KENYA ELECTRICITY GENERATING COMPANY PLC

KGN-GDD-056-2023

TENDER FOR CONNECTION OF MAKE-UP WELLS OW-50A, OW-50B AND OW-50C TO OLKARIA IAU POWER PLANT

(OPENING INTERNATIONAL TENDER)

Kenya Electricity Generating Company PLC
Stima Plaza Phase III, Kolobot Road, Parklands P.O.
BOX 47936-00100
NAIROBI.
Website: www.kengen.co.ke

March 2023

INVITATION TO TENDER

PROCURING ENTITY: **KENYA ELECTRICITY GENERATING COMPANY PLC**

CONTRACT NAME AND DESCRIPTION: **TENDER FOR THE CONNECTION OF MAKE-UP WELLS OW-50A, OW-50B AND OW-50CV TO OLKARIA IAU POWER PLANT**.

KenGen PLC invites sealed tenders from eligible candidates for **TENDER FOR THE CONNECTION OF MAKE-UP WELLS OW-50A, OW-50B AND OW-50C TO OLKARIA IAU POWER PLANT,** whose specifications are detailed in the Tender Document.

The tender is specific to **Open International** using a standardized tender document.

Qualified and interested tenderers may obtain further information and inspect the Tender

Qualified and interested tenderers may obtain further information and inspect the Tender Documents during office hours between **8am and 5pm** starting at the date of advert at the office of:

General Manager, Supply Chain
Tel: (254) (020) 3666000
Email: tenders@kengen.co.ke;cc ponyango1@kengen.co.ke

The document can be viewed and downloaded for free from the website www.kengen.co.ke and/or on E- procurement https://eprocurement.kengen.co.ke:50001/irj/portal . Tenderers who download the tender document must forward their particulars immediately to (tenders@kengen.co.ke , 0711036000 and P.O.BOX 47936-00100 postal address) to facilitate any further clarification or addendum

Bidders who are unable to download the tender documents from the website may collect them from any KenGen Supply Chain Office upon payment of a non-refundable fee of **KShs.1, 000.00 paid via Mpesa, pay bill no. 400200 and account no. 01120069076000**, then share the MPesa message to KenGen Finance office staff for receipt and issuance of official receipt or through a banker's cheque and payable to the address given below.

The Original Tender Security of **KES. 18,000,000.00** valid for 30 days beyond the tender validity period from any reputable banks registered by the Central Bank of Kenya. International bidders, should have tender security through local corresponding banks registered by the Central Bank of Kenya and MUST be submitted in a plain sealed envelope and clearly marked **"KGN-GDD-056-2023 - TENDER FOR THE CONNECTION OF MAKE-UP WELLS OW-50A, OW-50B AND OW-50C TO OLKARIA IAU POWER PLANT"** And addressed to:

General Manager-Supply Chain,
Kenya Electricity Generating Company PLC,
Ground Floor, KenGen Pension
Plaza I, Kolobot Road, Parklands,
P.O. Box 47936, 00100
NAIROBI.

The Original Tender Security clearly labeled should be dropped at the tender box located on Ground Floor at KenGen, RBS building on or before tender closing date.

Electronic tender securities are acceptable and shall be authenticated through the use of the QR scanner.
All tender securities submitted shall be subject to authentication by KenGen.

There shall be a ***Mandatory Site Visit*** on **30th March, 2023** starting at **10.00 a.m.** at **Olkaria 1 AU.**

The Tenderer shall chronologically serialize all pages of the tender documents submitted.

Completed tenders must be submitted online on or before **12th April, 2023 at 10.00 a.m.**

Electronic Tenders will be permitted through our e-procurement platform found at www.kengen.co.ke (https://eprocurement.kengen.co.ke:50001/irj/portal)

Internet Explorer and Firefox Mozilla are the preferred web browsers.

Tenders will be opened immediately after the deadline date and time specified above or any dead line date and time specified later. Tenders will be publicly opened in the presence of the Tenderers' designated representatives who choose to attend at the address below.

Late tenders will be rejected.

1. The addresses referred to above are:

a. Address for obtaining further information and for purchasing tender documents Physical address for hand Courier Delivery to an office or Tender Box (City, Street Name, Building, Floor Number and Room)

Kenya Electricity Generating Company
PLC Stima Plaza Phase III, Kolobot Road,
Parklands P.O. BOX 47936-00100
tenders@kengen.co.ke ;

b. Address for Opening of Tenders.

General Manager, Supply Chain
Kenya Electricity Generating Company
PLC Stima Plaza Phase III, Kolobot Road,
Parklands P.O. BOX 47936-00100
6th Floor

KenGen adheres to high standards of integrity in its business operations.
Report any unethical behavior immediately to any of the provided anonymous hotline service.

1) Call Toll Free: 0800722626;
2) Free-Fax: 00800 007788;
3) Email: kengen@tip-offs.com
4) Website: www.tip-offs.com

GENERAL MANAGER, SUPPLY CHAIN

SECTION 1 – INSTRUCTION TO TENDERERS (ITT)

INSTRUCTIONS TO TENDERERS

A General Provisions

1 Scope of Tender

1.1 The Procuring Entity as defined in the Appendix to Conditions of Contract invites tenders for Works Contract as described in the tender documents. The name, identification, and number of lots (contracts) of this Tender Document are specified in the TDS.

2 Fraud and Corruption

2.1 The Procuring Entity requires compliance with the provisions of the Public Procurement and Asset Disposal Act, 2015, Section 62 "Declaration not to engage in corruption". The tender submitted by a person shall include a declaration that the person shall not engage in any corrupt or fraudulent practice and a declaration that the person or his or her sub-contractors are not debarred from participating in public procurement proceedings.

2.2 The Procuring Entity requires compliance with the provisions of the Competition Act 2010, regarding collusive practices in contracting. Any tenderer found to have engaged in collusive conduct shall be disqualified and criminal and/or civil sanctions may be imposed. To this effect, Tenders shall be required to complete and sign the "Certificate of Independent Tender Determination" annexed to the Form of Tender.

2.3 Unfair Competitive Advantage - Fairness and transparency in the tender process require that the firms or their Affiliates competing for a specific assignment do not derive a competitive advantage from having provided consulting services related to this tender. To that end, the Procuring Entity shall indicate in the Data Sheet and make available to all the firms together with this tender document all information that would in that respect give such firm any unfair competitive advantage over competing firms.

2.4 Unfair Competitive Advantage -Fairness and transparency in the tender process require that the Firms or their Affiliates competing for a specific assignment do not derive a competitive advantage from having provided consulting services related to this tender being tendered for. The Procuring Entity shall indicate in the TDS firms (if any) that provided consulting services for the contract being tendered for. The Procuring Entity shall check whether the owners or controllers of the Tenderer are same as those that provided consulting services. The Procuring Entity shall, upon request, make available to any tenderer information that would give such firm unfair competitive advantage over competing firms.

3 Eligible Tenderers

3.1 A Tenderer may be a firm that is a private entity, a state-owned enterprise or institution subject to ITT 3.7 or any combination of such entities in the form of a joint venture (JV) under an existing agreement or with the intent to enter into such an agreement supported by a letter of intent. Public employees and their close relatives (spouses, children, brothers, sisters and uncles and aunts) are not eligible to participate in the tender. In the case of a joint venture, all members shall be jointly and severally liable for the execution of the entire Contract in accordance with the Contract terms. The JV shall nominate a Representative who shall have the authority to conduct all business for and on behalf of any and all the members of the JV during the tendering process

and, in the event the JV is awarded the Contract, during contract execution. The maximum number of JV members shall be specified in the TDS.

3.2 Public Officers of the Procuring Entity, their Spouses, Child, Parent, Brothers or Sister. Child, Parent, Brother or Sister of a Spouse, their business associates or agents and firms/organizations in which they have a substantial or controlling interest shall not be eligible to tender or be awarded a contract. Public Officers are also not allowed to participate in any procurement proceedings.

3.3 A Tenderer shall not have a conflict of interest. Any tenderer found to have a conflict of interest shall be disqualified. A tenderer may be considered to have a conflict of interest for the purpose of this tendering process, if the tenderer:

a) Directly or indirectly controls, is controlled by or is under common control with another tenderer; or

b) Receives or has received any direct or indirect subsidy from another tenderer; or

c) Has the same legal representative as another tenderer; or

d) Has a relationship with another tenderer, directly or through common third parties, that puts it in a position to influence the tender of another tenderer, or influence the decisions of the Procuring Entity regarding this tendering process; or

e) Any of its affiliates participated as a consultant in the preparation of the design or technical specifications of the works that are the subject of the tender; or

f) any of its affiliates has been hired (or is proposed to be hired) by the Procuring Entity as Engineer for the Contract implementation; or

g) Would be providing goods, works, or non-consulting services resulting from or directly related to consulting services for the preparation or implementation of the contract specified in this Tender Document or

h) Has a close business or family relationship with a professional staff of the Procuring Entity who:

i. are directly or indirectly involved in the preparation of the Tender document or specifications of the Contract, and/or the Tender evaluation process of such contract; or

ii. would be involved in the implementation or supervision of such Contract unless the conflict stemming from such relationship has been resolved in a manner acceptable to the Procuring Entity throughout the tendering process and execution of the Contract.

3.4 A tenderer shall not be involved in corrupt, coercive, obstructive, collusive or fraudulent practice. A tenderer that is proven to have been involved any of these practices shall be automatically disqualified.

3.5 A Tenderer (either individually or as a JV member) shall not participate in more than one Tender, except for permitted alternative tenders. This includes participation as a subcontractor in other Tenders. Such participation shall result in the disqualification of all Tenders in which the firm is involved. A firm that is not a tenderer or a JV member may participate as a subcontractor in more than one tender. Members of a joint venture may not also make an individual tender, be a subcontractor in a separate tender or be part of another joint venture for the purposes of the same Tender.

3.6 A Tenderer may have the nationality of any country, subject to the restrictions pursuant to ITT 4.8.A Tenderer shall be deemed to have the nationality of a country if the Tenderer is constituted, incorporated or registered in and operates in conformity with the provisions of the laws of that country, as evidenced by its articles of incorporation (or equivalent documents of constitution or association) and its registration documents, as the case may be. This criterion also shall apply to the determination of the nationality of proposed subcontractors or sub- consultants for any part of the Contract including related Services.

3.7 Tenderer that has been debarred from participating in public procurement shall be ineligible to tender or be awarded a contract. The list of debarred firms and individuals is available from the website of PPRA www.ppra.go.ke

3.8 Tenderers that are state-owned enterprises or institutions may be eligible to compete and be awarded a Contract(s) only if they are accredited by PPRA to be (i) a legal public entity of the state Government and/or public administration, (ii) financially autonomous and not receiving any significant subsidies or budget support from any public entity or Government, and (iii) operating under commercial law and vested with legal rights and liabilities similar to any commercial enterprise to enable it compete with firms in the private sector on an equal basis.

3.9 A Firms and individuals may be ineligible if their countries of origin (a) as a matter of law or official regulations, Kenya prohibits commercial relations with that country, or (b) by an act of compliance with a decision of the United Nations Security Council taken under Chapter VII of the Charter of the United Nations, Kenya prohibits any import of goods or contracting of works or services from that country, or any payments to any country, person, or entity in that country. A tenderer shall provide such documentary evidence of eligibility satisfactory to the Procuring Entity, as the Procuring Entity shall reasonably request.

3.10 Foreign tenderers are required to source at least forty (40%) percent of their contract inputs (in supplies, subcontracts and labor) from national suppliers and contractors. To this end, a foreign tenderer shall provide in its tender documentary evidence that this requirement is met. Foreign tenderers not meeting this criterion will be automatically disqualified. Information required to enable the Procuring Entity determine if this condition is met shall be provided in for this purpose.

