arrangement and the torsional characteristics, cyclic irregularity, angular deviation and freedom from resonance shall comply with BS 4999, Part 142 and BS 5514 Part 5. The interchange of information between the engine and alternator manufacturers as directed therein shall be observed so as to ensure this.

Governor and Speed Control

The engine shall be fitted with a governor suitable for automatically controlling the engine speed in accordance with class 2 of BS 5524, Part 4. Provision shall be made for variable hand speed control, emergency manual shutdown and an over-speed trip arranged to cut-off the fuel supply.

Air Intake

The combustion air for the engine shall be drawn from the area specified, through an air filter having elements of a type commonly available.

Where combustion air is ducted from outside the building, the duct entry shall be fitted with a coarse mesh and fixed louvers arranged to prevent the entry of debris, small animals and the products of inclement weather.

Fuel Systems

The engine fuel system shall consist of an engine mounted daily service tank, filters and fuel injection equipment with solenoid operated fuel cut-off valve, a gear driven mechanical high pressure fuel pump and isolating valves for the fuel supply to and from the service tank, all mounted adjacent to the engine.

Fuel leak off shall be piped back to the fuel filter assembly or the daily service tank. The high pressure fuel lines between the pump and the injectors shall be sheathed to contain and return any spillage to the daily service tank. Such return pipework shall incorporate a reservoir chamber with a float switch to detect any accumulated leakage. Fuel atomizers shall be easily removable and interchangeable.

All fuel pipework on the engine shall be rigid tubing neatly dressed and clipped to avoid vibration interference with the maintenance procedures, have simple facilities for the relief of air locks and be spaced at least 50mm clear of any surfaces whose temperature exceeds 200°C.

Fuel filters shall be full flow type fitted with re-useable mesh material. For continuously running, base load applications, filters shall be twin or triple compartment type with a change-over cock to enable one cartridge to be removed for cleaning without stopping the engine.

Lubricating System

The lubrication system shall permit automatic starting of the engine and immediate load acceptance and consist of wet sump with integral engine driven gear type pump providing forced lubrication to working parts through an oil cooler and a duplex full flow filter. The filter shall use disposable elements commonly available and be of adequate capacity to allow continuous period of running without changing or cleaning.

Independent electric motor driven engine lubricating/pre-heating units shall be provided to give automatic periodic priming in accordance with the manufacturer's recommendation while the engine is at rest.

A hand priming pump shall also be fitted to enable all parts of the engine to be lubricated as required.

The cooling of lubricating oil on engines with engine mounted radiators may be by 'oil' section in the radiator. Engines with remote mounted radiators shall be provided with engine mounted water-to-oil heat exchangers for the cooling of lubricating oil.

The engine shall employ thermostatically controlled, liquid cooling using fresh water in a closed circuit, designed to suit the ambient conditions specified and comprise an engine driven circulating pump and a self-ventilating radiator. The pump shall also be capable of circulating sufficient coolant through the engine's lubricating oil cooler. Facilities for topping up and draining the system shall be provided together with a thermostat with a warming up by-pass.

A make-up header tank and automatic float valve shall be provided, together with all necessary connections to the specified supply source and the cooling system.

The cooling water shall include a quantity of anti-freeze to give protection to minus 10 degrees centigrade. An immersion heater and control thermostat shall be fitted to the system within the engine block to protect the coolant from freezing and shall operate from a 220V AC supply when the engine is not running.

Radiators mounted on engines shall be cooled by a 'pusher' type engine driven fan which draws air from the vicinity of the engine block and discharges it through the radiator core. They shall also include a suitable mounting flange for the attachment of air ducting trunking.

Remotely mounted radiators shall be cooled by an electric motor driven fan fed from an auxiliary generator directly driven by the engine.

If the engine cannot be fitted with a suitable direct driven coolant circulating pump capable of maintaining adequate circulation through remote radiator, an auxiliary electric motor driven pump shall be provided. This pump shall be arranged to operate from the same supply serving the electric motor driven radiator fan.

Exhaust System

Each engine shall be fitted with a suitable exhaust system from the engine to the specified discharge point. The route shall be as short as site conditions allow and minimize the number of bends, which must be of a large radius. The system shall include primary residential type silencer, flexible and rigid pipework, roof cowl, flashing and all necessary ties and support. The primary silencer shall be supported from the engine set and

shall have a flanged outlet incorporating a flexible stainless steel bellows section for ease of disconnection from the remainder of the exhaust system. The exhaust system shall be insulated with a non-asbestos material. Removable cladding shall be provided on the exhaust system where specified.

Support brackets shall allow for pipe expansion and where the pipe expansion and where the pipe passes through walls, a sleeve or wall plate shall be fitted with an adequate hole clearance to prevent wall damage or fire hazard. Pipe flanges shall be fitted on each side of the wall.

The interior of the pipework and silencers shall be metallic aluminum spray coated to BS 2569 Part 2 Class 'D'. Where insulation is not applied, the exterior shall be similarly coated and shall be finished with a coat of high temperature aluminum paint from and approved manufacturer.

Daily Service Tank

A daily service tank sized to hold at least nine hours of supply fuel shall be mounted on a substantial steel frame above the set. The tank shall be totally enclosed, of non-galvanized material and have the following features:-

- Fuel inlet connection;
- Fuel outlet to engine with lockable valve;
- Overflow connection, piped with a fall to the drip tray or bulk supply tank as specified;
- Gasketed inspection plate on top;
- Fuel contents gauge (circular type) incorporating separate switches for:-

Control of fuel transfer pump;

Low level alarm (mounted on remote control panel).

The fuel inlet connections shall be piped to a conveniently placed quick release pressure coupling on the engine set for connection to the bulk fuel supply.

The fuel outlet within the tank shall be raised clear of the tank bottom to prevent water or sediment entering the fuel line.

The contents gauge shall be calibrated 0 – 100% in 10% graduations, 100% tank capacity (in litres) being painted on the tank alongside the gauge. The drive from the float arm mechanism to the gauge and switch cams shall be transmitted by a magnetic coupling to ensure that no fuel can enter the switch compartment.

Fire Cut-off Valves

Fire cut-off valves shall be incorporated in the fuel delivery pipe to each engine from the daily service tank and be located in an accessible horizontal position, coil uppermost, closest to the tank.

The valves shall be manually operated and solenoid maintained in accordance with BS 799 Part 7, the solenoid will be arranged to release in the event of a fire signal. The emergency handle shall be labeled with a conspicuous permanent notice reading:

**“FIRE VALVE -PULL LEVER DOWN TO ISOLATE FUEL SUPPLY.
LIFT TO RESET”.**

Where specified, a dump valve shall be fitted in the pipeline immediately beneath the daily service tanks so that the tank contents can be returned by gravity head to the bulk storage tank or a suitable external dump tank in the event of a fire signal. Electrically operated valves shall open when the operating solenoid is de-energised.

Fuel Transfer Pumps

An electrically driven fuel transfer pump shall be provided for automatic filling of the daily service tank. Valves shall be installed on either side of the pump so that it can be removed without draining the pipework. The pump shall be located adjacent to the daily service tank or bulk supply tank as specified.

In addition to the above, a hand operated pump shall be installed, complete with adjacent isolating valves. Where a dump tank is necessary because the service tank will not drain by gravity to the bulk tank, a hand operated pump shall be provided to enable the contents of the dump tank to be returned to the bulk tank.

Fuel Supply

All necessary pipework, supports, isolating valves and fittings to connect the engine set to the bulk fuel supply or terminating point shown on the Specification drawings shall be provided.

A length of flexible hose fitted with a quick release pressure coupling shall be installed in the line at the engine set fuel connection point.

Fuel Storage Tanks

Bulk fuel storage tanks shall be located as indicated on the Specification drawings.

The tanks shall be manufactured in accordance with BS 799: Part 5 and fabricated from mild steel plate of 5mm minimum thickness with ends and flanged, electrically welded throughout and spatter removed. Galvanized materials shall not be used.

Each tank shall be provided with the following features:-

- a 480mm dia. raised manhole with a gasketted 8mm thick bolt on cover;
- fuel contents gauge;
- BSP threaded male bosses for filling, venting, outlet, drainage and overflow connections;
- Provision of cleaning of the tank;
- Tank full warning alarm float and suitable boss.

The fuel outlet shall be at least 90mm above the drainage cock and preferably at the opposite end to the tank. The fuel supply line shall incorporate a mesh type filter, not coarser than 120 mesh, together with a weight operated, automatic fire shut-off valve located within the bund wall. The tank shall be positioned with a fall to the drainage cock.

Isolating valves shall be fitted within the bund wall to the outlet and drainage connections.

Bulk Tank Fill Point

The tank filling access pipe shall be extended to the bund wall perimeter to be readily accessible for road tankers and shall be down-turned and capped to protect against the ingress of dirt and water.

The fill point shall be protected by a corrosion resistant enclosure having a padlocked cover to prevent unauthorized access. The tank full warning alarm shall be included within the fill point enclosure. This shall be designed to prevent overfilling the storage tank and be initiated by a float operated switch in the tank, arranged to give an audible and visible indication at the fill point when the tank is full.

The circuit shall operate at extra low voltage derived from a local control transformer suitable for a 220V 50Hz supply.

Engine Starting

The engine shall be arranged for automatic starting and stopping arranged in conjunction with the overall control system. The engines shall not require pre-start priming of lubrication and shall be arranged for instant starting by batteries or compressed air as specified, the starter motor(s) engaging with the flywheel ring gear and disengaging automatically when the engine starts.

The system when fully charged, shall have sufficient capacity to crank the engine when cold, for at least three consecutive 10 second periods at 0°C. A self contained charging system shall be provided to meet these requirements.

Engine Instruments

An instrument panel shall be resiliently mounted on the engine complete with the necessary piping, connections, isolating cocks and indicators for the following:

- Cooling water temperature;
- Lubricating oil temperature;
- Lubricating oil pressure;
- Revolutions per minute;
- Exhaust temperature at each cylinder outlet;
- Running hours totaliser (showing 5 digits & non-resettable);

All instruments shall be scaled in approved metric units and gauges shall comply with C1 5.13 – Indicator gauges.

Engine Protection

The engine shall be provided with alarm and shutdown features as specified in Section 6 – Electrical Specification. Shutdown conditions shall be arranged to operate through the fuel solenoid.

A manual fuel rack release knob shall be provided for emergency use.