3.11 Pursuant to the eligibility requirements of ITT 4.10, a tender is considered a foreign tenderer, if the tenderer is not registered in Kenya or if the tenderer is registered in Kenya and has less than 51 percent ownership by Kenyan Citizens. JVs are considered as foreign tenderers if the individual member firms are not registered in Kenya or if are registered in Kenya and have less than 51 percent ownership by Kenyan citizens. The JV shall not subcontract to foreign firms more than 10 percent of the contract price, excluding provisional sums.

3.12 The National Construction Authority Act of Kenya requires that all local and foreign contractors be registered with the National Construction Authority and be issued with a Registration Certificate before they can undertake any construction works in Kenya.

Registration shall not be a condition for tender, but it shall be a condition of contract award and signature. A selected tenderer shall be given opportunity to register before such award and signature of contract. Application for registration with National Construction Authority may be accessed from the website www.nca.go.ke

3.13 The Competition Act of Kenya requires that firms wishing to tender as Joint Venture undertakings which may prevent, distort or lessen competition in provision of services are prohibited unless they are exempt in accordance with the provisions of Section 25 of the Competition Act, 2010. JVs will be required to seek for exemption from the Competition Authority. Exemption shall not be a condition for tender, but it shall be a condition of contract award and signature. A JV tenderer shall be given opportunity to seek such exemption as a condition of award and signature of contract. Application for exemption from the Competition Authority of Kenya may be accessed from the website www.cak.go.ke

3.14 A Kenyan tenderer shall provide evidence of having fulfilled his/her tax obligations by producing a valid tax clearance certificate or tax exemption certificate issued by the Kenya Revenue Authority

4 Eligible Goods, Equipment, and Services

4.1 Goods, equipment and services to be supplied under the Contract may have their origin in any country that is not eligible under ITT 3.9. At the Procuring Entity's request, Tenderers may be required to provide evidence of the origin of Goods, equipment and services.

4.2 Any goods, works and production processes with characteristics that have been declared by the relevant national environmental protection agency or by other competent authority as harmful to human beings and to the environment shall not be eligible for procurement.

5 Tenderer's Responsibilities

5.1 The tenderer shall bear all costs associated with the preparation and submission of his/her tender, and the Procuring Entity will in no case be responsible or liable for those costs.

5.2 The tenderer, at the tenderer's own responsibility and risk, is encouraged to visit and examine the Site of the 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.

5.3 The Tenderer and any of its personnel or agents will be granted permission by the Procuring Entity to enter upon its premises and lands for the purpose of such visit. The Tenderer shall indemnify the Procuring Entity against all liability arising from death or personal injury, loss of or damage to property, and any other losses and expenses incurred as a result of the inspection.

5.4 The tenderer shall provide in the Form of Tender and Qualification Information, a preliminary description of the proposed work method and schedule, including charts, as necessary or required.

B Contents of Tender Documents

6 Sections of Tender Document

6.1 The tender document consists of Parts 1, 2, and 3, which includes all the sections specified below, and which should be read in conjunction with any Addenda issued in accordance with ITT 8.

PART 1 Tendering Procedures
i) Section I - Instructions to Tenderers (ITT)
ii) Section II - Tender Data Sheet (TDS)
iii) Section III - Evaluation and Qualification Criteria
iv) Section IV - Tendering Forms

PART 2 Works Requirements
i) Section V - Drawings
ii) Section VI - Specifications
iii) Section VII - Bills of Quantities

PART 3 Conditions of Contract and Contract Forms
i) Section VIII - General Conditions of Contract (GCC)
ii) Section IX - Special Conditions of Contract (SC)
iii) Section X - Contract Forms

6.2 The Invitation to Tender Document (ITT) issued by the Procuring Entity is not part of the Contract documents.

6.3 Unless obtained directly from the Procuring Entity, the Procuring Entity is not responsible for the completeness of the Tender document, responses to requests for clarification, the minutes of the pre-Tender meeting (if any), or Addenda to the Tender document in accordance with ITT 8. In case of any contradiction, documents obtained directly from the Procuring Entity shall prevail.

The Tenderer is expected to examine all instructions, forms, terms, and specifications in the Tender Document and to furnish with its Tender all information and documentation as is required by the Tender document.

7 Site Visit

7.1 The Tenderer, at the Tenderer's own responsibility and risk, is encouraged to visit and examine and inspect the Site of the Required Services and its surroundings and obtain all information that may be necessary for preparing the Tender and entering into a contract for the Services. The costs of visiting the Site shall be at the Tenderer's own expense.

8 Pre-Tender Meeting

8.1 The Procuring Entity shall specify in the TDS if a pre-tender meeting will be held, when and where. The Procuring Entity shall also specify in the TDS if a pre-arranged

pretender site visit will be held and when. The Tenderer's designated representative is invited to attend a pre-arranged pretender visit of the site of the works. The purpose of the meeting will be to clarify issues and to answer questions on any matter that may be raised at that stage.

8.2 The Tenderer is requested to submit any questions in writing, to reach the Procuring Entity not later than the period specified in the TDS before the meeting.

8.3 Minutes of the pre-Tender meeting and the pre-arranged pretender site visit of the site of the works, if applicable, including the text of the questions asked by Tenderers and the responses given, together with any responses prepared after the meeting, will be transmitted promptly to all Tenderers who have acquired the Tender Documents in accordance with ITT 6.3. Minutes shall not identify the source of the questions asked.

The Procuring Entity shall also promptly publish anonym zed (no names) Minutes of the pre-Tender meeting and the pre-arranged pretender visit of the site of the works at the web page identified in the TDS. Any modification to the Tender Documents that may become necessary as a result of the pre-tender meeting and the pre-arranged pretender site visit, shall be made by the Procuring Entity exclusively through the issue of an Addendum pursuant to ITT 8 and not through the minutes of the pre-Tender meeting. Nonattendance at the pre-Tender meeting will not be a cause for disqualification of a Tenderer.

9 Clari**fi**cation and amendments of Tender Documents

9.1 A Tenderer requiring any clarification of the Tender Document shall contact the Procuring Entity in writing at the Procuring Entity's address specified in the TDS or raise its enquiries during the pre-Tender meeting and the pre- arranged pretender visit of the site of the works if provided for in accordance with ITT 8.4. The Procuring Entity will respond in writing to any request for clarification, provided that such request is received no later than the period specified in the TDS prior to the deadline for submission of tenders. The Procuring Entity shall forward copies of its response to all tenderers who have acquired the Tender Documents in accordance with ITT 6.3, including a description of the inquiry but without identifying its source. If specified in the TDS, the Procuring Entity shall also promptly publish its response at the web page identified in the TDS. Should the clarification result in changes to the essential elements of the Tender Documents, the Procuring Entity shall amend the Tender Documents appropriately following the procedure under ITT 8.4.

10 Amendment of Tendering Document

10.1 At any time prior to the deadline for submission of Tenders, the Procuring Entity may amend the Tendering document by issuing addenda.

10.2 Any addendum issued shall be part of the tendering document and shall be communicated in writing to all who have obtained the tendering document from the Procuring Entity in accordance with ITT 6.3. The Procuring Entity shall also promptly publish the addendum on the Procuring Entity's web page in accordance with ITT 8.4.

10.3 To give prospective Tenderers reasonable time in which to take an addendum into account in preparing their Tenders, the Procuring Entity shall extend, as necessary, the deadline for submission of Tenders, in accordance with ITT 25.2 below.

C Preparation of Tenders

11 Cost of Tendering

11.1 The Tenderer shall bear all costs associated with the preparation and submission of its Tender, and the Procuring Entity shall not be responsible or liable for those costs, regardless of the conduct or outcome of the tendering process.

12 Language of Tender

12.1 The Tender, as well as all correspondence and documents relating to the tender exchanged by the tenderer and the Procuring Entity, shall be written in the English Language. Supporting documents and printed literature that are part of the Tender may be in another language provided they are accompanied by an accurate and notarized translation of the relevant passages into the English Language, in which case, for purposes of interpretation of the Tender, such translation shall govern.

13 Documents Comprising the Tender

13.1 The Tender shall comprise the following:

a) Form of Tender prepared in accordance with ITT 14;
b) Schedules including priced Bill of Quantities, completed in accordance with ITT 14 and ITT 16;
c) Tender Security or Tender-Securing Declaration, in accordance with ITT 21.1;
d) Alternative Tender, if permissible, in accordance with ITT 15;
e) Authorization: written confirmation authorizing the signatory of the Tender to commit the Tenderer, in accordance with ITT 22.3;
f) Qualifications: documentary evidence in accordance with ITT 19establishing the Tenderer's qualifications to perform the Contract if its Tender is accepted;
g) Conformity: a technical proposal in accordance with ITT 18;
h) Any other document required in the TDS.

13.2 In addition to the requirements under ITT 11.1, Tenders submitted by a JV shall include a copy of the Joint Venture Agreement entered into by all members. Alternatively, a letter of intent to execute a Joint Venture Agreement in the event of a successful Tender shall be signed by all members and submitted with the Tender, together with a copy of the proposed Agreement. The Tenderer shall chronologically serialize pages of all tender documents submitted.

13.1 The Tenderer shall furnish in the Form of Tender information on commissions and gratuities, if any, paid or to be paid to agents or any other party relating to this Tender.

14 Form of Tender and Schedules

14.1 The Form of Tender and Schedules, including the Bill of Quantities, shall be prepared using the relevant forms furnished in Section IV, Tendering Forms. The forms must be completed without any alterations to the text, and no substitutes shall be accepted except as provided under ITT 20.3. All blank spaces shall be filled in with the information requested.

15 Alternative Tenders

15.1 Unless otherwise specified in the TDS, alternative Tenders shall not be considered.

15.2 When alternative times for completion are explicitly invited, a statement to that effect will be included in the TDS, and the method of evaluating different alternative times for completion will be described in Section III, Evaluation and Qualification Criteria.

15.3 Except as provided under ITT 13.4 below, Tenderers wishing to offer technical alternatives to the requirements of the Tender Documents must first price the Procuring Entity's design as described in the Tender Documents and shall further provide all information necessary for a complete evaluation of the alternative by the Procuring Entity, including drawings, design calculations, technical specifications, breakdown of prices, and proposed construction methodology and other relevant details. Only the technical alternatives, if any, of the Tenderer with the Winning Tender conforming to the basic technical requirements shall be considered by the Procuring Entity. When specified in the TDS, Tenderers are permitted to submit alternative technical solutions for specified parts of the Works, and such parts will be identified in the TDS, as will the method for their evaluating, and described in Section VII, Works' Requirements.

16 Tender Prices and Discounts

16.1 The prices and discounts (including any price reduction) quoted by the Tenderer in the Form of Tender and in the Bill of Quantities shall conform to the requirements specified below.

16.2 The Tenderer shall fill in rates and prices for all items of the Works described in the Bill of Quantities. Items against which no rate or price is entered by the Tenderer shall be deemed covered by the rates for other items in the Bill of Quantities and will not be paid for separately by the Procuring Entity. An item not listed in the priced Bill of Quantities shall be assumed to be not included in the Tender, and provided that the Tender is determined substantially responsive notwithstanding this omission, the average price of the item quoted by substantially responsive Tenderers will be added to the Tender price and the equivalent total cost of the Tender so determined will be used for price comparison.

16.3 The price to be quoted in the Form of Tender, in accordance with ITT 14.1, shall be the total price of the Tender, including any discounts offered.

16.4 The Tenderer shall quote any discounts and the methodology for their application in the Form of Tender, in accordance with ITT 14.1.

16.5 It will be specified in the TDS if the rates and prices quoted by the Tenderer are or are not subject to adjustment during the performance of the Contract in accordance with the provisions of the Conditions of Contract, except in cases where the contract is

subject to fluctuations and adjustments, not fixed price. In such a case, the Tenderer shall furnish the indices and weightings for the price adjustment formulae in the Schedule of Adjustment Data and the Procuring Entity may require the Tenderer to justify its proposed indices and weightings.