Engine Wiring

All wiring for engine mounted electrical components shall be carried out in suitable rated heat and oil resistant cabling fixed to the equipment where necessary and terminated in a wiring terminal box or boxes mounted in an accessible position on the bedplate, suitable for the necessary cabling to be extended to the local control panel. Separate boxes shall be provided for AC and DC circuits.

For full details of terminal boxes and auxiliary switches see section 2 – Electrical Specification.

Engine Mounting Arrangement

Engine driven sets shall be either close coupled or open coupled as specified, via a flexible coupling. The driven unit shall have two independent bearings and all major items of the rotating assembly shall be dowelled to preserve alignment.

Close coupled sets shall be secured through anti-vibration mounts to a substantial fabricated steel base fixed to the floor.

Open coupled sets shall be fixed to a substantial fabricated steel base frame, secured direct to the floor, or where specified, secured through anti-vibration mounts between the base frame and floor.

The base frame shall be structurally designed and constructed to ensure maximum strength and may be used to mount engine ancillaries, set wiring marshaling boxes and control panels. The frame shall include jacking facilities where anti-vibration mountings are used. These shall not project to cause hazards to operating personnel.

Anti-vibration mountings shall be multiple neoprene bonded pattern, arranged to distribute without resonance the total weight and dynamic loads of the assembled engine set and auxiliaries supported on the base frame.

Drip Tray

A drip tray, complete with drainage cock, shall be fitted within the confines of the baseframe and shall have a capacity at least equal to that of the lubricating oil contained in the engine.

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).

Gas Chlorination

General

Gas chlorination equipment for installation at pumping stations, reservoirs and water treatment works and other locations on the system generally come under one of two categories:

- Gas chlorination feeding into pressurized and gravity lines at locations where an electricity supply is available;
- Gas chlorination at those locations, such as water catchment works, outlets from reservoirs etc. where there is not electricity supply.

This specification covers both categories.

The Contractor is responsible for the safe design, provision and installation of the chlorination dosing system and associated safety equipment. The safety equipment required varies from site to site depending on site location, quantity of chlorine stored or dosed and type of equipment supplied. The Contractor shall access the requirements of each installation with respect to the following points:

- Ventilation system;
- Leakage detectors;
- Audio and/or visual alarms;
- Automatic shut down systems;
- Personal protection equipment;
- Procedures and training.

The equipment called for in this section are nominal requirements.

Scope of Works

The scope of works for the provision of chlorination equipment includes, as appropriate to the particular category above:

Supply and transport to site of all equipment including chlorinators, centrifugal booster pumps, chlorine bottles, and all other material and equipment necessary for the installation;

Installation of chlorination equipment and fittings, pumping equipment, metering, pipework and valves, control and protection equipment to form a safe, effective and fully operational installation;

All necessary civil and building works;
Testing, commissioning, training and putting into service full equipment.

Vacuum Chlorination of Pressurized Water System

This system is applicable at pumping stations, water catchment works etc. where the water to be treated is under pressure and electricity is available.

A centrifugal booster pump shall be provided to supply pressurized water to the chlorinators.

Where specified the rate of chlorine injection shall be controlled by flow metering and valving as a function of the water flow rate.

Equipment Characteristics

Injection of chlorinated solution shall be by vacuum type chlorinator, the vacuum being achieved by pressurized water and ejector.

The chlorination may be either wall mounted or mounted directly on the head of the chlorine bottle. It shall include:

- Pressure reducing valve;
- Flow control valve;
- Injection device;
- Pressure relief valve to act in case of surge pressure of chlorine or loss of suction;
- Pressure gauges up and downstream of the booster pump;
- Non return valve downstream of the chlorinator.

The injection service pressure (bar) and chlorinator capacity shall be calculated by the Contractor and designed from information in the particular specification for each installation.

The Contractor shall supply all necessary equipment and fittings for operation, control and maintenance in accordance with the following list.

The list is indicative and by no means restrictive.

Water Circuit

Motor Driven Pumpset;

An electric motor driven pumpset shall be provided to achieve the discharge rate and pressure for chlorinator operation;

The booster pump discharge rate and pressure shall be as the chlorination equipment manufacturer's specification. The pump assembly shall comprise:

- Three phase 380V electric motor with a minimum protection class IP55 and a maximum speed of 3000 rpm, and a centrifugal pump mounted on a common base plate;
- Non return valve downstream of the pump;
- PVC or bronze valves (Upstream and downstream of the pump);
- PVC or bronze control valve downstream of the pump;
- Bronze strainer (1mm) upstream and downstream of the pump;

- or 25 bar pressure gauges as appropriate upstream and downstream of the pump;
- Piping, treated against or resistant to corrosion.

Chlorine Units

Chlorine Units shall comprise:

- Chlorine resistant non-return valve;
- Anti-siphon system;
- Chlorine resistant chlorinated solution injection device;
- Chlorine resistant pipework for chlorinated solution injection;
- Chlorine resistant pressure relief piping for release of gaseous chlorine in the event of over pressure, to a maximum length of 8m;
- Piping between chlorinator and injection device, complete with fitting all of chlorine resistant material;

Chlorination in the Absence of Electric Power Supply

This system is for use where there is no power supply available, for example, supply and delivery lines at reservoirs, catchment areas and headworks.

The chlorination process shall cease immediately in the event of lack of water.

Chlorination Under Low Pressure

Use of low pressure chlorinators shall only be used where use of vacuum typeS is impossible due to insufficient line pressure.

The chlorinator shall be either wall mounted or directly assembled to a gaseous chlorine bottle, the latter providing pressure for operation of the chlorinator. A chlorine resistant piping connection shall link the chlorinator to a diffuser. In the case of a reservoir a spring loaded check valve shall be installed at the point of chlorine injection.

A nozzle injector rather than a diffuser shall be used for injection into a pipeline.

Where injection is into the pipeline pressure in the line shall always be more than 0.1 bar (g) and shall not exceed 0.7 bar (g). Partial vacuum in the pipe must be prevented.

In the case of a reservoir the level of water in the reservoir shall always be at least 1 m above the diffuser.

The size of the piping between the chlorinator and the injection point will be a function of both dose rate and distance between points.

Chlorination by Vacuum Chlorinator

Chlorination under vacuum only applies to reservoir gravity supply lines, the latter associated with a minimum hydraulic pressure of 0.5 bar. A hydro ejector shall achieve the required hydraulic pressure for injection provided a pressure drop is produced downstream of the hydro ejector feed point (by a valve or diaphragm).

The Contractor shall optimize the locations of feed and injection points in such a way as to achieve a minimum hydraulic pressure of 0.5 bar upstream of the hydro ejector. The capacity of the chlorinator shall not exceed 200 gr/hr at a hydraulic pressure of 0.5 bar or 300 gr/hr at a pressure of 1 bar.

Chlorination shall cease immediately in the event of lack of water in the line.

Chlorination Dosing Pump

Disinfection shall be achieved by injection of chlorinated lime or sodium chlorite (Javel water), by means of a dosing pump proportionally to the rate of flow water. The chlorinated solution shall be stored in corrosion proof tanks. The operation of the dosing pump shall be controlled by a flow meter equipped with a pulse transmitter. A control system receiving the transmitted pulses, shall regulate the dosage of chlorinated solution. Supply of power shall be by:

- A low leakage, self discharge, maintenance free battery with no water addition required.
- A battery charging solar panel complete with either a charge regulator or an electronically controlled battery charger housed in a class IP55 box equipped with LED indicator.

The Contractor shall supply and install such other equipment as may be necessary for the safe operation of the system.

Chlorination Systems Based on Flow Rate of Water

General

The control system shall comprise a chlorine injection regulating system. It shall include:

- A chlorinator for use with pressurized water systems.
- A water flow meter with an output signal proportional to the rate of flow to be treated.
- A motorized chlorine flow control valve with feedback signal to the control system, the signal to be proportioned to the chlorine injection rate.
- A feed back control system with signal comparator. In the case of signal discrepancy the control valve servomotor shall be actuated to adjust the injected dose of chlorine.
- The injection nozzle and/or hydro ejector.

If specified the facility to receive a signal from a residual chlorine analyzer which will adjust the chlorine/water ratio.

Requirements of the above Control Systems

Chlorine Flow Control Valve

The motorized control valve shall be functionally compatible with the chlorinator. It shall achieve automatic control of the chlorination process as a function of the rate of flow of water to be treated.

The supply voltage shall be 220V, 50 Hz with a two pole circuit breaker equipped with adjustable thermal trip.

The valve capacity shall not exceed 10 kg (gaseous chlorine)/hr. It shall receive and transmit a 4-20 mA signal to the chlorinator. The valve can either be incorporated in the chlorinator or installed separately in the system.

Water Meter

The water flow meter which may be of the turbine, magnetic flow, diaphragm or ultrasonic type, shall control the operation of the motorized control valve. It shall have the following characteristics:

Be suitable for fluids with up to 80 m/l solids particle content. It shall be designed for a range of water velocities from 0.5 to 3.0 m/s and shall transmit a 4-20 mA signal.

Operate on a supply voltage of 220V or 110V – 50 Hz.

Be equipped with a rate of flow indicator.

Chlorination Systems Based on Residual Chlorine Metering

General

The system shall include:

A vacuum chlorinator injecting into a pressurized water system.

Chlorine injector flow control valve actuated by a converter to a residual chlorine analyzer with signal transmission to the control valve of a signal proportional to residual chlorine concentration in the treated water.

The residual chlorine analyzer shall be equipped with an electronic transmitter, and shall be one of two types.

Type "A" (with reagent)

The residual chlorine analyzer shall be of the amperometric type for measurement of residual chlorine in water.

It shall include:

- Measuring cell;
- Suitable reagent to allow measurement of the concentration of total and/or free residual chlorine;
- Amplifying circuit and converter with 4-20 mA output signal. The above to be incorporated in the analyser bar;
- Zero point and scale adjustment feature with automatic temperature compensation feature, to compensate for errors due to temperature fluctuation of the sample;
- Direct reading indicator;

All components to be installed in a corrosion resistant box. The characteristics shall include:

- Scale range 0-0.5, 0-2.0 mg/l;
- Water sample temperature range 0-50°C;
- Output signal 4-20 mA;
- Supply voltage 220v – 50 Hz with 2 pole circuit breaker with adjustable thermal trip;
- Indicator: located on front of analyzer;

Direct reading in mg/l

Accuracy $\pm 2\%$ of scale range.

Type "B" (Dry type)

The analyzer shall consist of a potentiometric cell fitted with three metallic electrodes that shall generate a current directly proportional to the concentration of free residual chlorine.

It shall be equipped with a potentiometric amplifier and a converter to transform the current to a 4-20 mA signal.

The circuitry shall include zero point and scale adjustment feature as well as automatic temperature compensation feature (Thermistor) in order to compensate for errors due to temperature fluctuations of the sample.

It shall have a direct reading indicator and be installed in a corrosion resistant box.

The characteristics shall include:

- Scale range 0-0.5, 0-2.0 mg/l;
- Water sample temperature range 0-50°C;

- Output signal 4-20 mA;
- Supply voltage 220v – 50 Hz with 2 pole thermal magnetic breaker;
- Indicator: located on front of analyzer.
- Direct reading in mg/l
- Accuracy $\pm 2\%$ of scale range.

Auxiliary Equipment for Chlorination and Storage

General

Where electric power is available the chlorination room shall be equipped with an extractor fan at low level with high level air inlet. The fan shall give twenty air changes per hour and shall have a control switch located inside and outside the building. A sign shall be fixed to the outside of the door “Danger, Toxic Gas – Access for authorized personnel only”, in English.

There shall be available at each chlorination building 2 No gas masks consisting of an integral mouth piece and wide view visual piece covering the entire face, complete with flexible breathing tube and filter cartridge with hipstops.

2 No additional filter cartridges shall be supplied with each mask.

The filter shall be effective in neutralizing gaseous chlorine.

A shower shall be fitted to the wall immediately outside the chlorination room for emergency use. It shall have a chain operated valve. The masks shall be kept in a dedicated wall mounted cupboard in the control room or attendant’s room.

The cupboard door shall have affixed to it a label stating “Chlorine gas masks. Fit new cartridge before use.”

Chlorine Bottles

2 No or more chlorine bottles shall be supplied with each chlorinator. They shall be 50 kg capacity each unless specified otherwise.

Each bottle shall be equipped with:

- An isolating valve, which shall be provided with a protective cap during transport;
- Where specifically called for, an automatic chlorine supply change over to a standby bottle on depletion of the duty bottle. The system shall be wall mounted and shall be functionally compatible with the chlorinators. It shall function on partial vacuum and shall be complete with all accessories and fittings;
- A bottle rack and chain support;
- Where specifically called for, a permanent weighing device shall be provided beneath the bottle in service to continuously monitor the rate of chlorine consumption.
- The chlorine bottle storage area/room shall be sized and equipped to facilitate a safe environment for the bottles storage, handling and changing.

Chlorine Detector

Where specifically called for or deemed necessary, gaseous chlorine detector units shall be fitted. The gas leak detector shall be used in conjunction with an alarm which shall be actuated if the gas concentration arises above 1 ppm or 3 mg/gas/cu.m of air.

The detector may be one of tow types:

Type “A” (Dry Cell)

The gas detector shall consist of an independent tank and detection cell located outside the tank. The tank capacity shall be sufficient to give 6 months operation. The detection cell (sensibility 1 mg/cu.m) shall be connected to an electronic measuring device located in a wall mounted box. In the presence of an oxidizing gas the detected cell shall generate a current proportional to the gas concentration.

The box shall have an electronic indicating device and shall give continuous monitoring.

When gas concentration reaches its maximum permissible limit the detector shall activate an acoustic alarm, and shall trigger the operation of a remote alarm, where fitted, the operation of the extractor fan and closure of the supply line valves.

A test push button shall be provided to allow the operation to be checked.

Leak Detection, Residual, Free Residual and Total Residual Measurement

A bottle of liquid ammonia for chlorine vapour leak detection purposes and a measuring kit for quick determination of the concentration of the following shall be provided with every chlorination equipment installation.

- Free residual chlorine;
- Residual chlorine;
- Total residual chlorine.

Details of the equipment to be provided, which shall include all auxiliaries, shall be provided with the tender.

Installation of Equipment

The location of the chlorine bottles in the store shall be away from direct sunlight at all times. During transportation of bottles the Contractor shall ensure that gas bottles are not overturned and that safe handling procedures are adopted at all times.

Gaseous chlorine connections between system components shall follow the shortest and most direct route possible and shall be laid to falls.

Water and other piping shall not be laid immediately alongside gaseous chlorine piping in order to prevent cooling and condensation.

Only grease or other lubricant as recommended by the equipment manufacturer shall be applied to all removable fittings.

Where the chlorinator is installed remote from gas bottle the distance apart shall not exceed 10 metres.

The chlorinator vapour vent pipe shall be extended to outside the building away from inhabited areas. The vent pipe shall be covered with a mosquito net.

Chlorination equipment piping shall be secured to the wall by brackets with a minimum clearance of 100mm off the walls for painting and maintenance purposes.

System Start-up

The procedure for putting chlorination equipment into services shall include:

- A bacteriological and physico-chemical analysis of the water to be disinfected;

- Determination of the chlorine demand of the water to be disinfected based on break point method;
- Adjustment of the chlorinator capacity to achieve, after 30 minutes of chlorine to water contact a residual concentration of 0.5 mg/l. A check shall be made by measurement of the concentration of free chlorine in water at a pre-determined location in the water distribution system.

In the case of a chlorinator controlled by an automatic residual chlorine measuring device, the indicated concentration shall be checked against the result of an analysis of residual chlorine in the water sample.

Disinfection Control

Following start up of the chlorination system the contractor shall take five samples of disinfected water at five different locations situated at representative distances from the chlorination point so as to achieve effective control of the quality of disinfected water. The following tests shall be undertaken.

- Measurement of free chlorine (Type b1);
- Measurement of free chlorine in water.

Pressure Testing of System

Prior to system start up all chlorination systems shall be pressure tested for leaks.

The system shall be tested with nitrogen or dry air at a test pressure 50% higher than the service pressure. Soapy water shall be applied to all joints and connections to facilitate detection of leaks.

The system shall be tested with chlorine. A rag soaked in liquid ammonia shall be brought to the vicinity of all potential leak points, leaks being evidenced by production of white ammonium chloride fumes. In the event of a leak, prior to effecting repairs, gas bottles shall be isolated and the lines drained through the dosing pumps.

IMPORTANT Procedure for Pressure Tests

- Open all valves one turn except gas bottle valves;
- Open gas bottle valves to achieve a system pressure of 1-2 kg/cm² and
- close them again;
- Search for leaks with an ammonia soaked rag;
- In the event of a leak drain the lines with dosing pumps and repair the
- leak;
- Open gas bottle valve to achieve maximum system pressure;
- Repeat 4 and 5 above;
- When the system is leak free open gas bottle valves one turn.

Tests on Completion

The tests on completion shall include the following:

- Injection rate;
- Injection pressure;

- Absence of leaks;
- Injected concentrations;
- Compliance with specification;
- Safety criteria and equipment;
- Such other tests as the Project Manager may determine.

Site Procedures and Training

Training should be carried out with emphasis being given to safety precautions and methods of dealing with emergencies. Particular attention should be given to the following aspects:

- the hazards and characteristics of the material;
- safe methods of plant operation, including handling of the connection to supply systems;
- methods of maintenance;
- special operations, for example, plant shut down and start-up, methods of isolation and preparation of equipment for periodic maintenance and inspection;
- the location and operation of emergency shut-off valves;
- the procedures to be followed if releases occur;
- training in the use of all personal protective equipment supplied.

Operating Instructions

The operating instructions should cover each process of operation. Written operating instructions are required in English, for all routine and emergency operations, ranging from guide cards to simple operations to complete manuals.

Copies of instructions, which should include a flowsheet and indicate valves to be closed in an emergency, should be available in the working area for operators.

Emergency Arrangements

The emergency procedure should include how gas may be dealt with safely by site personnel. The procedure should cover various degrees of emergency and should be either supplied in written form or made available to employees so that they know the steps they are required to take. This procedure should include first aid and evacuation arrangements.

Miscellaneous Equipment

Automatic Desludging Equipment

Auto desludging equipment must conform to the following:

Automatic desludging of tanks may be by actuated bellmouth valve, positive displacement pump, submersible pump, actuated sluice valve, or air lift, as specified. Positive displacement shall be of the progressive cavity, rotary lobe or double disc type as specified, and rotary blowers for incorporation in an air lift system shall be of the low pressure, positive displacement rotary lobe type. The method selected shall have regard to the type of

sludge to be removed, the shape of the tank to be desludged and the arrangement of pipework and valves and, where applicable, conformity with existing practice and for standardization with existing equipment.

Desludging shall normally be on time control with preset, locally adjustable timers to control the frequency and duration of desludging. Manual over-ride of the control shall always be possible and, where specified, the timer control system may be over-ride automatically e.g., on sludge density in the sludge line, inhibit on full reception tank, as specified. Whatever the method of desludging, where automatic desludging of more than one tank is installed the pumps, valve actuators or air lift as appropriate, shall be programmed to ensure that only one tank or hopper is desludged at any one time.

The desludging system shall in all cases be designed to minimize risk of blockage, and rodding facilities or other means of clearing blockages shall be built in at vulnerable points.

Unless otherwise specified, equipment shall be installed in the open and shall be suitable for this environment.

The desludging system shall be considered as a process unit inclusive of metering and delivery pipework and valves, controls etc. which shall combine to make a functioning system.

Where ductile iron is not specified. Pumps or blowers mounted at ground level shall be fitted with removable GRP kiosks of the “dog kennel” type.

Pipework shall be wire armoured PVC flexible hose or rigid uPVC/MDPE as appropriate and/or as specified.

Air delivery pipework shall be wire armoured PVC flexible hose or rigid uPVC as appropriate and/or as specified. Where possible, connection shall be by tapping into the standpipe at a depth to provide a minimum of 65% submergence. Where tapping is possible the air delivery pipe shall be inserted into a standpipe to a depth of approximately 3m to achieve the minimum percentage submergence of 65%.

Where necessary, pipework shall be surrounded with 25mm minimum thickness of insulating foam externally protected with aluminum sheet. Trace heating shall be thermostatically controlled. Insulation shall be in removable sections for ease of maintenance. Sections shall be held in position by bands or clips. The insulation shall be designed to prevent ingress of water and vermin.

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.