16.6 Where tenders are being invited for individual lots (contracts)or for any combination of lots (packages), tenderers wishing to offer discounts for the award of more than one Contract shall specify in their Tender the price reductions applicable to each package, or alternatively, to individual Contracts within the package. Discounts shall be

submitted in accordance with ITT 16.4, provided the Tenders for all lots (contracts) are opened at the same time.

16.7 All duties, taxes, and other levies payable by the Contractor under the Contract, or for any other cause, as of the date 30 days prior to the deadline for submission of Tenders, shall be included in the rates and prices and the total Tender Price submitted by the Tenderer.

17 Currencies of Tender and Payment

17.1 Tenderers shall quote entirely in Kenya Shillings. The unit rates and the prices shall be quoted by the Tenderer in the Bill of Quantities, entirely in Kenya shillings. A Tenderer expecting to incur expenditures in other currencies for inputs to the Works supplied from outside Kenya shall device own ways of getting foreign currency to meet those expenditures.

18 Documents Comprising the Technical Proposal

18.1 The Tenderer shall furnish a technical proposal including a statement of work methods, equipment, personnel, schedule and any other information as stipulated in Section IV, Tender Forms, in sufficient detail to demonstrate the adequacy of the Tenderer's proposal to meet the work's requirements and the completion time.

19 Documents Establishing the Eligibility and Qualifications of the Tenderer

19.1 Tenderers shall complete the Form of Tender, included in Section IV, Tender Forms, to establish Tenderer's eligibility in accordance with ITT 4.

19.2 In accordance with Section III, Evaluation and Qualification Criteria, to establish its qualifications to perform the Contract the Tenderer shall provide the information requested in the corresponding information sheets included in Section IV, Tender Forms.

19.3 A margin of preference will not be allowed. Preference and reservations will be allowed, individually or in joint ventures. Applying for eligibility for Preference and reservations shall supply all information required to satisfy the criteria for eligibility specified in accordance with ITT 33.1.

19.4 Tenderers shall be asked to provide, as part of the data for qualification, such information, including details of ownership, as shall be required to determine whether, according to the classification established by the Procuring Entity, a contractor or group of contractors qualifies for a margin of preference. Further the information will enable the Procuring Entity identify any actual or potential conflict of interest in relation to the procurement and/or contract management processes, or a possibility of collusion between tenderers, and thereby help to prevent any corrupt influence in relation to the procurement process or contract management.

19.5 The purpose of the information described in ITT 19.4 above overrides any claims to confidentiality which a tenderer may have. There can be no circumstances in which it would be justified for a tenderer to keep information relating to its ownership and control confidential where it is tendering to undertake public sector work and receive public sector funds. Thus, confidentiality will not be accepted by the Procuring Entity

as a justification for a Tenderer's failure to disclose, or failure to provide required information on its ownership and control.

19.6 The Tenderer shall provide further documentary proof, information or authorizations that the Procuring Entity may request in relation to ownership and control which information on any changes to the information which was provided by the tenderer under ITT 6.3. The obligations to require this information shall continue for the duration of the procurement process and contract performance and after completion of the contract, if any change to the information previously provided may reveal a conflict of interest in relation to the award or management of the contract.

19.7 All information provided by the tenderer pursuant to these requirements must be complete, current and accurate as at the date of provision to the Procuring Entity. In submitting the information required pursuant to these requirements, the Tenderer shall warrant that the information submitted is complete, current and accurate as at the date of submission to the Procuring Entity.

19.8 If a tenderer fails to submit the information required by these requirements, its tender will be rejected. Similarly, if the Procuring Entity is unable, after taking reasonable steps, to verify to a reasonable degree the information submitted by a tenderer pursuant to these requirements, then the tender will be rejected.

19.9 If information submitted by a tenderer pursuant to these requirements, or obtained by the Procuring Entity (whether through its own enquiries, through notification by the public or otherwise), shows any conflict of interest which could materially and improperly benefit the tenderer in relation to the procurement or contract management process, then:

i) if the procurement process is still ongoing, the tenderer will be disqualified from the procurement process,
ii) if the contract has been awarded to that tenderer, the contract award will be set aside,
iii) the tenderer will be referred to the relevant law enforcement authorities for investigation of whether the tenderer or any other persons have committed any criminal offence.

19.10 If a tenderer submits information pursuant to these requirements that is incomplete, inaccurate or out-of-date, or attempts to obstruct the verification process, then the consequences ITT 6.7 will ensue unless the tenderer can show to the reasonable satisfaction of the Procuring Entity that any such act was not material, or was due to genuine error which was not attributable to the intentional act, negligence or recklessness of the tenderer.

20 Period of Validity of Tenders

20.1 Tenders shall remain valid for the Tender Validity period specified in the TDS. The Tender Validity period starts from the date fixed for the Tender submission deadline (as prescribed by the Procuring Entity in accordance with ITT 24). A Tender valid for a shorter period shall be rejected by the Procuring Entity as non-responsive.

20.2 In exceptional circumstances, prior to the expiration of the Tender validity period, the Procuring Entity may request Tenderers to extend the period of validity of their Tenders. The request and the responses shall be made in writing. If a Tender Security is requested

in accordance with ITT 21.1, it shall also be extended for thirty (30) days beyond the deadline of the extended validity period. A Tenderer may refuse the request without forfeiting its Tender security. A Tenderer granting the request shall not be required or permitted to modify its Tender, except as provided in ITT 20.3.

20.3 If the award is delayed by a period exceeding the number of days to be specified in the TDS days beyond the expiry of the initial tender validity period, the Contract price shall be determined as follows:

a) in the case of **fi**xed price contracts, the Contract price shall be the tender price adjusted by the factor specified in the TDS;
b) in the case of adjustable price contracts, no adjustment shall be made; or in any case, tender evaluation shall be based on the tender price without taking into consideration the applicable correction from those indicated above.

21 Tender Security

21.1 The Tenderer shall furnish as part of its Tender, either a Tender-Securing Declaration or a Tender Security as specified in the TDS, in original form and, in the case of a Tender Security, in the amount and currency specified in the TDS. A Tender-Securing Declaration shall use the form included in Section IV, Tender Forms.

21.2 If a Tender Security is specified pursuant to ITT 19.1, the Tender Security shall be a demand guarantee in any of the following forms at the Tenderer's option:

a) an unconditional Bank Guarantee issued by reputable commercial bank); or
b) an irrevocable letter of credit;
c) a Banker's cheque issued by a reputable commercial bank; or
d) another security specified in the TDS,

21.3 If an unconditional bank guarantee is issued by a bank located outside Kenya, the issuing bank shall have a correspondent bank located in Kenya to make it enforceable. The Tender Security shall be valid for thirty (30) days beyond the original validity period of the Tender, or beyond any period of extension if requested under ITT 20.2.

21.4 If a Tender Security or Tender-Securing Declaration is specified pursuant to ITT 19.1, any Tender not accompanied by a substantially responsive Tender Security or Tender-Securing Declaration shall be rejected by the Procuring Entity as non-responsive.

21.5 If a Tender Security is specified pursuant to ITT 21.1, the Tender Security of unsuccessful Tenderers shall be returned as promptly as possible upon the successful Tenderer's signing the Contract and furnishing the Performance Security and any other documents required in the TDS. The Procuring Entity shall also promptly return the tender security to the tenderers where the procurement proceedings are terminated, all tenders were determined nonresponsive or a bidder declines to extend tender validity period.

21.6 The Tender Security of the successful Tenderer shall be returned as promptly as possible once the successful Tenderer has signed the Contract and furnished the required Performance Security, and any other documents required in the TDS.

21.7 The Tender Security may be forfeited or the Tender-Securing Declaration executed:

e) if a Tenderer withdraws its Tender during the period of Tender validity specified by the Tenderer on the Form of Tender, or any extension thereto provided by the Tenderer; or
f) if the successful Tenderer fails to:
   i) sign the Contract in accordance with ITT 50; or
   ii) furnish a Performance Security and if required in the TDS, and any other documents required in the TDS.

21.8 Where tender securing declaration is executed, the Procuring Entity shall recommend to the PPRA that PPRA debars the Tenderer from participating in public procurement as provided in the law.

21.9 The Tender Security or the Tender-Securing Declaration of a JV shall be in the name of the JV that submits the Tender. If the JV has not been legally constituted into a legally enforceable JV at the time of tendering, the Tender Security or the Tender-Securing Declaration shall be in the names of all future members as named in the letter of intent referred to in ITT 4.1 and ITT 11.2.

21.10 A tenderer shall not issue a tender security to guarantee itself.

22 Format and Signing of Tender

22.1 The Tenderer shall prepare one original of the documents comprising the Tender as described in ITT 13 and clearly mark it "ORIGINAL." Alternative Tenders, if permitted in accordance with ITT 15, shall be clearly marked "ALTERNATIVE." In addition, the Tenderer shall submit copies of the Tender, in the number specified in the TDS and clearly mark them "COPY." In the event of any discrepancy between the original and the copies, the original shall prevail.

22.2 Tenderers shall mark as "CONFIDENTIAL" all information in their Tenders which is confidential to their business. This may include proprietary information, trade secrets, or commercial or financially sensitive information.

22.3 The original and all copies of the Tender shall be typed or written in indelible ink and shall be signed by a person duly authorized to sign on behalf of the Tenderer. This authorization shall consist of a written confirmation as specified in the TDS 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 where entries or amendments have been made shall be signed or initialed by the person signing the Tender.

22.4 In case the Tenderer is a JV, the Tender shall be signed by an authorized representative of the JV on behalf of the JV, and to be legally binding on all the members as evidenced by a power of attorney signed by their legally authorized representatives.

22.5 Any inter-lineation, erasures, or overwriting shall be valid only if they are signed or initialed by the person signing the Tender.

D Submission and Opening of Tenders

23 Sealing and Marking of Tenders

23.1 Depending on the sizes or quantities or weight of the tender documents, a tenderer may use an envelope, package or container. The Tenderer shall deliver the Tender in a single sealed envelope, or in a single sealed package, or in a single sealed container bearing the name and Reference number of the Tender, addressed to the Procuring Entity and a warning not to open before the time and date for Tender opening date. Within the single envelope, package or container, the Tenderer shall place the following separate, sealed envelopes:

a) in an envelope or package or container marked "ORIGINAL", all documents comprising the Tender, as described in ITT 11; and
b) in an envelope or package or container marked "COPIES", all required copies of the Tender; and
c) if alternative Tenders are permitted in accordance with ITT 15, and if relevant:
   i) in an envelope or package or container marked "ORIGINAL – ALTERNATIVE TENDER", the alternative Tender; and
   ii) in the envelope or package or container marked "COPIES- ALTERNATIVE TENDER", all required copies of the alternative Tender.

The inner envelopes or packages or containers shall:

a) bear the name and address of the Procuring Entity.
b) bear the name and address of the Tenderer; and
c) bear the name and Reference number of the Tender.

23.2 If an envelope or package or container is not sealed and marked as required, the Procuring Entity will assume no responsibility for the misplacement or premature opening of the Tender. Tenders that are misplaced or opened prematurely will not be accepted.

24 Deadline for Submission of Tenders

24.1 Tenders must be received by the Procuring Entity at the address specified in the TDS and no later than the date and time also specified in the TDS. When so specified in the TDS, Tenderers shall have the option of submitting their Tenders electronically. Tenderers submitting Tenders electronically shall follow the electronic Tender submission procedures specified in the TDS.

24.2 The Procuring Entity may, at its discretion, extend the deadline for the submission of Tenders by amending the Tender Documents in accordance with ITT 8, in which case all rights and obligations of the Procuring Entity and Tenderers previously subject to the deadline shall thereafter be subject to the deadline as extended.