Flumes

Flume formers shall be provided for construction of concrete flumes by the Civil Contractor. The liners shall be a matched pair and a locating jig shall be included to

ensure correct installation in the channel. The liners shall conform to BS 3680: Part 4C: 19/4. (Level shall be measured by an ultrasonic measuring system, the detector head to be mounted over the channel. The requirements for ultrasonic level detectors are specified separately).

Weirs (Vee Notch or Straight Weir)

Weir plates shall be manufactured from stainless steel or non-ferrous material suitable for the liquid being measured. Weir plate shall be mounted on a fabricated mild steel plate for fixing into the weir chamber. The mounting plate shall be sealed where it fits into the chamber and against the weir plate. The weir plate fixings shall be slotted to allow adjustment on site.

The weir and Vee-notch weir plates shall comply with BS 3680: Part 4A.

Thin plates weirs will only be used on sediment free water.

Section 5. General Specification - Instrumentation and Control

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 Project Manager under other contracts, it shall be the responsibility of the Instrumentation Contractor to advise and provide all relevant information on such matters to the Project Manager 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 Project Manager'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 clips 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 1.0mm^2 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 16mm^2 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.

Uninterruptible Power Supply

A rectifier/battery/inverter system shall be rated and arranged to provide a 'no-break' supply to the specified loads.

The UPS shall incorporate maintenance free, sealed batteries and operate in a continuous mode to protect the connected loads from AC supply interruptions and irregularities to maintain a controlled output of $220\text{V} \pm 5\%$ at $50\text{Hz} \pm 1\%$ for up to 30 minutes.

The unit shall incorporate a static by-pass switch arrangement such that in the event of failure of the inverter, it shall automatically transfer the load to the bypass supply with no loss of continuity in supply. This unit shall monitor the mains and output frequencies to maintain synchronization within $\pm 0.5\text{Hz}$ and $\pm 5\%$ voltage. Where these tolerances are not maintained, the static by-pass shall be inhibited to prevent out of sync switching. Where generator sets are to be connected, a frequency tracking inhibit switch shall be included.

A manual by-pass switch shall also be provided to enable the UPS to be taken out of service for maintenance. No feedback shall be possible and any live parts shall be fully shrouded.

During mains failure, the battery will take over the supply via the inverter. On re-connection of the mains supply, the system shall automatically revert to its normal operating mode and the battery recharged to full operating capacity.

Controls, metering and indications shall be provided on the panel front and arranged in an approved manner.

- Start, Stop and Reset push buttons.
- Metering shall be provided for:
- battery voltage
- battery amps (centre zero)
- output voltmeter
- load ammeter

Status indications shall be provided for:

Normal Conditions – White	Fault Conditions – Amber
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Mains on	Battery volts low
Boost charge	Charge failure
Inverter on	Inverter failure
By-pass supply available	Static by-pass inhibited
By-pass supply to load.	

All fault indications shall provide ‘volt free’ contacts for remote indication.

On/Off control switches shall be provided within the panel for:

- Mains input
- Battery isolator
- By-pass supply
- Boost charge

When isolating the UPS for maintenance, separate mains input and battery supply isolators shall be provided, interlocked such that the battery isolator cannot be closed before the mains switch is closed (to limit stress on the storage capacitors).

The UPS output shall be protected against under/over voltages and overcurrent during load transfers. The UPS shall be capable of satisfactorily withstanding an overload of 125% for 10 minutes and maintain output frequency stability of $\pm 5\%$ for 100% load changes.

Current limiting and over-voltage protection shall be included in the charger circuit together with charge rate adjustment to suit the battery manufacturer’s recommendations, with automatic initiation of a timed boost charge as required.

The harmonics generated shall be restricted by suitable filters to be within the tolerances defined in Engineering Recommendations G5/3 “Limits for Harmonics in the UK Electricity Supply System”.

The rectifier output shall also include filters to reduce DC ripple to the batteries to maximize battery life.

The UPS shall preferably be located within the Control & Monitoring Panel but where the panel is a separately mounted, free-standing unit, all construction component and finish details shall comply with those specified for the switch board panels.

Instrumentation

Instrumentation

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 Project Manager, 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 3m/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 not 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 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 presetable 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 venture 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 plat before the orifice is machined.

Insertion probe type installations shall follow the equipment manufacturer's recommendations. The probe shall be mounted to a standard sired 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 and the flow rate and a totaliser. The sensor shall be protected to IP 66 and having the following characteristics:

- Accuracy: $\leq \pm 0,25\%$ 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.

Variable Area Flow Meters

Variable area flow meters shall have glass or metallic tubes according to the particular application.

Metering tubes shall be removable for range change or cleaning without disassembling the meter or removing it from the line. Metering tubes shall have ends of equal cross-sectional area and if O ring seals are used, tube retainer springs shall be outside the fluid stream. End fittings shall be rotatable to any angle. Connections shall be horizontal and plugged vertical openings shall be provided for cleaning purposes.

Ultrasonic In-line Flow Meters

The flow meters shall have flanged steel bodies and be without probes or pressure tapings which can foul or create a disturbance to the flow. The meter performance shall not be affected by emptying of the pipeline, and servicing shall be possible without the need to remove the meter from the pipeline.

The sensor tube and associated equipment shall be capable of withstanding occasional submergence in the flow metering chambers. The Contract shall include for the provision of a 230 V 50 Hz power supply from the nearest distribution panel, and a power pack unit if required for flow meter operation.

The converter/transmitter unit and the power pack unit shall be housed in a g.r.p lockable cabinet which may be either pedestal or wall mounted as appropriate to the meter location. The cabinets shall have heaters and thermostats if required to prevent condensation.

The Contract shall include for all internal wiring, and for cabling between the flow meter and cabinet. Where necessary cabling shall be screened to prevent interference.

The transmitter shall give an output signal of 4-20mA.

The span of the instrument shall be adjustable and the range of each instrument shall be chosen to unit the particular flow range. Meters shall be able to withstand surge flow above the normal operating range. Means shall be provided for check calibrating the meter on site.

The output signals from the flow meters shall be wired back for indication, integration and recording of flows with provision for future wiring to a telemetry outstation.

Meters on gravity lines will normally have flow, and although this could be low at some times of the day, in practice flow is unlikely to drop below approximately 20% of maximum. The meters on the pumping mains will have flow dependent on the operation of the pumps.

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

Size mm	50	80	100	150
Qmax:	70	150	250	350
Peak flow (short duration)				
Qm : Max Continuous flow at $\pm 2\%$ measuring error.	35	90	125	250
Qmm : Min. flow at 5% measuring error.	0.02	0.02	0.04	0.06

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.

Where specified meters shall incorporate a pulsed output unit and portable data logger connection to enable flow rates to be monitored and transferred for plotting at a remote data port, microcomputer and printer for analysis. The pulse unit and data module shall be self supporting using dry batteries.

Compound Meters

Compound meters for use on distribution systems shall comprise a main water meter capable of measuring the high flow rate, a smaller sized meter on a bypass for measuring the low flow rates and automatic change-over valve for controlling and apportioning the flow through the meters,

The change-over valve shall be of the hydraulically operated diaphragm/spring type. The main meter unit shall be equipped with a removable measuring element.

The change-over valve shall withstand a working pressure of 16 bar. The measuring range shall be in accordance with the table given below:

Data Loggers and Software

Compatible data loggers shall be provided complete with interface cables and connectors for connection between the meter and the logger.

Data loggers shall be provided with a long-life battery, be of a robust construction and be waterproofed to IP 68 standard. They shall be capable of logging rates of flow in litres per second (l/s) and Cubic metres per hours (m^3/h); and the totalized quantity in:- cubic metres (m^3).

They shall also be capable of downloading such data into an IBM compatible personal computer.

WOLTMAN TYPE METER

Data loggers for the Woltman Type meters shall have both digital and analog logging facilities.

COMPOUND METER

Data loggers for the compound meter shall be capable of digital logging of data from both meters and combining such data into an integrated whole for downloading into a PC.

SOFTWARE

Loggers shall be provided with software together with an interface cable complete with connectors for connection between loggers and the PC.

SECTION VI- DRAWINGS

(ATTACHED SEPARATELY)

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

BILL OF QUANTITIES
(ATTACHED SEPARATELY)

[illegible]

	Materials				
	All materials as per specifications. The rate to include for delivery to site, storage and handling.				
A413.1	Coarse aggregates for concrete	m3	150.00		
A413.2	Fine aggregates (sand) for concrete	m3	150.00		
A413.3	Ordinary portland cement	t	5.00		
A413.4	150mm thick building stone/concrete blocks	nr	500.00		
A413.5	225mm thick building stone/concrete blocks	nr	500.00		
A413.6	Hardcore	m3	50.00		
A413.7	Murram/gravel	m3	50.00		
A413.26	Concrete Class 10/20	m3	20.00		
A413.27	Concrete Grade 15/20	m3	20.00		
A413.28	Concrete Grade 20/20	m3	20.00		
A413.29	Concrete Grade 25/20	m3	20.00		
A413.30	Concrete Grade 30/20	m3	20.00		
A413.31	BRC mesh No. A142	m2	20.00		
A413.32	BRC mesh No. A193	m2	20.00		
A413.33	12mm and under mild steel round bars	t	1.00		
A413.34	16mm and over mild steel round bars	t	1.00		
A413.35	12mm and under high yield steel bars	t	1.00		
A413.36	16mm and over high yield steel bars	t	1.00		
A413.37	Shuttering timber	m2	10.00		
A413.38	Petrol	l	1,000.00		
A413.39	Diesel	l	1,000.00		
A413.40	Lubricants	l	250.00		
A413.41	Road marking paint	l	50.00		
A413.42	Emulsion paint	l	50.00		
A413.43	Gross paint	l	50.00		
	Rate to include for all operation and maintenance costs, fuel, oil, grease, operators etc.				
A415.1	1 tonne pickup	h	200.00		
A415.2	7 tonne lorry (tipper)	h	100.00		
Total Dayworks C/F to Next Page					

[illegible]

BILL NO. 1 - PRELIMINARIES AND GENERAL ITEMS

Item No	Description	Unit	Quantity	Rate (KSh.)	Amount (KSh.)
	CLASS A - GENERAL ITEMS				
	Contractual Requirements				
A110	Performance Security	sum			1,000,000.00
A120	Insurance of the works, plant and materials against loss or damage.	sum			500,000.00
A130	Third Party Insurance	sum			500,000.00
A140.1	Allow for monthly site meetings as specified or directed by the Engineer.	month	12		
A140.2	Provide for preparation and submission to the employer 1No set of virograph and 2No sets of blue print copies (A1 SIZE) of as built drawings for all the waterpipelines in the contract. Note that valve chamber positions in the layout should be actual (geo-referenced to the national grid).	sum	1	150,000.00	150,000.00
	Specified Requirements				
	Offices and Accomodation for the Contract Administrators				
A150	Provide for provision of Contractor's temporary yard, site office and stores and also accommodate the Engineer and his staff. Rate to include for furnishing, equipping, stationary, general yard and office security including guarding and maintenance for the contract period	month	12		
	Specified Requirements				
	Services for Engineer's Staff				
A160	Allow for the engineers transport to and from site during the construction period.	Km	18000		-
A170	Allow the Provisional Sum of KShs.1,500,000 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.	PS	1	1,500,000.00	1,500,000.00
A180	Allow Kshs1,500,000 for Engineers staff miscellaneous expenses including communication, transport, allowances, etc costs during the construction period. Rate to include purchase of high end laptop core i7, 16gb RAM and 2TB HDD & Camera	PS	1	1,500,000.00	1,500,000.00
A190	Contractors mark up to items A160-A180 above	%			
	Specified Requirements				
	Equipment for use by Engineer's Staff				
A224	Provision of office equipment	sum	1		2,000,000.00
A225	Maintenance of office equipment	month	12		
A226	Maintenance of Surveying equipment	month	12		
	Attendance Upon Engineer's Staff				
A227	Driver, 1No	month	12		
A228	Chainmen, 2No	month	12		
A229	Office Assistants, 2No	month	12		
	Total C/F to Collection Sheet				

	Testing of Materials and Works				
A250.1	Provide for materials testing.Rate to include for transport from site and fees payable to testing institutions.	sum	1	1,000,000.00	1,000,000.00
A250.2	% Adjustment to the provisional sum for Item A250.1	%			-
A260.1	Allow for testing of the Works as specified or directed by the Engineer (Provisional)	sum	1	1,000,000.00	1,000,000.00
A260.2	% Adjustment to the provisional sum for Item A260.1	%			-
	Temporary Works				
A300	Traffic management during road crossing works	Sum			200,000.00
A310	Allow for dewatering of the works for the entire contract period.	Sum			200,000.00
A320	Provision, fixing and maintaining of signboards as specified by the Engineer. Other Provisional sums	nr	2		
A321	Payment of road cutting/microtunnelling Permits .This includes fees payable to the road authorities,police department ,Nairobi City County Government, Kenya Railways etc towards sourcing of the permits.	PS	1	2,500,000.00	2,500,000.00
A322	Allow PS for realignment of communication services including but not limited to Telkom.Jamii,safaricom kplc etc in liason with service provider.	PS	1	1,500,000.00	1,500,000.00
A323	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.	PS	1	1,000,000.00	1,000,000.00
A325	Allow for realignment of water and sewerage service lines in liaison with service provider. Rate to include provision of all necessary materials and logistics during the relocation exercise.	PS	1	1,000,000.00	1,000,000.00
A327	Contractor's mark up to items A322-A326 above.	%			
	Provisional Sums - Dayworks				
A 411	Labour	PS	1		-
A 412	Add a percentage for the Contractors profit for Dayworks Labour	%			-
A 413	Materials	PS	1		-
A 414	Add a percentage for the Contractors profit for Dayworks Materials	%			-
A 415	Plant	PS	1		-
A 416	Add a percentage for the Contractors profit for Dayworks Plant	%			-
	Other Provisional Sums				
A.420.1	Allow for provision of statutory requirements for payment to KPLC, Kenya Railways, Rift Valley Railways, KPC, SGR, Data Utilities, KURA, NCCG and other Government Agencies.	PS			3,000,000.00
A.420.2	Add a percentage for the Contractors profit for Item A.420.1	%			-
	Total C/F to Collection Sheet				

BILL NO. 1 SUMMARY SHEET

PAGE NO.

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BILL No. 2 - WATER WORKS (KIBERA B HOUSING)					
ITEM No.	DESCRIPTION	UNIT	QUANTITY	RATE (KSHS)	AMOUNT (KSHS)
	<u>CLASS A -PIPES</u>				
	<i>Supply and transport to site HDPE PIPES according to technical specifications; break out surface, excavate trench to inverts, cut and lay pipes, backfill with selected material from the trench excavations and compact, disposal of surplus all as specified.</i>				
A260.8	OD225 HDPE PE100 PN12.5 pipe	m	3,200		
A260.9	DN200 steel pipes to 150m maximum test pressure	m	300		
A260.10	OD160 HDPE PE100 PN12.5 pipe	m	300		
	<i>Identify and locate existing pipeline and services, set-out pipeline, showing ground and pipe profile. The Contractor shall produce pipeline construction drawings for Engineers approval</i>				
A290	Set out and prepare construction drawings for all the pipelines under the Contract	Item	Sum		
	<u>CLASS B - GROUND INVESTIGATIONS</u>				
	<i>Excavation of trial pits or trenches for ground investigations or locate existing pipes as directed by the Engineer</i>				
B112	Trial pit in material other than rock; depth 1 - 2m	nr	5.00		
B113	Trial pit in material other than rock; depth 2 - 3m	nr	5.00		
B123	Trial pit in material which includes rock; depth 2 - 3m	nr	10.00		
	<u>CLASS D - DEMOLITION AND SITE CLEARANCE</u>				
D100	General clearance and demolition of structures for pipeline for full width of easement including grubbing out all shrubs, temporary roadside business structures etc and removal of all trees of girth < 0.5m	M ²	11,400.00		
	<i><u>Cutting of trees, removal and disposal of stumps with hole backfilled with suitable material from excavated pipe trench</u></i>				
D210	Tree girth 0.5 - 1.0m	nr	20.00		
	<u>CLASS I - PIPEWORK TESTING AND SETTING OUT OF WORKS</u>				
	<i><u>General clearance for laying of pipelines.</u></i>				
	<i><u>Pressure Testing pipelines including flushing and sterilizing in accordance with the technical specification</u></i>				
	OD 225 HDPE DN PE 100 mm clear water pipe PN 12.5	M	3,040.00		
	OD 160 HDPE pipes PE 100 CONSUMER CONNECTIONS	m	500.00		
	DN 200 Steel Pipes	m	500.00		
I421.3	Nominal bore 200mm not in trenches	m	50.00		
I422.3	Nominal bore 200mm in trenches, depth not exceeding 1.5m	m	50.00		
	<i><u>Supply and transport to site PN12.5 High Density Polyethylene (HDPE) PE100 pipes as per technical specifications:break out surface, excavate trench, cut and joint pipes using butt fusion, backfill with selected material from the trench excavations and compact, disposal of surplus all as specified.</u></i>				
I712.1	Nominal bore 225mm in trenches, depth not exceeding 2.5 m	m	2,000.00		
I712.1	Nominal bore 160mm in trenches, depth not exceeding 2.5m	m	200.00		
	Total C/F to Collection Sheet				

CLASS J: PIPEWORK FITTINGS AND VALVES				
	<u>HDPE Fittings (Rate to include supply and fixing inclusive of Associated Fittings i.e. gaskets, bolts and nuts etc.)</u>			
J642.1	225x160mm saddle clamp	nr	4.00	
J642.2	225x110mm saddle clamp	nr	5.00	
J642.3	225x90 mm saddle clamp	nr	5.00	
J642.4	225 x63 mm saddle clamp	nr	5.00	
J642.5	225x50 mm saddle clamp	nr	5.00	
J642.6	225x32mm saddle clamp	nr	5.00	
J642.7	225x25mm saddle clamp	nr	5.00	
J642.8	225x20 mm saddle clamp	nr	5.00	
J641.1	160x110 mm saddle clamp	nr	4.00	
J641.2	160x90mm saddle clamp	nr	5.00	
J641.3	160x63mm saddle clamp	nr	5.00	
J641.4	160x50mm saddle clamp	nr	5.00	
J641.5	160x32mm saddle clamp	nr	5.00	
J641.6	160x25mm saddle clamp	nr	5.00	
J641.7	160x20mm saddle clamp	nr	5.00	
	<u>Steel pipe horizontal and Vertical Bends (Rate to include supply and fixing inclusive of Associated Fittings i.e. Mechanical Couplings, bolts and nuts etc.)</u>			
J312.3	Nominal bore 200mm double flanged bend of varying angles.	nr	10.00	
	<u>Air Valves and Washouts Fittings(Rate to include supply and fixing inclusive of Associated Fittings i.e. Mechanical Couplings, bolts and nuts etc.)</u>			
	<u>Bends (NP25)(Rate to include supply and fixing inclusive of Associated Fittings)</u>			
J311.1	Nominal bore 100mm, plain ended 90° bend (for Type 1 Washouts)	nr	6.00	
J311.2	Nominal bore 100mm, double flanged long radius 90° bend (for air valves vents)	nr	8.00	
	<u>Steel Junctions and Branches (NP25)(Rate to include supply and fixing inclusive of Associated Fittings)</u>			
J323.1	1500mm DN 200mm spigot welded on DN 500 spigot and socket steel for offtake/branch line.	nr	4.00	
	<u>Valves to PN 16 Pressure as specified(Rate to include supply and fixing inclusive of Associated Fittings)</u>			
J811.1	Nominal bore 100mm double flanged isolating Valve (for air valves)	nr	8.00	
J811.2	Nominal bore 100mm double flanged Gate Valve (for washouts)	nr	3.00	
	<u>Air Valves to PN 16 Pressure as specified(Rate to include supply and fixing inclusive of Associated Fittings)</u>			
J861	Nominal bore 100mm ARI series or similar approved flanged double orifice air release and vacuum break valve	nr	4.00	
	<u>Double Collars to PN25 as specified(Rate to include supply and fixing inclusive of Associated Fittings)</u>			
J342.2	Nominal bore 225mm flexible coupling	nr	15.00	
J342.3	Nominal bore 200mm flexible coupling	nr	10.00	
J341.1	Nominal bore 160mm flexible coupling	nr	5.00	
Total C/F to Collection Sheet				