25 Late Tenders

25.1 The Procuring Entity shall not consider any Tender that arrives after the deadline for submission of tenders, in accordance with ITT 24. 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.

26 Withdrawal, Substitution, and Modification of Tenders

26.1 A Tenderer may withdraw, substitute, or modify its Tender after it has been submitted by sending a written notice, duly signed by an authorized representative, and shall include a copy of the authorization in accordance with ITT 22.3, (except that withdrawal notices do not require copies). The corresponding substitution or

modification of the Tender must accompany the respective written notice. All notices must be:

a) prepared and submitted in accordance with ITT 22 and ITT 23 (except that withdrawals notices do not require copies), and in addition, the respective envelopes shall be clearly marked "WITHDRAWAL," "SUBSTITUTION," "MODIFICATION;" and

b) received by the Procuring Entity prior to the deadline prescribed for submission of Tenders, in accordance with ITT 24.

26.2 Tenders requested to be withdrawn in accordance with ITT 26.1 shall be returned unopened to the Tenderers.

26.3 No Tender may be withdrawn, substituted, 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 Form of Tender or any extension thereof.

27 Tender Opening

27.1 Except in the cases specified in ITT 23 and ITT 26.2, the Procuring Entity shall publicly open and read out all Tenders received by the deadline, at the date, time and place specified in the TDS, in the presence of Tenderers' designated representatives who chooses to attend. Any specific electronic Tender opening procedures required if electronic Tendering is permitted in accordance with ITT 24.1, shall be as specified in the TDS.

27.2 First, envelopes marked "WITHDRAWAL" shall be opened and read out and the envelopes with the corresponding Tender shall not be opened, but returned to the Tenderer. No Tender withdrawal shall be permitted unless the corresponding withdrawal notice contains a valid authorization to request the withdrawal and is read out at Tender opening.

27.3 Next, envelopes marked "SUBSTITUTION" shall be opened and read out and exchanged with the corresponding Tender being substituted, and the substituted Tender shall not be opened, but returned to the Tenderer. No Tender substitution shall be permitted unless the corresponding substitution notice contains a valid authorization to request the substitution and is read out at Tender opening.

27.4 Next, envelopes marked "MODIFICATION" shall be opened and read out with the corresponding Tender. No Tender modification shall be permitted unless the corresponding modification notice contains a valid authorization to request the modification and is read out at Tender opening.

27.5 Next, all remaining envelopes shall be opened one at a time, reading out: the name of the Tenderer and whether there is a modification; the total Tender Price, per lot (contract) if applicable, including any discounts and alternative Tenders; the presence or absence of a Tender Security or Tender-Securing Declaration, if required; and any other details as the Procuring Entity may consider appropriate.

27.6 Only Tenders, alternative Tenders and discounts that are opened and read out at Tender opening shall be considered further for evaluation. The Form of Tender and pages of the Bills of Quantities are to be initialed by the members of the tender opening committee attending the opening. The number of representatives of the Procuring Entity to sign shall be specified in the TDS.

27.7 At the Tender Opening, the Procuring Entity shall neither discuss the merits of any Tender nor reject any Tender (except for late Tenders, in accordance with ITT 25.1).

27.8 The Procuring Entity shall prepare minutes of the Tender Opening that shall include, as a minimum:

a) the name of the Tenderer and whether there is a withdrawal, substitution, or modification;
b) the Tender Price, per lot (contract) if applicable, including any discounts;
c) any alternative Tenders;
d) the presence or absence of a Tender Security, if one was required.
e) number of pages of each tender document submitted.

27.9 The Tenderers' representatives who are present shall be requested to sign the minutes. The omission of a Tenderer's signature on the minutes shall not invalidate the contents and effect of the minutes. A copy of the tender opening register shall be distributed to all Tenderers upon request.

E Evaluation and Comparison of Tenders

28 Con**fi**dentiality

28.1 Information relating to the evaluation of Tenders and recommendation of contract award shall not be disclosed to Tenderers or any other persons not officially concerned with the Tender process until information on Intention to Award the Contract is transmitted to all Tenderers in accordance with ITT 46.

28.2 Any effort by a Tenderer to influence the Procuring Entity in the evaluation of the Tenders or Contract award decisions may result in the rejection of its tender.

28.3 Notwithstanding ITT 28.2, from the time of tender opening to the time of contract award, if a tenderer wishes to contact the Procuring Entity on any matter related to the tendering process, it shall do so in writing.

29 Clarification of Tenders

29.1 To assist in the examination, evaluation, and comparison of the tenders, and qualification of the tenderers, the Procuring Entity may, at its discretion, ask any tenderer for a clarification of its tender, given a reasonable time for a response. Any clarification submitted by a tenderer that is not in response to a request by the Procuring Entity shall not be considered. The Procuring Entity's request for clarification and the response shall be in writing. No change, including any voluntary increase or decrease, 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 the tenders, in accordance with ITT 33.

29.2 If a tenderer does not provide clarifications of its tender by the date and time set in the Procuring Entity's request for clarification, its Tender may be rejected.

30 Deviations, Reservations, and Omissions

30.1 During the evaluation of tenders, the following definitions apply:

a) "Deviation" is a departure from the requirements specified in the tender document;
b) "Reservation" is the setting of limiting conditions or withholding from complete acceptance of the requirements specified in the tender document; and
c) "Omission" is the failure to submit part or all of the information or documentation required in the Tender document.

31 Determination of Responsiveness

31.1 The Procuring Entity's determination of a Tender's responsiveness is to be based on the contents of the tender itself, as defined in ITT 13.

31.2 A substantially responsive Tender is one that meets the requirements of the Tender document without material deviation, reservation, or omission. A material deviation, reservation, or omission is one that, if accepted, would:

a) affect in any substantial way the scope, quality, or performance of the Works specified in the Contract; or
b) limit in any substantial way, inconsistent with the tender document, the Procuring Entity's rights or the tenderer's obligations under the proposed contract; or
c) if rectified, would unfairly affect the competitive position of other tenderers

presenting substantially responsive tenders.

31.3 The Procuring Entity shall examine the technical aspects of the tender submitted in accordance with ITT 18, to confirm that all requirements of Section VII, Works' Requirements have been met without any material deviation, reservation or omission.

31.4 If a tender is not substantially responsive to the requirements of the tender document, it shall be rejected by the Procuring Entity and may not subsequently be made responsive by correction of the material deviation, reservation, or omission.

32 Non-material Non-conformities

32.1 Provided that a tender is substantially responsive, the Procuring Entity may waive any non-conformity in the tender.

32.2 Provided that a Tender is substantially responsive, the Procuring Entity may request that the tenderer submit the necessary information or documentation, within a reasonable period, to rectify nonmaterial non-conformities in the tender related to documentation requirements. Requesting information or documentation on such non-conformities shall not be related to any aspect of the price of the tender. Failure of the tenderer to comply with the request may result in the rejection of its tender.

32.3 Provided that a tender is substantially responsive, the Procuring Entity shall rectify quantifiable nonmaterial non-conformities related to the Tender Price. To this effect, the Tender Price shall be adjusted, for comparison purposes only, to reflect the price of a missing or non-conforming item or component in the manner specified in the TDS.

33 Arithmetical Errors

33.1 The tender sum as submitted and read out during the tender opening shall be absolute and final and shall not be the subject of correction, adjustment or amendment in any way by any person or entity.

33.2 Provided that the Tender is substantially responsive, the Procuring Entity shall handle errors on the following basis:

a) Any error detected if considered a major deviation that affects the substance of the tender, shall lead to disqualification of the tender as non-responsive.
b) Any errors in the submitted tender arising from a miscalculation of unit price, quantity, and subtotal and total bid price shall be considered as a major deviation that affects the substance of the tender and shall lead to disqualification of the tender as non-responsive. and
c) if there is a discrepancy between words and figures, the amount in words shall prevail

33.3 Tenderers shall be notified of any error detected in their bid during the notification of a ward.

34 Currency provisions

34.1 Tenders will priced be in Kenya Shillings only. Tenderers quoting in currencies other than in Kenya shillings will be determined non-responsive and rejected.

35 Margin of Preference and Reservations

35.1 No margin of preference shall be allowed on contracts for small works.

35.2 Where it is intended to reserve the contract to specific groups under Small and Medium Enterprises, or enterprise of women who are appropriately registered as such by the authority to be specified in the TDS, a procuring entity shall ensure that the invitation to tender specifically indicates that only businesses/firms belonging to those specified groups are the only ones eligible to tender. Otherwise if no so stated, the invitation will be open to all tenderers.

36 Nominated Subcontractors

36.1 Unless otherwise stated in the TDS, the Procuring Entity does not intend to execute any specific elements of the Works by subcontractors selected in advance by the Procuring Entity.

36.2 Tenderers may propose subcontracting up to the percentage of total value of contracts or the volume of works as specified in the TDS. Subcontractors proposed by the Tenderer shall be fully qualified for their parts of the Works.

36.3 The subcontractor's qualifications shall not be used by the Tenderer to qualify for the Works unless their specialized parts of the Works were previously designated by the Procuring Entity in the TDS as can be met by subcontractors referred to hereafter as 'Specialized Subcontractors', in which case, the qualifications of the Specialized Subcontractors proposed by the Tenderer may be added to the qualifications of the Tenderer.

37 Evaluation of Tenders

37.1 The Procuring Entity shall use the criteria and methodologies listed in this ITT and Section III, Evaluation and Qualification Criteria. No other evaluation criteria or methodologies shall be permitted. By applying the criteria and methodologies the Procuring Entity shall determine the Best Evaluated Tender in accordance with ITT 40.

37.2 To evaluate a Tender, the Procuring Entity shall consider the following:

a) price adjustment due to discounts offered in accordance with ITT 16;
b) converting the amount resulting from applying (a) and (b) above, if relevant, to a single currency in accordance with ITT 39;
c) price adjustment due to quantifiable nonmaterial non-conformities in accordance with ITT 30.3; and
d) any additional evaluation factors specified in the TDS and Section III, Evaluation and Qualification Criteria.

37.3 The estimated effect of the price adjustment provisions of the Conditions of Contract, applied over the period of execution of the Contract, shall not be considered in Tender evaluation.

37.4 In the case of multiple contracts or lots, Tenderers shall be allowed to tender for one or more lots and the methodology to determine the lowest evaluated cost of the lot (contract) combinations, including any discounts offered in the Form of Tender, is specified in Section III, Evaluation and Qualification Criteria.

38 Comparison of Tenders

38.1 The Procuring Entity shall compare the evaluated costs of all substantially responsive Tenders established in accordance with ITT 38.2 to determine the Tender that has the lowest evaluated cost.

39 Abnormally Low Tenders

39.1 An Abnormally Low Tender is one where the Tender price, in combination with other elements of the Tender, appears so low that it raises material concerns as to the capability of the Tenderer in regards to the Tenderer's ability to perform the Contract for the offered Tender Price or that genuine competition between Tenderers is compromised.

39.2 In the event of identification of a potentially Abnormally Low Tender, the Procuring Entity shall seek written clarifications from the Tenderer, including detailed price analyses of its Tender price in relation to the subject matter of the contract, scope, proposed methodology, schedule, allocation of risks and responsibilities and any other requirements of the Tender document.

39.3 After evaluation of the price analyses, in the event that the Procuring Entity determines that the Tenderer has failed to demonstrate its capability to perform the Contract for the offered Tender Price, the Procuring Entity shall reject the Tender.

40 Abnormally High Tenders

40.1 An abnormally high price is one where the tender price, in combination with other constituent elements of the Tender, appears unreasonably too high to the extent that

the Procuring Entity is concerned that it (the Procuring Entity) may not be getting value for money or it may be paying too high a price for the contract compared with market prices or that genuine competition between Tenderers is compromised.