	Sluice Valves to PN25 Pressure as specified(Rate to include supply and fixing inclusive of Associated Fittings)				
J812.2	Nominal bore 225mm double flanged sluice Valve	nr	2.00		
J812.3	Nominal bore 200mm double flanged sluice Valve	nr	2.00		
J811.1	Nominal bore 150mm double flanged sluice Valve	nr	3.00		
J811.2	Nominal bore 100mm double flanged sluice Valve	nr	3.00		
J811.3	Nominal bore 75 mm double flanged sluice Valve	nr	5.00		
J811.4	Nominal bore 50mm double flanged Gate Valve	nr	5.00		
J811.5	Nominal bore 37mm double flanged Gate Valve	nr	5.00		
J811.6	Nominal bore 25mm double flanged Gate Valve	nr	5.00		
	<u>Electromagnetic Water Meters</u>				
J91.2	DN 100 all flanged mechanical water meter complete with accessories, all to specifications.	nr	5.00		
	<u>Fire Hydrants</u>				
J10.1	Provide for supply and installation of Type 2 fire hydrant. Rate to include the installation tee, necessary concrete works and other associated fittings.	nr	4.00		
	<u>CLASS K - PIPEWORK - MANHOLES AND PIPEWORK ANCILLARIES</u>				
	<u>Chambers complete as per the drawings</u>				
K233.1	In situ concrete chamber, internal size 1200mm x 1200mm, depth not exceeding 2.0m. (Air Valve chambers)	nr	4.00		
K233.1	In situ concrete chamber, internal size 400mm x 400mm surface boxes for Washout Valves	nr	3.00		
K236.2	In situ concrete chamber, internal size 1800mm x 1800mm, depth not exceeding 4.0m for sluice valve chambers and Interconnection	nr	10.00		
	<u>Crossings</u>				
	<u>River crossings, width exceeding 10m, including all couplings, reinforced concrete piers, surrounds, bearings etc</u>				
K622	Over-crossing, pipe bore not exceeding 300 -900mm	nr	5.00		
K642	Crossing Hedge, pipe bore not exceeding 300 -900mm	nr	10.00		
K662	Crossing Fence, pipe bore not exceeding 300 -900mm	nr	10.00		
K672	Crossing existing sewer or drain, pipe bore not exceeding 300 -900mm	nr	10.00		
K682	Other underground service, 1.0m wide by 1.4m high microtunnel. Length 10-20m , pipe bore not exceeding 300 -900mm	nr	5.00		
	<u>Breaking up, temporary and permanent reinstatement of roads</u>				
K732.2	Urban Local Authority tarmac, cabro or concrete paved roads, pipe nominal bore not exceeding 300-900mm. To include traffic control and diversion and reinstatement to the original condition to Local Authority satisfactionand diversion and reinstatement to the original condition to Local Authority satisfaction	m	100.00		
	<u>Pipeline Marker Posts</u>				
K820.1	Marker post for Line Valve inscribed 'SV'	nr	10.00		
K820.2	-Ditto- but Air Valve inscribed 'AV'	nr	4.00		
K820.3	-Ditto- but Water Main inscribed 'WM '	nr	2.00		
K820.4	-Ditto- but Wash Out inscribed 'WO'	nr	3.00		
	Total C/F to Collection Sheet				

	<u>Connection to Existing Pipes in Chambers(Rate to include all materials associated)</u>				
K861	Connection to existing line pipe nominal bore n.e. 200mm	nr	10.00		
K862	Connection to existing line pipe nominal bore 200 - 300 mm	nr	10.00		
	<u>CLASS L : PIPEWORK SUPPORTS AND PROTECTION, ANCILLARIES TO LAYING AND EXCAVATION</u>				
	<u>Excavation of rock as defined in Specifications</u>				
L111	Extras to excavation and backfilling of pipe trenches; Excavation of rock of all classes	m ³	1,760.00		
L121	Extras to excavation and backfilling in chambers; Excavation of rock	m ³	55.08		
	<u>Trenchless Road And Railway Crossings</u>				
	Provide all equipment and materials, tunnel below road surface including any requisite shoring and strutting during tunneling, provide and install precast reinforced concrete lining segments to tunnel faces, blanking of tunnel ends with mass concrete/masonry walls upon pipework installation using any trenchless method subject to Engineer's approval and in accordance to standard specifications. Rate to include for all necessary grouting. All works to be executed in close liaison with relevant road/railway authorities. Rate to include facilitation of the same. The Bidder to submit method statement with bid for execution of this works. The bidder may quote for alternative method of trenchless road/railway crossing. Details of alternative method to be submitted with the bid.				
L233	Allow for special pipe laying methods through pipe jacking for nominal bore 300 - 600 mm	m	50		
L234	Allow for special pipe laying methods for nominal bore 300 - 600 mm	m	50		
L52*2	Surrounds with imported granular material, pipe bore "All" for trench in rock and clay soil.	m	2,200.00		
L52*3	Surrounds with Class C15/20 mass concrete, pipe bore "All" for road, river and stream crossings	m	100.00		
	<u>Thrust blocks for bends, tees, blank ends and anchor blocks for tapers, gate valves and vertical bends.</u>				
L74*	Concrete thrust and anchor blocks, volume 0.5 - 3 m ³ , pipe nominal bore "All"	nr	20.00		
	<u>Pipeline Piers and Supports as shown on drawing.</u>				
L8436.1	Reinforced concrete pier complete with pipe cradle and strap, pier height 1.0 - 10.0m.	nr	5.00		
	Total C/F to Collection Sheet				

BILL NO. 2 SUMMARY SHEET

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BILL No. 3 - WATER WORKS (MARIQUINI)

ITEM No.	DESCRIPTION	UNIT	QUANTITY	RATE (KSHS)	AMOUNT (KSHS)
	<u>CLASS A - PIPES</u>				
	Supply and transport to site PN12.5 High Density Polyethylene (HDPE) PE100 pipes as per technical specifications:break out surface, excavate trench, cut and joint pipes using butt fusion, backfill with selected material from the trench excavations and compact, disposal of surplus all as specified.				
A260.11	OD110 HDPE PE100 PN12.5 pipe	m	1,500		
	<i>Identify and locate existing pipeline and services, set-out pipeline, showing ground and pipe profile. The Contractor shall produce pipeline construction drawings for Engineers approval</i>				
A290	Set out and prepare construction drawings for all the pipelines under the Contract	Item	Sum		
	<u>CLASS B - GROUND INVESTIGATIONS</u>				
	<i>Excavation of trial pits or trenches for ground investigations or locate existing pipes as directed by the Engineer</i>				
B112	Trial pit in material other than rock; depth 1 - 2m	nr	10.00		
B113	Trial pit in material other than rock; depth 2 - 3m	nr	10.00		
B123	Trial pit in material which includes rock; depth 2 - 3m	nr	10.00		
	<u>CLASS D - DEMOLITION AND SITE CLEARANCE</u>				
D100	General clearance and demolition of structures for pipeline for full width of easement including grubbing out all shrubs, temporary roadside business structures etc and removal of all trees of girth < 0.5m	M²	6,000.00		
	<i>Cutting of trees, removal and disposal of stumps with hole backfilled with suitable material from excavated pipe trench</i>				
D210	Tree girth 0.5 - 1.0m	nr	3.00		
	<u>CLASS I PIPEWORK TESTING AND SETTING OUT OF WORKS</u>				
	<i>Pressure Testing pipelines including flushing and sterilizing in accordance with the technical specification</i>				
	OD110 HDPE PE100 PN12.5 pipe	m2	1,500.00		
I712.2	Nominal bore 110mm in trenches, depth not exceeding 1.5m	m	200.00		
I713.2	Ditto- but depth 1.5m - 2m	m	200.00		
	<u>CLASS J: PIPEWORK FITTINGS AND VALVES</u>				
	<i>HDPE Fittings (Rate to include supply and fixing inclusive of Associated Fittings i.e. gaskets, bolts and nuts etc.)</i>				
	<u>Bends</u>				
J311.1	OD 110mm Bends of varying degrees	nr	20.00		
	<u>Tees</u>				
J321.1	OD100mm Tees	nr	8.00		
J341.1	150x100mm saddle clamp	nr	4.00		
	<i>Steel pipe horizontal and Vertical Bends (Rate to include supply and fixing inclusive of Associated Fittings i.e. Mechanical Couplings, bolts and nuts etc.)</i>				
	<i>Double Collars to PN12.5 as specified(Rate to include supply and fixing inclusive of Associated Fittings)</i>				
J341.2	Nominal bore 100mm flexible coupling	nr	20.00		
	<i>Adaptors (NP25)(Rate to include supply and fixing inclusive of Associated Fittings)</i>				
J351.1	Nominal bore 100mm flange adaptor	nr	8.00		
	<i>Sluice Valves to PN25 Pressure as specified(Rate to include supply and fixing inclusive of Associated Fittings)</i>				
J811.1	Nominal bore 100mm double flanged sluice Valve	nr	8.00		
	<u>CLASS K - PIPEWORK - MANHOLES AND PIPEWORK ANCILLARIES</u>				
	<i>Chambers complete as per the drawings</i>				
K236.1	In situ concrete chamber, internal size 1200mm x 1200mm, depth not exceeding 4.0m for line valve chambers and Interconnection	nr	16.00		
	Total C/F to Collection Sheet				

	<u>Crossings</u>				
	<i>Breaking up, temporary and permanent reinstatement of roads</i>				
K732.1	Urban Local Authority tarmac, cabro or concrete paved roads, pipe nominal bore not exceeding 300mm. To include traffic control and diversion and reinstatement to the original condition to Local Authority satisfaction and diversion and reinstatement to the original condition to Local Authority satisfaction	m	3,000.00		
	<u>Pipeline Marker Posts</u>				
K820.1	Marker post for Line Valve inscribed 'SV'	nr	2.00		
K820.3	-Ditto- but Water Main inscribed 'WM'	nr	2.00		
	<u>CLASS L - PIPEWORK SUPPORTS AND PROTECTION, ANCILLARIES TO LAYING AND EXCAVATION</u>				
	<u>Excavation of rock as defined in Specifications</u>				
L111	Extras to excavation and backfilling of pipe trenches; Excavation of rock of all classes	m ³	800.00		
L121	Extras to excavation and backfilling in chambers; Excavation of rock	m ³	34.00		
L52*2	Surrounds with imported granular material, pipe bore "All" for trench in rock and clay soil.	m	150.00		
L52*3	Surrounds with Class C15/20 mass concrete, pipe bore "All" for road, river and stream crossings	m	40.00		
	<u>Thrust blocks for bends, tees, blank ends and anchor blocks for tapers, gate valves and vertical bends.</u>				
L74*	Concrete thrust and anchor blocks, volume 0.5 - 3 m ³ , pipe nominal bore "All"	nr	2.00		
	Total C/F to Collection Sheet				