40.2 In case of an abnormally high tender price, the Procuring Entity shall make a survey of the market prices, check if the estimated cost of the contract is correct and review the Tender Documents to check if the specifications, scope of work and conditions of contract are contributory to the abnormally high tenders. The Procuring Entity may also seek written clarification from the tenderer on the reason for the high tender price. The Procuring Entity shall proceed as follows:

i) If the tender price is abnormally high based on wrong estimated cost of the contract, the Procuring Entity may accept or not accept the tender depending on the Procuring Entity's budget considerations.

ii) If specifications, scope of work and/or conditions of contract are contributory to the abnormally high tender prices, the Procuring Entity shall reject all tenders and may retender for the contract based on revised estimates, specifications, scope of work and conditions of contract, as the case may be.

40.3 If the Procuring Entity determines that the Tender Price is abnormally too high because genuine competition between tenderers is compromised (often due to collusion, corruption or other manipulations), the Procuring Entity shall reject all Tenders and shall institute or cause competent Government Agencies to institute an investigation on the cause of the compromise, before retendering.

41 Unbalanced and/or Front-Loaded Tenders

41.1 If in the Procuring Entity's opinion, the Tender that is evaluated as the lowest evaluated price is seriously unbalanced and/or front loaded, the Procuring Entity may require the Tenderer to provide written clarifications. Clarifications may include detailed price analyses to demonstrate the consistency of the tender prices with the scope of works, proposed methodology, schedule and any other requirements of the Tender document.

41.2 After the evaluation of the information and detailed price analyses presented by the Tenderer, the Procuring Entity may as appropriate:

a) accept the Tender; or

b) require that the total amount of the Performance Security be increased at the expense of the Tenderer to a level not exceeding a 30% of the Contract Price; or

c) agree on a payment mode that eliminates the inherent risk of the Procuring Entity paying too much for undelivered works; or

d) reject the Tender,

42 Qualifications of the Tenderer

42.1 The Procuring Entity shall determine to its satisfaction whether the eligible Tenderer that is selected as having submitted the lowest evaluated cost and substantially responsive Tender, meets the qualifying criteria specified in Section III, Evaluation and Qualification Criteria.

42.2 The determination shall be based upon an examination of the documentary evidence of the Tenderer's qualifications submitted by the Tenderer, pursuant to ITT 19. The determination shall not take into consideration the qualifications of other firms such as the Tenderer's subsidiaries, parent entities, affiliates, subcontractors (other than

Specialized Subcontractors if permitted in the Tender document), or any other firm(s) different from the Tenderer.

42.3 An affirmative determination shall be a prerequisite for award of the Contract to the Tenderer. A negative determination shall result in disqualification of the Tender, in which event the Procuring Entity shall proceed to the Tenderer who offers a substantially responsive Tender with the next lowest evaluated price to make a similar determination of that Tenderer's qualifications to perform satisfactorily.

42.4 An Abnormally Low Tender is one where the Tender price, in combination with other elements of the Tender, appears so low that it raises material concerns as to the capability of the Tenderer in regards to the Tenderer's ability to perform the Contract for the offered Tender Price.

42.5 In the event of identification of a potentially Abnormally Low Tender, the Procuring Entity shall seek written clarifications from the Tenderer, including detailed price analyses of its Tender price in relation to the subject matter of the contract, scope, proposed methodology, schedule, allocation of risks and responsibilities and any other requirements of the Tender document.

42.6 After evaluation of the price analyses, if the Procuring Entity determines that the Tenderer has failed to demonstrate its capability to perform the Contract for the offered Tender Price, the Procuring Entity shall reject the Tender.

43 Best Evaluated Tender

43.1 Having compared the evaluated prices of Tenders, the Procuring Entity shall determine the Best Evaluated Tender. The Best Evaluated Tender is the Tender of the Tenderer that meets the Qualification Criteria and whose Tender has been determined to be:

a) Most responsive to the Tender document; and
b) the lowest evaluated price.

44 Procuring Entity's Right to Accept Any Tender, and to Reject Any or All Tenders.

44.1 The Procuring Entity reserves the right to accept or reject any Tender and to annul the Tender process and reject all Tenders at any time prior to Contract Award, without thereby incurring any liability to Tenderers. In case of annulment, all Tenderers shall be notified with reasons and all Tenders submitted and specifically, Tender securities, shall be promptly returned to the Tenderers.

F Award of Contract

45 Award Criteria

45.1 The Procuring Entity shall award the Contract to the successful tenderer whose tender has been determined to be the Lowest Evaluated Tender.

46 Notice of Intention to enter into a Contract

46.1 Upon award of the contract and Prior to the expiry of the Tender Validity Period the Procuring Entity shall issue a Notification of Intention to Enter into a Contract / Notification of award to all tenderers which shall contain, at a minimum, the following information:

a) the name and address of the Tenderer submitting the successful tender;
b) the Contract price of the successful tender;
c) a statement of the reason(s) the tender of the unsuccessful tenderer to whom the letter is addressed was unsuccessful, unless the price information in (c) above already reveals the reason;
d) the expiry date of the Standstill Period; and
e) instructions on how to request a debriefing and/or submit a complaint during the standstill period;

47 Standstill Period

47.1 The Contract shall not be signed earlier than the expiry of a Standstill Period of 14 days to allow any dissatisfied tender to launch a complaint. Where only one Tender is submitted, the Standstill Period shall not apply.

47.2 Where a Standstill Period applies, it shall commence when the Procuring Entity has transmitted to each Tenderer the Notification of Intention to Enter into a Contract with the successful Tenderer.

48 Debrie**fi**ng by the Procuring Entity

48.1 On receipt of the Procuring Entity's Notification of Intention to Enter into a Contract referred to in ITT 46, an unsuccessful tenderer may make a written request to the Procuring Entity for a debriefing on specific issues or concerns regarding their tender. The Procuring Entity shall provide the debriefing within five days of receipt of the request.

48.2 Debriefings of unsuccessful Tenderers may be done in writing or verbally. The Tenderer shall bear its own costs of attending such a debrie**fi**ng meeting.

49 Letter of Award

49.1 Prior to the expiry of the Tender Validity Period and upon expiry of the Standstill Period specified in ITT 42.1, upon addressing a complaint that has been filed within the Standstill Period, the Procuring Entity shall transmit the Letter of Award to the successful Tenderer. The letter of award shall request the successful tenderer to furnish the Performance Security within 21days of the date of the letter.

50 Signing of Contract

50.1 Upon the expiry of the fourteen days of the Notification of Intention to enter into contract and upon the parties meeting their respective statutory requirements, the Procuring Entity shall send the successful Tenderer the Contract Agreement.

50.2 Within fourteen (14) days of receipt of the Contract Agreement, the successful Tenderer shall sign, date, and return it to the Procuring Entity.

50.3 The written contract shall be entered into within the period specified in the notification of award and before expiry of the tender validity period

51 Appointment of Adjudicator

51.1 The Procuring Entity proposes the person named in the TDS to be appointed as Adjudicator under the Contract, at the hourly fee specified in the TDS, plus reimbursable expenses. If the Tenderer disagrees with this proposal, the Tenderer should so state in his Tender. If, in the Letter of Acceptance, the Procuring Entity does not agree on the appointment of the Adjudicator, the Procuring Entity will request the Appointing Authority designated in the Special Conditions of Contract (SCC) pursuant to Clause 23.1 of the General Conditions of Contract (GCC), to appoint the Adjudicator.

52 Performance Security

52.1 Within twenty-one (21) days of the receipt of the Letter of Acceptance from the Procuring Entity, the successful Tenderer shall furnish the Performance Security and, any other documents required in the TDS, in accordance with the General Conditions of Contract, subject to ITT 40.2 (b), using the Performance Security and other Forms included in Section X, Contract Forms, or another form acceptable to the Procuring Entity. A foreign institution providing a bank guarantee shall have a correspondent financial institution located in Kenya, unless the Procuring Entity has agreed in writing that a correspondent bank is not required.

52.2 Failure of the successful Tenderer to submit the above-mentioned Performance Security and other documents required in the TDS, or sign the Contract shall constitute sufficient grounds for the annulment of the award and forfeiture of the Tender Security. In that event the Procuring Entity may award the Contract to the Tenderer offering the next Best Evaluated Tender.

52.3 Performance security shall not be required for contracts estimated to cost less than **Kenya shillings five million shillings**.

53 Publication of Procurement Contract

53.1 Within fourteen days after signing the contract, the Procuring Entity shall publish the awarded contract at its notice boards and websites; and on the Website of the Authority. At the minimum, the notice shall contain the following information:

a) name and address of the Procuring Entity;
b) name and reference number of the contract being awarded, a summary of its scope and the selection method used;
c) the name of the successful Tenderer, the final total contract price, the contract duration.
d) dates of signature, commencement and completion of contract;
e) names of all Tenderers that submitted Tenders, and their Tender prices as read out at Tender opening.

54 Procurement Related Complaints and Administrative Review

54.1 The procedures for making Procurement-related Complaints are as specified in the TDS.

54.2 A request for administrative review shall be made in the form provided under contract forms.

SECTION II– TENDER DATA SHEET (TDS)

TENDER DATA SHEET (TDS)

The following specific data shall complement, supplement, or amend the provisions in the Instructions to Tenderers (ITT). Whenever there is a conflict, the provisions herein shall prevail over those in ITT.

ITT Reference	PARTICULARS OF APPENDIX TO INSTRUCTIONS TO TENDERS
	A. General
ITT 1.1	The name of the contract is **TENDER FOR THE CONNECTION OF MAKE-UP WELLS OW-50A, OW-50B AND OW-50C TO OLKARIA IAU POWER PLANT** The reference number of the Contract is **KGN-GDD-056-2023**
B. Contents of Tender Document	
8.1	(A) Pre-Tender conference and mandatory site visit shall take place: (B) A pre-arranged pretender visit of the site of the works "shall" take place at the following date, time and place: There shall be a **mandatory site visit** at Olkaria Date: **30th March, 2023** **Day: Thursday** Time: **10.00am** Place: **Olkaria 1 AU** A bidder shall visit the sites and acquaint himself with its nature and position, the nature of the local conditions, positions of existing power, water and other services, access roads or any other limitations that might affect his cost or progress. No claims for extras shall be considered on account of lack of knowledge in this respect. Non-attendance at the pre-tender meeting will result in **disqualification**. Bidders are strongly advised to visit site and obtain for themselves information adequate for them to prepare a responsive bid. **NOTE: Bidders who have have undertaken site visits in previous tenders are required to participate in the site visit for this particular tender afresh. Previous site visit certificates will therefore not be considered.** Tenderers shall bare their own cost of the site visit.
ITT 8.2	The Tenderer will submit any questions in writing, to reach the Procuring Entity not later than 7 days
ITT 8.4	The Procuring Entity's website where Minutes of the pre-Tender meeting and the pre-arranged pretender site visit will be published is www.kengen.co.ke

ITT 9.1	For Clarification of Tender purposes, for obtaining further information and for purchasing tender documents, the Procuring Entity's address is: General Manager, Supply Chain Kenya Electricity Generating Company PLC Stima Plaza Phase III, Kolobot Road, Parklands P.O. BOX 47936-00100 Ground Floor tenders@kengen.co.ke
C. Preparation of Tenders	
ITT 15.1	Alternative Tenders shall not be considered.
ITT 16.5	The prices quoted by the Tenderer shall be fixed
ITT 20.1	The Tender validity period shall be 126 days.

ITT 20.3 (a)	a) The delayed to exceeding _____number of days. b) The Tender price shall be adjusted by the following percentages of the tender price: i. By _____% of the local currency portion of the Contract price adjusted to reflect local inflation during the period of extension, and ii. By_____% the foreign currency portion of the Contract price adjusted to reflect the international inflation during the period of extension.
ITT 21.1	A Tender security of **Kenya Shillings 18,000,000.00** or equivalent in a freely convertible currency in the form of a Bank Guarantee issued or corresponded by a reputable commercial bank in Kenya, and valid for thirty days beyond the tender validity period.
ITT 21.5	On the Performance Security, other documents required shall be **10%** of the contract price.
D. Submission and Opening of Tenders	

ITT 24.1	(A) For Tender submission purposes only, the Procuring Entity's address is: The tender MUST be submitted through our e-procurement platform found at www.kengen.co.ke (https://eprocurement.kengen.co.ke:50001/irj/portal SUBMISSION OF TENDERS: For suppliers registering for the first time using the link https://supplierregistration.kengen.co.ke:4302/slc_selfreg ensure the **"Public Tender" checkbox is ticked** so that the login details are sent to suppliers automatically.  It is a mandatory requirement that all documents are uploaded to the ***c-folder*** of the SRM System through the link https://eprocurement.kengen.co.ke:50001/irj/portal '***Technical RFx response'***. Responses documents attached to the '***notes and attachments***' tab **will not be considered for evaluation**.  Prices MUST be entered under item tab of the RFx and MUST be similar to the prices in the price/BoQ Schedule.  Bidders should confirm on the supplier portal that the status of their RFx response shows "Submitted" and not "Saved" to ensure their RFx response is submitted.  Bidders who have submitted their bids should not click on WITHDRAW but click on EDIT to amend their bid response with appropriate changes if they desire to do so. Manuals to guide on the bidding process are accessible via the KenGen Tenders Portal.  Bidders to note that **system challenges/support** related to bid submission issues shall be **addressed 48 hours before** tender opening date and time. Date and time for submission of Tenders **12th April, 2023 at 10.00 a.m.** Tenders Must submitted tenders electronically.

ITT 27.1	The Tender opening shall take place at: **Kenya Electricity Generating Company PLC,** **6th Floor, KenGen Pension Plaza II,** **Kolobot Road, Parklands,** **P.O. Box 47936, 00100** **NAIROBI.** Date and time: **12th April, 2023 at 10.30a.m.** Note; In an effort to curb the spread of the COVID-19 pandemic the following measures shall apply: **•Where bidders or their representatives choose to attend the bid opening, KenGen shall limit the persons to a maximum of 5 people, whom shall be nominated by the bidders present for the opening session.** **•The tender opening shall be conducted in a spacious environment and observing a social distance of at least 1.5 meters away from each other. Screening and registration of all attendees shall take place in all sessions.** **•Failure to attend the bid opening shall not invalidate the process.** **Bidders can request for the tender opening minutes of the tender opening session through the following email address tenders@kengen.co.ke** :
E. Evaluation, and Comparison of Tenders	
ITT 35.2	ELIGIBLE TENDERERS The Invitation for Tenders is open to qualified international contractors who meet qualification criteria pursuant to PPADA 2015 and other relevant Government of Kenya regulations
ITT 37.2 (d)	Additional requirements apply. These are detailed in the evaluation criteria in Section III, Evaluation and Qualification Criteria.
ITT 54.1	The procedures for making a Procurement-related Complaints are detailed in the "Regulations" available from the PPRA Website www.ppra.go.ke or email complaints@ppra.go.ke. If a Tenderer wishes to make a Procurement-related

SECTION II – EVALUATION CRITERIA

EVALUATION AND QUALIFICATION CRITERIA

1 General Provisions

Wherever a Tenderer is required to state a monetary amount, Tenderers should indicate the Kenya Shilling equivalent using the rate of exchange determined as follows:

a) For construction turnover or financial data required for each year - Exchange rate prevailing on the last day of the respective calendar year (in which the amounts for that year is to be converted) was originally established.

b) Value of single contract - Exchange rate prevailing on the date of the contract signature.

c) Exchange rates shall be taken from the publicly available source identified in the ITT 14.3. Any error in determining the exchange rates in the Tender may be corrected by the Procuring Entity.

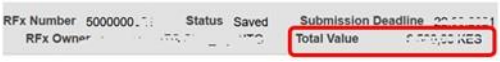
This section contains the criteria that the Employer shall use to evaluate tender and qualify tenderers. No other factors, methods or criteria shall be used other than specified in this tender document. The Tenderer shall provide all the information requested in the forms included in Section IV, Tendering Forms. The Procuring Entity should use the Standard Tender Evaluation Document for Goods and Works for evaluating Tenders.

REGISTRATION AND BIDDING PROCESS

1. For suppliers registering for the first time using the link https://supplierregistration.kengen.co.ke:4302/slc_selfreg(bD1lbiZjPTMwMCZkPW1pbg==)/bspwdapplication.do#VIEW_ANCHOR-ROS_TOP ensure the "Public Tender" checkbox is ticked so that the login details are sent to suppliers automatically.

2. It is a mandatory requirement that all documents are uploaded to the SRM System through the link https://eprocurement.kengen.co.ke:50001/irj/portal '

- Prices MUST be entered under item tab of the RFx and MUST be similar to the prices in the price/BoQ Schedule.



- Bidders should confirm on the supplier portal that the status of their RFx response shows "Submitted" and not "Saved" to ensure their RFx response is submitted.

Event Number	Event Description	Event Type	Event Status	Start Date	End Date	Response Number	Response Status
500000	Test Bid Invite to Bidders	Open Tendering	Published		22.09.	600000	Saved
500000	Test 4 in sus portal	Open Tendering	Published		15.02.	600000	Submitted

- Bidders who have submitted their bids should not click on WITHDRAW but click on EDIT to amend their bid response with appropriate changes if they desire to do so.
- Manuals to guide on the bidding process are accessible via the KenGen Tenders Portal.

- Bidders to note that system challenges/support related to bid submission issues shall be addressed to eprocurement@kengen.co.ke tender closing date and time.

Evaluation and contract award Criteria

The Procuring Entity shall use the criteria and methodologies listed in this Section to evaluate tenders and arrive at the Lowest Evaluated Tender. The tender that (i) meets the qualification criteria, (ii) has been determined to be substantially responsive to the Tender Documents, and (iii) is determined to have the Lowest Evaluated Tender price shall be selected for award of contract.

2 Preliminary examination for Determination of Responsiveness

The Procuring Entity will start by examining all tenders to ensure they meet in all respects the eligibility criteria and other requirements in the ITT, and that the tender is complete in all aspects in meeting the requirements of "Part 2 – Procuring Entity's Works Requirements", including checking for tenders with unacceptable errors, abnormally low tenders, abnormally high tenders and tenders that are front loaded. The Standard Tender Evaluation Report Document for Goods and Works for evaluating Tenders provides very clear guide on how to deal with review of these requirements. Tenders that do not pass the Preliminary Examination will be considered irresponsive and will not be considered further.

STAGE1: MANDATORY REQUIREMENTS

The following mandatory requirements must be met not withstanding other requirements in the tender document:

No	Requirements
MR 1	Copy of Registration Certificate /Certificate of Incorporation in the country of domicile.
MR 2	Valid Tax Compliance Certificate or equivalent issued by a government/ tax authority in the country of domicile.
MR 3	Duly filled, signed & stamped Tenderer's Eligibility Confidential Business Questionnaire form.

MR 4	Copy of a valid CR 12 issued within 6 months of tender closure or equivalent government document showing the directors of the company and shareholding structure.
MR 5	Duly filled and signed and stamped tender form.
MR 6	Duly filled and signed and stamped price schedule.
MR 7	Duly filled and stamped Addendum(s) and Clarification(s) issued must be attached.
MR 8	All items must be quoted to be considered responsive.
MR 9	The Tender MUST be submitted be in the required format and serialized on each page of the bid submitted, Sec.74.1.i. of the PPADA, 2015.
MR 10	Tender documents Must be submitted through our e-procurement platform found at www.kengen.co.ke (https://eprocurement.kengen.co.ke:50001/irj/portal.
MR 11	Duly filled and signed Certificate of Independent Tender Determination.
MR 12	Duly filled signed and stamped Self Declaration form that the tenderer is not debarred in the Matter of the Public Procurement And Asset Disposal Act 2015.
MR 13	Duly filled signed and stamped Self Declaration form that the tenderer will not engage in any corrupt or Fraudulent Practice.
MR 14	Duly filled and signed Declaration and Commitment to the Code of Ethics.
MR 15	The tender has been dully signed by the person lawfully authorized to do so through the power of Attorney.
MR 16	Duly filled and signed Tenderer Information Form.
MR 17	Tender Security shall be in the amount of **Kenya Shillings, Eighteen Million (KES. 18,000,000/=)** or equivalent a freely convertible currency valid for 30 days beyond the tender validity period from any reputable banks registered by the Central Bank of Kenya. International bidders, should have tender security through local corresponding banks registered by the Central Bank of Kenya The hard copy of the Original Tender Security clearly labeled should be dropped at the tender box located on Ground Floor at KenGen, KenGen, RBS building on or before the tender closing date.
MR 18	Duly signed and stamped Manufacturer's Authorization Letter if not a manufacturer
MR 19	Attach Acknowledged and Signed **Mandatory Site Visit Certificate for this tender**
MR 20	Copy of valid relevant National Construction Authority certificates of NCA2 in Mechanical Works or Civil Works and above or a suitable equivalent
MR 21	Copy of valid Annual NCA Practicing Licence

MR 22	Duly Signed and notarized Joint Venture (JV) Agreement in case of a JV bid. NOTE: In the case of a JV, **each JV Member MUST individually** meet these mandatory requirements, except the Site Visit Certificate.	
MR 23	Duly Signed power of attorney appointing the lead partner in case of a Joint Venture **(JV)** and also duly signed and notarized power of attorney authorizing the person signing the bid on behalf of the bidder's company or JV.	
MR 24	Duly signed and stamped Manufacturer"s Authorization Letter of the followingitems; Pipes and all their fittings – The manufacturer must have relevant valid API certification to manufacture the pipes and fittings – attach API certificate. Pressure vessels Steam traps Rapture discs Flow meters Insulation	
MR 25	The bidders Must provide brochures, catalogues or technical data for the following items; Pipes and all their fittings Pressure vessels Steam traps Rapture discs Flow meters Insulation	
MR 26	Health, Safety and Environmental Protection Methodology.	
MR 27	Proposed Work Plan & Methodology.	
MR 28	Audited financial statements by a registered audit firm for the last 3 years shall be submitted and must demonstrate the current soundness of the Bidder's financial position and its prospective long-term profitability with positive financial ratios.	
MR 29	Financial ratios	Current Ratio 1:1
		Positive net worth in their audited balance sheet.
		At least one year out of the recent three years of positive Profit before Tax.

STAGE 2: TECHNICAL EVALUATION ON CAPACITY TO DELIVER THE CONTRACT

Technical evaluation carried out only if the tender is determined to be responsive to the preliminary examination.