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BILL NO. 4: SEWERS (KIBERA B HOUSING)					
Item No	Description	Unit	Quantity	Rate (KSh.)	Amount (KShs)
CLASS A - GENERAL ITEMS					
Setting Out and Testing of the Works					
A140.3	Allow for setting out of the works	m	1200		
A260	Carrying out test on 500 mm pipeline as specified or directed by the Engineer. Include provision of all equipment and materials	m	1200		
A261	Allow for desilting of the existing manholes (depth upto 3.0m) in vicinity of the works and as instructed by the Engineer. Rate to include disposal of the solid and liquid wastes to appropriate sites.	nr	20		
A262	Allow for repair/replacement and realignment of the of damaged/collapsed sections of manholes (depth up to 3m) as instructed by the Engineer	nr	20		
A263	Allow for desilting of the existing manholes (depth greater than 3.0m) in vicinity of the works and as instructed by the Engineer. Rate to include disposal of the solid and liquid wastes to appropriate sites.	nr	10		
A264	Allow for repair/replacement and realignment of the of damaged/collapsed sections of manholes (depth greater than 3.0m) as instructed by the Engineer	nr	15		
CLASS B - SITE INVESTIGATION					
B111	Trial holes where ordered to check on position of underground services and condition of subsurface materials, max depth 1-2m	nr	5		
B112	Trial holes where ordered to check on position of underground services and condition of subsurface materials, max depth 2-3m	nr	5		
B113	Trial holes where ordered to check on position of underground services and condition of subsurface materials, max depth 3-4m	nr	5		
CLASS D - DEMOLITION AND SITE SITE CLEARANCE					
D100	General site clearance through undeveloped land over the wayleave, include for any additional clearance required	m ²	3600		
	Provide for breaking up, excavation across temporary and permanent, closed/open, concrete/masonry lined drains. Rate to include reinstatement to original status including supply of drain materials, preparation of surfaces, spreading of excess excavated material as directed by Engineer and cost of sourcing for permits to undertake the works from the relevant authorities.				
D210	Removal of trees, girth n.e 1m	nr	15		
D310	Removal of stump, diameter 0.5-1m	nr	15		
D461	Buildings of indeterminate construction Volume not exceeding 50m ³	nr	15		
D561	Other structures of indeterminate construction Volume not exceeding 50m ³	nr	15		
CLASS I: PIPEWORK - PIPES					
DOUBLE WALL CORRUGATED PIPES IN ACCORDANCE TO BS 4660					
	The rates entered against the items in this section shall include for stripping top soil, laying aside and subsequently replacing over refilled trench, excavation in trench in material other than rock, shuttering where necessary, refilling and compacting, spreading surplus soil evenly over and alongside pipe trench, compacting, supply lay and joint pipes to correct line and level. Depths are stated from ground level to invert level including pipe thickness and pipe bedding.				
I231	Supply DWC SN8 400mm pipes complete with jointing materials pipe DN400 Nominal bore 400mm in trenches	m	1200		
I 232	Depth n.e. 1.5m	m	50		
I 233	Depth 1.5m - 2.0m	m	50		
I 234	Depth 2.0m - 2.5m	m	300		
I 235	Depth 2.5m - 3.0m	m	200		
I 236	Depth 3.0m - 3.5m	m	300		
I 237	Depth 3.5m - 4.0m	m	200		
I 238	Depth >4.0m	m	100		
Total C/F to Collection Sheet					

CLASS K: PIPEWORK - MANHOLES AND PIPEWORK ANCILLARIES					
	Excavation quantities are given net. The rates entered are to include for manhole concrete slabs and covers, step irons or ladder as case applies, extra excavation, trimming the base of the excavation, shuttering where necessary, refilling and compacting around the finished manholes, and disposing of surplus materials to spoil.				
	Manholes Manhole type B, size 1050mm, reinforced concrete manhole slab and cover.				
K 151	Depth n.e 1.5m	nr	2		
K 152	Ditto- but depth 1.5m - 2.0m	nr	2		
K 153	Ditto- but depth 2.0m - 2.5m	nr	7		
K 154	Ditto- but depth 2.5m - 3.0m	nr	5		
K 155	Ditto- but depth 3.0m - 3.5m	nr	7		
K 156	Ditto- but depth 3.5m - 4.0m	nr	5		
K 157	Ditto- but depth >4.0m	nr	3		
	Manhole type B, size 1050mm, reinforced concrete manhole slab and cover with backdrop.				
K165	Ditto- but depth 3.0m - 3.5m	nr	8		
K166	Ditto- but depth 3.5m - 4.0m	nr	8		
	Crossings Include for all work associated with the crossings <i>Pipe nominal bore 400mm</i>				
K 631	River, stream and valley crossing and reinstatement;	nr	5		
K 642	Hedge crossing and reinstatement;	nr	5		
K 652	Wall crossing and reinstatement;	nr	5		
K 662	Fence crossing and reinstatement;	nr	5		
K682	Underground water mains crossing	nr	5		
	Reinstatement <i>Pipe nominal bore 400mm</i>				
K 731.1	Breaking up, temporary and permanent reinstatement of murram roads	m	200		
K 731.2	Breaking up, temporary and permanent reinstatement of bitumen paved roads	m	200		
K 731.3	Breaking up, temporary and permanent reinstatement of concrete paved roads, surfaces and drainage	m	200		
K 741	Breaking up, temporary and permanent reinstatement of footpaths with slabs	m	500		
K 751	Reinstatement of land	m	1200		
	Other Pipework ancillaries				
K853	Connection to existing manholes and other chambers	nr	20		
CLASS L: SUPPORTS AND PROTECTION ANCILLARIES TO LAYING AND EXCAVATION					
	Extras to Excavation and Backfilling (Note: Blasting not allowed for any rock excavation)				
	<i>In Pipe Trenches</i>				
L111	Excavation of rock to invert including extra over excavation for pipe thickness and spigot.	m ³	2160		
L118	Allow for excavation of soft material below final surface of pipe trench and backfill with approved hardcore, well compacted in layers of 200mm thickness, depth not exceeding 4.0m .	m ³	864		
	<i>In manholes and Other Chambers</i> (Note: Blasting not allowed for any rock excavation)				
L121	Excavation of rock (Provisional)	m ³	370		
L127	Excavation of soft material below the final surface and backfilling with mass concrete, depth not exceeding 1.0m.	m ³	106		
L128	Allow for excavation of soft material below final surface of pipe trench and backfill with approved hardcore, well compacted in layers of 200mm thickness, depth not exceeding 4.0	m ³	106		
Total C/F to Collection Sheet					

	Bed, Haunches and Surrounds				
	<i>Granular Material</i>				
	Pipeline nominal bore 400mm				
L312	Sand as per specifications Beds 150 mm thick	m	480		
L322	Selected excavated granular material as per specifications Beds 150 mm thick	m	360		
L332	Imported granular material as per specifications Beds 150 mm thick	m	360		
	Mass Concrete Grade 15/20 in 150mm Thick Beds, Haunches and Surrounds				
	400mm nominal bore pipeline				
L542	Surround Type D	m ³	600		
	(Concrete 0.4818m ³ /m)				
	CLASS Y: SEWER AND WATER MAIN RENOVATION AND ANCILLARY WORKS				
	The rates entered are to include preparation and renovation of existing sewer mains, new manholes within the length of existing sewers and work to existing manholes				
	Preparation of Existing sewers				
Y110	Cleaning	m	100		
	<i>Removing intrusions</i>				
Y121	Laterals bore not exceeding 150mm	nr	20		
Y122	Laterals, stated profile and exceeding 150mm in one or more dimension	nr	20		
	Renovation of Existing sewers				
Y370	Replacing damaged sections bore n.e 400mm	m	100		
Y720	Renovating damaged Manholes (To include cover slab, step irons and access cover)	nr	20		
	Total C/F to Collection Sheet				

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BILL NO. 5: SEWERS (MARIGUINI)

Item No	Description	Unit	Quantity	Rate (KSh.)	Amount (KShs)
	CLASS A - GENERAL ITEMS				
	Testing of the Works				
A260.1	Carrying out test on 300mm pipeline as specified or directed by the Engineer. Include provision of all equipment and materials	m	500		
A260.2	Carrying out test on 400 mm pipeline as specified or directed by the Engineer. Include provision of all equipment and materials	m	500		
A260.2	Carrying out test on 400mm pipeline as specified or directed by the Engineer. Include provision of all equipment and materials	m	500		
A260.3	Allow for desilting of the existing manholes (depth upto 3.0m) in vicinity of the works and as instructed by the Engineer. Rate to include disposal of the solid and liquid wastes to appropriate sites.	nr	10		
A260.4	Allow for repair/replacement and realignment of the of damaged/collapsed sections of manholes (depth up to 3m) as instructed by the Engineer	nr	10		
A260.5	Allow for desilting of the existing manholes (depth greater than 3.0m) in vicinity of the works and as instructed by the Engineer. Rate to include disposal of the solid and liquid wastes to appropriate sites.	nr	10		
A260.6	Allow for repair/replacement and realignment of the of damaged/collapsed sections of manholes (depth greater than 3.0m) as instructed by the Engineer	nr	10		
	CLASS B - SITE INVESTIGATION				
B112	Trial holes where ordered to prove location, construction size etc, of pipelines, services or existing structures, max depth 1-2m	nr	2		
B113	Trial holes where ordered to prove location, construction size etc, of pipelines, services or existing structures, max depth 2-3m	nr	2		
B114	Trial holes where ordered to prove location, construction size etc, of pipelines, services or existing structures, max depth 3-5m	nr	2		
	CLASS D - DEMOLITION AND SITE CLEARANCE				
D100	General site clearance through undeveloped land over the wayleave, include for any additional clearance required Provide for breaking up, excavation across temporary and permanent, closed/open, concrete/masonry lined drains. Rate to include reinstatement to original status including supply of drain materials, preparation of surfaces, spreading of excess excavated material as directed by Engineer and cost of sourcing for permits to undertake the works form the relevant authorities.	M ²	450		
D210	Removal of trees and stumps girth 0.5-1m	nr	5		
D220	Removal of trees and stump girth 1-2m	nr	5		
D230	Removal of trees and stump girth 2-3m	nr	5		
D310	Removal of stump, diameter 0.5-1m	nr	5		
D461	Buildings of indeterminate construction Volume not exceeding 50m ³	nr	30		
D462	Buildings of indeterminate construction Volume not exceeding 50-100m ³	nr	30		
D561	Other structures of indeterminate construction Volume not exceeding 50m ³	nr	15		
D562	Other structures of indeterminate construction Volume not exceeding 50-100m ³	nr	15		
	Total C/F to Collection Sheet				