Bidder must demonstrate conformance to the all the technical specifications and requirements as per SECTION V

TECHNICAL REQUIREMENTS:

2.1.1 Personnel

The bidder must demonstrate that it has the personnel for the key positions that meet the following requirements. The CVs for the proposed personnel should be provided. Please note that Total work experience means the total number of years worked since leaving school or college and similar experience means number of years while working on high pressure piping projects. **Documentary evidence e.g Academic certificates and recommendation letters from Employers MUST be provided.**

No.	Position	Total Work Experience (Years)	Experience in Similar Works (Years)	Qualification Criteria Total Work Experience	Qualification criteria Similar Experience
1	*Project Manager*	At least fifteen (15) years total experience or equivalent as a manager in construction of civil and pipe line works	Including a minimum of ten (10) Years' experience as project manager of contracts for construction of cross county pressure pipelines and vessels. (Provide client letter of reference together with reputable contact person).	a) 15 Years and above **2 marks** b) Between 5 and 10 Years **1marks** c) Between 1 and 5 years **0.5 mark**	a) Over 10 Years **2 marks** b) Between 5 and 10 years **1 marks** c) Between 1 and 5 Years **0.5 mark**
2	*Contractors Site Manager (to be Contractor's Representative on Site*	At least fifteen (15) years total experience or equivalent as a manager in construction of civil and pipe line works	Including a minimum of ten (10) Years' experience as project manager of contracts for construction of cross county pressure pipe lines and vessels. (Provide client letter of reference together with reputable	a) 15 Years and above **2 marks** b) Between 5 and 10 Years **1 marks** c) Between 1 and 5 years **0.5 mark**	a) Over 10 Years **2 marks** b) Between 5 and 10 years **1 marks** c) Between 1 and 5 Years **0.5 mark**

3	Project Civil Engineer	At least ten (10) years total experience as a Site Engineer in civil works and pipe line installations	Including a minimum of eight (8) Years' experience in design and construction of civil and structural Works of similar nature. (Provide client letter of reference together with reputable Contact person).	a) 10 years and above **2 Marks** b) Between 5 and 10 years **1 marks** c) Below 5 years **0.5 Mark**	a) 8 years and above **2 Marks** b) Between 4 and 8 years **1 mark** c) Less than 4 years **0.5 Mark**
4	Project Mechanical Engineer	With more than ten(10) years total experience in mechanical works and pipe line installations Engineer	Including a minimum of eight (8) years' experience in installation and Construction of pressure pipe lines and vessels. (Provide client letter of reference together with reputable	a) 10 years and above **2 Marks** b) Between 5 and 10 years **1 marks** c) Below 5 years **0.5 Mark**	a) 8 years and above **2 Marks** b) Between 4 and 8 years **1 mark** c) Less than 4 Years **0.5 Mark**
5	*Chief Electrical Instrumentation and Controls Engineer*	With more than ten (10) years total experience as a site engineer in Electrical, Control & Instrumentation works and pipe line installations	Including a minimum of eight (8) years' experience in design and Installation of Electrical, Control & Instrumentation systems. (Provide client letter of reference together with reputable Contact person).	a) 10 years and above **2Marks** b) Between 5 and 10 years **1 marks** c) Below 5 years **0.5 Mark**	a) 10 years and above **2 marks** b) Below 10 years – **0.5 marks**
6	*Health, Safety& Environment Officer*	With more than eight (8) (10) years total experience in Health and Safety in a Construction industry.	Including a minimum of four (4) years' experience as a safety officer for complex projects Of similar nature. (Provide client letter of reference together with reputable contact Person).	a) 8 years and above **1 Mark** b) below 8 years **0.5 marks**	a) Above 4 years **1 Marks** b) Below 4 years – **0 marks**
7	*QA/QC Manager*	With more than eight (8) years total experience in the Construction industry.	Including a minimum of five (4) years experience as quality assurance	a) 8 years and above **1Mark**	a) Above 4 years **1 Mark**

			officer for civil and pressure pipe Line projects. (Provide client letter of reference together with reputable contact Person).	b) Below 8 years **0.5 Mark**	b) Below 4 years **0 marks**
8	*Welding Inspector*	With more than ten (10) Years total experience in cross country pipelines.	Including a minimum of five (5) years' experience as a welding inspector for pressure pipelines. (Provide client letter of reference together with reputable Contact person).	a)8 years and above **2Mark** b) Below 8 years **0.5 Mark**	a)Above 4 years **2 Marks** b) Below 4 years – **0.5 marks**
9	*Testing and Commissioning Engineer*	With more than fifteen (15) years total experience or equivalent as an engineer in testing and commissioning of pressurized Vessels.	Including a minimum of ten (10) Years' experience as a testing and commissioning Engineer for geothermal steam gathering systems. (Provide client letter of reference together with reputable contact Person).	a)15 Years and above **1 mark** b) Between 5 and 15 Years **0.5 Marks** c) Below 5 years **0 mark**	a) Over 10 Years **1 mark** b) Below 10 years – **0.5 mark**

Total maximum Marks for Personnel = 30 marks

2.1.2. Bidders/ Company's experience

Bidders must demonstrate their experience in high pressure piping and pressure vessels. Give evidence of either **certificate of completion** of such a job or previous client's **recommendation letter** on a similar job. Any forged documentation will be detected and the bidder disqualified from further evaluation.

No.	Experience in Installation of High-pressure piping and Pressure Vessel	Relevant Experience in Steamfield Installation	Experience in installation of High-pressure piping and pressure Vessel	Relevant experience in Steam field Installation
1	A minimum of 2 No. Project and maximum of 4 No. and above which involve high pressure piping and pressure	At least 1No. Project in Geothermal Steamfield Installation that has a separator or equivalent high pressure vessel.	a) Above 4 Projects – **20marks** b) 4 Projects – **15 marks**	1 No. Project in Geothermal Steamfield installation that has a separator or equivalent

	vessels completed in the last 10 years		c) 3 projects– **10 marks** d) 2 projects - **5 marks**	high pressure vessel = 10 **marks** Geothermal Steamfield installation but without separator or equivalent high pressure vessel -**5 marks** No geothermal Steamfield installation– **0** marks

Total marks on the Company's experience = 30 marks.

2.1.3 Availability of Key Construction equipment.

The bidder must demonstrate availability of the following equipment

No.	Equipment type and characteristics	Required No.	Qualification criteria
1	Mobile Crane	1No.	2 Marks
2	Concrete batching plant	1No.	3 Marks
3	Hydraulic excavator at least 232 Horse power	1No.	1Mark
4	Mobile concrete mixer. Minimum capacity 4M^3	1No.	1 Mark
5	Mobile Generator minimum 50 KVA	2 No.	1 Mark
6	Welding machines at least 50 KVA	2No.	2Mark
7	Vibrating steel drum rollers	2No.	1Mark
8	Piling rig	1No.	3Mark
9	Radiographic equipment set for weld joint inspection.	1No.	1Mark

Total Marks for Equipment = 15 Marks

2.1.4 Methodology of project execution and program of weeks

The Bidder must demonstrate understanding of the project scope by submitting methodology of execution of the works covering all aspect of installations and the proposed program of works. Methodology will include but not limited to the following;

No.	Description	Qualification Criteria
1	Work procedures including Civil, Mechanical, Electrical, Instrumentation and control and inspection of testing	3 marks
2	Proposed program of works	3 Marks
3	Health, safety and quality procedures while executing the woks	2 marks

4	Inclusion of tools, equipment and personnel required for every process of executing the works	2 Marks

Total marks for Methodology = 10marks.

2.1.5 Financial Capability

The bidder should demonstrate his liquidity so that he will not have financial challenges while implementing the project.

The bidder should produce evidence of availability of at least KES. 500, 000,000.00 *in terms of credit facility or Annual net income of* KES. 700,000,000.00. – **15 Marks**

The total marks for Technical Evaluation of = **100 %**

Only bids which scores more than 75% will proceed to financial evaluation.

STAGE 3. FINANCIAL EVALAUATION

- Financial evaluation shall involve checking completeness of financial bids
-
- ➢Consideration of the prevailing market price and value for money.
- ➢ Tender sum as submitted and read out during tender opening as per the form of tender is absolute and
- final and shall not be subject to correction, adjustment, or amendment.
- ➢ All prices must be inclusive of all the applicable taxes.
- ➢Preferential treatment for local and Open International.
-
- In accordance to evaluation criteria, preferential treatment for local and Open International shall apply in accordance to Section 164 (c), (d) and (e) of The Public Procurement And Asset Disposal Regulations, 2020.
-

Shareholding of Kenyan Citizen	Percentage Margin of Preference (on read out price)
Less than 20% but above 5%	6%
Less than 50% but above20%	8%
Over 50%	10%
Joint Venture with Open International	10%

- The Margin of Preference shall apply for price comparison only. Thereafter the award will be based on the lowest evaluated bidder (Price as read out)
- Tenderers who qualify for this scheme shall attach CR12 forms to support their bid.
- Citizen contractor means a person or a firm wholly owned and controlled by persons who are citizens of Kenya;
- Award shall be based on the lowest evaluated bidder.
- Tender sum as submitted and read out during tender opening is absolute and final and shall not be subject to correction, adjustment or amendment major deviation shall result in disqualification.
-
-
- STAGE 4. DUE DILLIGENCE
-
- KenGen may, prior to award of the tender, conduct due diligence on the recommended bidder to ascertain the information provided in their bid document

8. QUALIFICATION FORM SUMMARY

1	2	3	4	5
Item No.	Qualification Subject	Qualification Requirement	Document To be Completed by Tenderer	For Procuring Entity's Use (Qualification met or Not Met)
1	Nationality	Nationality in accordance with ITT 3.6	Forms ELI – 1.1 and 1.2, with attachments	
2	Tax Obligations for Kenyan Tenderers	Has produced a current tax clearance certificate or tax exemption certificate issued by the the Kenya Revenue Authority in accordance with ITT 3.14.	Form of Tender	
3	Conflict of Interest	No conflicts of interest in accordance with ITT 3.3	Form of Tender	
4	PPRA Eligibility	Not having been declared ineligible by the PPRA as described in ITT 3.8	Form of Tender	
5	State- owned Enterprise	Meets conditions of ITT 3.7	Forms ELI – 1.1 and 1.2, with attachments	
6	Goods, equipment and services to be supplied under the contract	To have their origin in any country that is not determined ineligible under ITT 4.1	Forms ELI – 1.1 and 1.2, with attachments	
7	History of Non-Performing Contracts	Non-performance of a contract did not occur as a result of contractor default since 1st January […….].	Form CON-2	
8	Suspension Based on Execution of Tender/Proposal Securing Declaration by the Procuring Entity	Not under suspension based on-execution of a Tender/Proposal Securing Declaration pursuant to ITT 19.9	Form of Tender	

1	2	3	4	5
Item No.	Qualification Subject	Qualification Requirement	Document To be Completed by Tenderer	For Procuring Entity's Use (Qualification met or Not Met)
9	Pending Litigation	Tender's financial position and prospective long-term profitability still sound according to criteria established in 3.1 and assuming that all pending litigation will NOT be resolved against the Tenderer.	Form CON – 2	
10	Litigation History	No consistent history of court/arbitral award decisions against the Tenderer since 1st January 2017.	Form CON – 2	
11	Financial Capabilities	(i) The Tenderer shall demonstrate that it has access to lines of credit, and other financial means (independent of any contractual advance payment) sufficient to meet the construction cash flow requirements estimated as Kenya Shillings Forty Million (KShs. 40,000,000.00) equivalent for the subject contract(s) net of the Tenderer's other commitments. (ii) The Tenderers shall also demonstrate, to the satisfaction of the Procuring Entity, that it has adequate sources of finance to meet the cash flow requirements on works currently in progress and for future contract commitments.	Form FIN – 3.1, with attachments	

QUALIFICATION FORMS

1. FORM EQU: EQUIPMENT

The Tenderer shall provide adequate information to demonstrate clearly that it has the capability to meet the requirements for the key equipment listed in Section III, Evaluation and Qualification Criteria. A separate Form shall be prepared for each item of equipment listed, or for alternative equipment proposed by the Tenderer.

Item of equipment		
Equipment information	Name of manufacturer	Model and power rating
	Capacity	Year of manufacture
Current status	Current location	
	Details of current commitments	
Source	Indicate source of the equipment □ Owned □ Rented □ Leased □ Specially manufactured	

Omit the following information for equipment owned by the Tenderer.

Owner	Name of owner	
	Address of owner	
	Telephone	Contact name and title
	Fax	Telex
Agreements	Details of rental / lease / manufacture agreements specific to the project	

2 FORM PER -1

Contractor's Representative and Key Personnel Schedule

Tenderers should provide the names and details of the suitably qualified Contractor's Representative and Key Personnel to perform the Contract. The data on their experience should be supplied using the Form PER-2 below for each candidate.