BILL NO. 5 - SEWERS (Continued)					
Item No	Description	Unit	Quantity	Rate (KSh.)	Amount (KShs)
	CLASS I: PIPEWORK - PIPES				
	DOUBLE WALL CORRUGATED PIPES TO BS 4660				
	The rates entered against the items in this section shall include for stripping top soil, laying aside and subsequently replacing over refilled trench, excavation in trench in material other than rock, shuttering where necessary, refilling and compacting, spreading surplus soil evenly over and alongside pipe trench compacting, supply lay and joint pipes to correct line and level. Depths are stated from ground level to invert level.				
I 221	Supply DWC pipes complete with jointing materials	m	1500		
	Nominal bore 300mm in trenches				
I 222	Depth n.e. 1.5m	m	10		
I 223	Depth 1.5m - 2.0m	m	10		
I 224	Depth 2.0m - 2.5m	m	10		
I 225	Depth 2.5m - 3.0m	m	10		
I 226	Depth 3.0m - 3.5m	m	10		
I 227	Depth 3.5m - 4.0m	m	10		
I 228	Depth >4.0m	m	10		
	Nominal bore 375mm in trenches				
I 222	Depth n.e. 1.5m	m	10		
I 223	Depth 1.5m - 2.0m	m	10		
I 224	Depth 2.0m - 2.5m	m	10		
I 225	Depth 2.5m - 3.0m	m	10		
I 226	Depth 3.0m - 3.5m	m	10		
I 227	Depth 3.5m - 4.0m	m	10		
I 228	Depth >4.0m	m	10		
	Nominal bore 400mm in trenches				
I 232.1	Depth n.e. 1.5m	m	10		
I 233.1	Depth 1.5m - 2.0m	m	10		
I 234.1	Depth 2.0m - 2.5m	m	10		
I 235.1	Depth 2.5m - 3.0m	m	10		
I 236.1	Depth 3.0m - 3.5m	m	10		
I 237.1	Depth 3.5m - 4.0m	m	10		
I 238.1	Depth >4.0m	m	10		
	CLASS K: PIPEWORK - MANHOLES AND PIPEWORK ANCILLARIES				
	Excavation quantities are given net. The rates entered are to include for manhole concrete slabs and covers, step irons or ladder, excavation, working room, trimming the base of the excavation, shuttering where necessary, refilling and compacting around the finished manholes, and disposing of surplus spoil local to the trench. Surplus spoil is to be evenly spread.				
	Manholes				
	Manhole as per NCWSC Standard Drawings SR/743/1, size 1050mm, rings, reinforced concrete manhole slab, step-irons and heavy duty Cast Iron triangular access cover.				
K 151.1	Depth n.e 1.5m	nr	4		
K 151.2	Ditto- but depth 1.5m - 2.0m	nr	2		
K 151.3	Ditto- but depth 2.0m - 2.5m	nr	2		
K 151.4	Ditto- but depth 2.5m - 3.0m	nr	2		
K 151.5	Ditto- but depth 3.0m - 3.5m	nr	2		
K 151.6	Ditto- but depth 3.5m - 4.0m	nr	2		
K 151.7	Ditto- but depth >4.0m	nr	2		
	Total C/F to Collection Sheet				

	Manhole as per NCWSC Standard Drawings SR/743/1, size 1050mm, rings, reinforced concrete manhole slab, step-irons and heavy duty Cast Iron triangular access cover.				
K 151.1	Depth n.e 1.5m	nr	4		
K 151.2	Ditto- but depth 1.5m - 2.0m	nr	2		
K 151.3	Ditto- but depth 2.0m - 2.5m	nr	2		
K 151.4	Ditto- but depth 2.5m - 3.0m	nr	2		
K 151.5	Ditto- but depth 3.0m - 3.5m	nr	2		
K 151.6	Ditto- but depth 3.5m - 4.0m	nr	2		
K 151.7	Ditto- but depth >4.0m	nr	2		
	Manhole as per NCWSC Standard Drawings SR/743/1, size 1050mm, rings, reinforced concrete manhole slab, step-irons and heavy duty Cast Iron triangular access cover with back drop.				
K 161.1	Depth n.e 1.5m	nr	4		
K 161.2	Ditto- but depth 1.5m - 2.0m	nr	2		
K 161.3	Ditto- but depth 2.0m - 2.5m	nr	2		
K 161.4	Ditto- but depth 2.5m - 3.0m	nr	2		
K 161.5	Ditto- but depth 3.0m - 3.5m	nr	2		
K 161.6	Ditto- but depth 3.5m - 4.0m	nr	2		
K 161.7	Ditto- but depth >4.0m	nr	2		
	Manhole as per NCWSC Standard Drawings SR/743/1, size 1050mm, rings, reinforced concrete manhole slab, step-irons and heavy duty Cast Iron triangular access cover with back drop.				
K 161.1	Depth n.e 1.5m	nr	4		
K 161.2	Ditto- but depth 1.5m - 2.0m	nr	2		
K 161.3	Ditto- but depth 2.0m - 2.5m	nr	2		
K 161.4	Ditto- but depth 2.5m - 3.0m	nr	2		
K 161.5	Ditto- but depth 3.0m - 3.5m	nr	2		
K 161.6	Ditto- but depth 3.5m - 4.0m	nr	2		
K 161.7	Ditto- but depth >4.0m	nr	2		
	Crossings Include for all work associated with the crossings <i>Pipe nominal bore 300mm</i>				
K 631	River, stream and valley crossing and reinstatement;	nr	5		
K 641	Hedge crossing and reinstatement;	nr	5		
K 651	Wall crossing and reinstatement;	nr	5		
K 661	Fence crossing and reinstatement;	nr	5		
K 681	Underground water mains crossing	nr	5		
	<i>Pipe nominal bore 400mm</i>				
K 632.1	River, stream and valley crossing and reinstatement;	nr	5		
K 642.1	Hedge crossing and reinstatement;	nr	5		
K 652.1	Wall crossing and reinstatement;	nr	5		
K 662.1	Fence crossing and reinstatement;	nr	10		
K 682.1	Underground water mains crossing	nr	4		
	Reinstatement <i>Pipe nominal bore not exceeding 300mm</i>				
K 731.1	Breaking up, temporary and permanent reinstatement of murrum roads	m	200		
K 731.2	Breaking up, temporary and permanent reinstatement of bitumen paved roads	m	200		
K 731.3	Breaking up, temporary and permanent reinstatement of cabro paved roads	m	200		
K 731.4	Breaking up, temporary and permanent reinstatement of concrete paved roads, surfaces and drainage	m	200		
K 741	Breaking up, temporary and permanent reinstatement of footpaths with slabs	m	200		
K 751	Reinstatement of land	m	200		
	Total C/F to Collection Sheet				

	<i>Pipe nominal bore 300-1000mm</i>				
K 732.1	Breaking up, temporary and permanent reinstatement of murrum roads	m	200		
K 732.2	Breaking up, temporary and permanent reinstatement of bitumen paved roads	m	200		
K 732.3	Breaking up, temporary and permanent reinstatement of cabro paved roads	m	200		
K 732.4	Breaking up, temporary and permanent reinstatement of concrete paved roads, surfaces and drainage	m	200		
K 742.1	Breaking up, temporary and permanent reinstatement of footpaths with slabs	m	200		
K 752.1	Reinstatement of land	m	200		
K852	Connections to existing manholes and other chambers				
K853	Pipe bore 200-300mm	nr	8		
	Pipe bore 300-600mm	nr	6		
	CLASS L: SUPPORTS AND PROTECTION ANCILLARIES TO LAYING AND EXCAVATION				
	Extras to Excavation and Backfilling (Note: Blasting not allowed for any rock excavation)				
	<i>In Pipe Trenches</i>				
L111	Excavation of rock of all classes	m ³	4500		
L117	Excavation of soft material below the final surface and backfilling with mass concrete, depth not exceeding 1.0m	m ³	35		
L118	Allow for excavation of soft material below final surface of pipe trench and backfill with approved hardcore, well compacted in layers of 200mm thickness, depth not exceeding 1.0m	m ³	42		
	<i>In manholes and Other Chambers</i> (Note: Blasting not allowed for any rock excavation)				
L121	Excavation of rock	m ³	100		
L127	Excavation of soft material below the final surface and backfilling with mass concrete, depth not exceeding 4.0m	m ³	50		
L128	Allow for excavation of soft material below final surface of pipe trench and backfill with approved hardcore, well compacted in layers of 200mm thickness, depth not exceeding 1.0m (Provisional)	m ³	50		
	Bed, Haunches and Surrounds as per NCWSC Standard Drawings Ref. SR/743/2				
	<i>Mass Concrete Grade 15/20 in 150mm Thick Beds, Haunches and Surrounds</i> <u>300mm nominal bore pipeline</u>				
L442	Bed and haunch Type D (Concrete 0.3449m3/m)	m	80		
	<u>375mm nominal bore pipeline</u>				
L442	Bed and haunch Type D (Concrete 0.4093m3/m)	m	50		
	<u>400mm nominal bore pipeline</u>				
L443.1	Bed and haunch Type D (Concrete 0.4818m3/m)	m	50		
	Total C/F to Collection Sheet				

BILL NO. 5 SUMMARY SHEET

PAGE NO.

1
2
3
4

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

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GRAND SUMMARY		
Bill No.	Description	Amount (KSh.)
1	Preliminaries and General Items	
2	Water Works (Kibera B)	
3	Water Works (Mariguini)	
4	Sewer Works (Kibera B)	
5	Sewer Works (Mariguini)	
	SUBTOTAL 1	
	Add 10% Contingencies	
	SUBTOTAL 2	
	16% VAT	
	TOTAL	

SECTION 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.

[*date*]

[*signature of the Bank*]

[*witness*]

[*seal*]

(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)

Name of the Bank or financial institution

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

36

.....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