Contractor' Representative and Key Personnel

1.	Title of position: Contractor's Representative	
	Name of candidate:	
	Duration of appointment:	[insert the whole period (start and end dates) for which this position will be engaged]
	Time commitment: for this position:	[insert the number of days/week/months/ that has been scheduled for this position]
	Expected time schedule for this position:	[insert the expected time schedule for this position (e.g. attach high level Gantt chart]
2.	Title of position:	
	Name of candidate:	

	Duration of appointment:	[insert the whole period (start and end dates) for which this position will be engaged]
	Time commitment: for this position:	[insert the number of days/week/months/ that has been scheduled for this position]
	Expected time schedule for this position:	[insert the expected time schedule for this position (e.g. attach high level Gantt chart]
3.	Title of position:	
	Name of candidate:	
	Duration of appointment:	[insert the whole period (start and end dates) for which this position will be engaged]
	Time commitment: for this position:	[insert the number of days/week/months/ that has been scheduled for this position]

	Expected time schedule for this position:	[insert the expected time schedule for this position (e.g. attach high level Gantt chart]
4.	Title of position: [insert title]	
	Name of candidate:	
	Duration of appointment:	[insert the whole period (start and end dates) for which this position will be engaged]
	Time commitment: for this position:	[insert the number of days/week/months/ that has been scheduled for this position]
	Expected time schedule for this position:	[insert the expected time schedule for this position (e.g. attach high level Gantt chart]
5.	Title of position: [insert title]	
	Name of candidate	
	Duration of appointment:	[insert the whole period (start and end dates) for which this position will be engaged]
	Time commitment: for this position:	[insert the number of days/week/months/ that has been scheduled for this position]
	Expected time schedule for this position:	[insert the expected time schedule for this position (e.g. attach high level Gantt chart]

3 FORM PER-2:

Resume and Declaration - Contractor's Representative and Key Personnel.

Summarize professional experience in reverse chronological order. Indicate particular technical and managerial experience relevant to the project.

Name of Tenderer

Position [#1]: [title of position from Form PER-1]		
Personnel information	Name:	Date of birth:
	Address:	E-mail:
	Professional qualifications:	
	Academic qualifications:	
	Language proficiency: [language and levels of speaking, reading and writing skills]	
Details		
	Address of Procuring Entity:	
	Telephone:	Contact (manager / personnel officer):
	Fax:	
	Job title:	Years with present Procuring Entity:

Summarize professional experience in reverse chronological order. Indicate particular technical and managerial experience relevant to the project.

Project	Role	Duration of involvement	Relevant experience
[main project details]	[role and responsibilities on the project]	[time in role]	[describe the experience relevant to this position]

Declaration

I, the undersigned _____ [insert either "Contractor's Representative" or "Key Personnel" as applicable], certify that to the best of my knowledge and belief, the information contained in this Form PER-2 correctly describes myself, my qualifications and my experience.

I confirm that I am available as certified in the following table and throughout the expected time schedule for this position as provided in the Tender:

Commitment	Details
Commitment to duration of contract:	[insert period (start and end dates) for which this Contractor's Representative or Key Personnel is available to work on this contract]
Time commitment:	[insert period (start and end dates) for which this Contractor's Representative or Key Personnel is available to work on this contract]

I understand that any misrepresentation or omission in this Form may:

a) be taken into consideration during Tender evaluation;
b) result in my disqualification from participating in the Tender;
c) result in my dismissal from the contract.

Name of Contractor's Representative or Key Personnel:
_____[insert name]

Signature:_____

Date: (day month year): _____

Counter signature of authorized representative of the Tenderer:_____

Signature:_____ Date: (day month year): _____

4 TENDERER'S QUALIFICATION WITHOUT PRE-QUALIFICATION

To establish its qualifications to perform the contract in accordance with Section III, Evaluation and Qualification Criteria the Tenderer shall provide the information requested in the corresponding Information Sheets included hereunder.

4.1 FORM ELI -1.1

Tenderer Information Form

Date:_____

ITT No. and title: _____

Tenderer's name
In case of Joint Venture (JV), name of each member:
Tenderer's actual or intended year of incorporation:
Tenderer's legal address [in country of registration]:
Tenderer's authorized representative information Name:
Address:
Telephone/Fax numbers:
E-mail address:
1. Attached are copies of original documents of □ Articles of Incorporation (or equivalent documents of constitution or association), and/or documents of registration of the legal entity named above, in accordance with ITT 3.6 □ In case of JV, letter of intent to form JV or JV agreement, in accordance with ITT 3.5 □ In case of state-owned enterprise or institution, in accordance with ITT 3.8, documents establishing: □ Legal and financial autonomy □ Operation under commercial law □ Establishing that the Tenderer is not under the supervision of the Procuring Entity 2. Included are the organizational chart, a list of Board of Directors, and the beneficial ownership.

4.2 FORM ELI -1.2

Tenderer's JV Information Form
(to be completed for each member of Tenderer's JV)

Date:_____

ITT No. and title: _____

Tenderer's JV name:
JV member's name:
JV member's country of registration:
JV member's year of constitution:
JV member's legal address in country of constitution:
JV member's authorized representative information Name:
Address:
Telephone/Fax numbers: _____ E-mail address: _____
1. Attached are copies of original documents of □ Articles of Incorporation (or equivalent documents of constitution or association), and/or registration documents of the legal entity named above, in accordance with ITT 3.6. □ In case of a state-owned enterprise or institution, documents establishing legal and financial autonomy, operation in accordance with commercial law, and that they are not under the supervision of the Procuring Entity, in accordance with ITT 3.8. 2. Included are the organizational chart, a list of Board of Directors, and the beneficial ownership.

4.3 FORM CON – 2

Historical Contract Non-Performance, Pending Litigation and Litigation History

Tenderer's Name: _____

Date: _____

JV Member's Name_____

ITT No. and title: _____

<table>
<tr><td colspan="4">Non-Performed Contracts in accordance with Section III, Evaluation and Qualification Criteria</td></tr>
<tr><td colspan="4">☐ Contract non-performance did not occur since 1st January 2017 specified in Section III, Evaluation and Qualification Criteria, Sub-Factor 2.1.

☐ Contract(s) not performed since 1st January 2017 specified in Section III, Evaluation and Qualification Criteria, requirement 2.1</td></tr>
<tr><td>Year</td><td>Non- performed portion of contract</td><td>Contract Identification</td><td>Total Contract Amount (current value, currency, exchange rate and Kenya Shilling equivalent)</td></tr>
<tr><td>[insert year]</td><td>[insert amount and percentage]</td><td>Contract Identification: [indicate complete contract name/ number, and any other identification]

Name of Procuring Entity:

Address of Procuring Entity:

Reason(s) for nonperformance:</td><td>[insert amount]</td></tr>
<tr><td colspan="4">Pending Litigation, in accordance with Section III, Evaluation and Qualification Criteria</td></tr>
<tr><td colspan="4">☐ No pending litigation in accordance with Section III, Evaluation and Qualification Criteria, Sub-Factor 2.3.

☐ Pending litigation in accordance with Section III, Evaluation and Qualification Criteria, Sub-Factor 2.3 as indicated below.</td></tr>
</table>

Year of dispute	Amount in dispute (currency)	Contract Identification	Total Contract Amount (currency), Kenya Shilling Equivalent (exchange rate)
		Contract Identification: Name of Procuring Entity: Address of Procuring Entity: Matter in dispute: Party who initiated the dispute: Status of dispute:	

		Contract Identification: Name of Procuring Entity: Address of Procuring Entity: Matter in dispute: Party who initiated the dispute: Status of dispute:	
Litigation History in accordance with Section III, Evaluation and Qualification Criteria			
□ No Litigation History in accordance with Section III, Evaluation and Qualification Criteria, Sub-Factor 2.4. □ Litigation History in accordance with Section III, Evaluation and Qualification Criteria, Sub-Factor 2.4 as indicated below.			

Year of award	Outcome as percentage of Net Worth	Contract Identification	Total Contract Amount (currency), Kenya Shilling Equivalent (exchange rate)
[insert year]	[insert percentage]	Contract Identification: [indicate complete contract name, number, and any other identification] Name of Procuring Entity: [insert full name] Address of Procuring Entity: [insert street/city/country] Matter in dispute: [indicate main issues in dispute] Party who initiated the dispute: [indicate "Procuring Entity" or "Contractor"] Reason(s) for Litigation and award decision [indicate main reason(s)]	[insert amount]

4.4 FORM FIN – 3.1:

Financial Situation and Performance

Tenderer's Name: _____

Date: _____

JV Member's Name_____

ITT No. and title: _____

4.4.1 Financial Data

Type of Financial information in_____ (currency)	Historic information for previous _____years, _____ (amount in curre ıcy, currency, exchange rate*, USD equivalent)				
	Year 1	Year 2	Year 3	Year 4	Year 5
Statement of Financial Position (Information from Balance Sheet)					
Total Assets (TA)					
Total Liabilities (TL)					
Total Equity/Net Worth (NW)					
Current Assets (CA)					
Current Liabilities (CL)					
Working Capital (WC)					
Information from Income Statement					
Total Revenue (TR)					
Profits Before Taxes (PBT)					
Cash Flow Information					
Cash Flow from Operating Activities					

*Refer to ITT 15 for the exchange rate

4.4.2 Sources of Finance

Specify sources of finance to meet the cash flow requirements on works currently in progress and for future contract commitments.

No.	Source of finance	Amount (Kenya Shilling equivalent)
1		
2		
3		

4.4.3 Financial documents

The Tenderer and its parties shall provide copies of financial statements for _____years pursuant Section III, Evaluation and Qualifications Criteria, Sub-factor 3.1. The financial statements shall:

a) reflect the financial situation of the Tenderer or in case of JV member, and not an affiliated entity (such as parent company or group member).
b) be independently audited or certified in accordance with local legislation.
c) be complete, including all notes to the financial statements.
d) correspond to accounting periods already completed and audited.

□ Attached are copies of financial statements[1] for the _____years required above; and complying with the requirements

[1] *If the most recent set of financial statements is for a period earlier than 12 months from the date of Tender, the reason for this should be justified.*

4.5 FORM FIN – 3.2

Average Annual Construction Turnover

Tenderer's Name: _____

Date: _____

JV Member's Name_____

ITT No. and title: _____

	Annual turnover data (construction only)		
Year	Amount Currency	Exchange rate	Kenya Shilling equivalent
[indicate year]	[insert amount and indicate currency]		
Average Annual Construction Turnover *			

* See Section III, Evaluation and Qualification Criteria, Sub-Factor 3.2.

4.6 FORM FIN – 3.3:

Financial Resources

Specify proposed sources of financing, such as liquid assets, unencumbered real assets, lines of credit, and other financial means, net of current commitments, available to meet the total construction cash flow demands of the subject contract or contracts as specified in Section III, Evaluation and Qualification Criteria

Financial Resources		
No.	Source of financing	Amount (Kenya Shilling equivalent)
1		
2		
3		

4.7 FORM FIN – 3.4:

Current Contract Commitments / Works in Progress

Tenderers and each member to a JV should provide information on their current commitments on all contracts that have been awarded, or for which a letter of intent or acceptance has been received, or for contracts approaching completion, but for which an unqualified, full completion certificate has yet to be issued.

Current Contract Commitments					
No.	Name of Contract	Procuring Entity's Contact Address, Tel,	Value of Outstanding Work [Current Kenya Shilling /month Equivalent]	Estimated Completion Date	Average Monthly Invoicing Over Last Six Months [Kenya Shilling /month)]
1					
2					
3					
4					
5					

4.8 FORM EXP - 4.1

General Construction Experience

Tenderer's Name: _____

Date: _____

JV Member's Name_____

ITT No. and title: _____

Page _____of _____pages

Starting Year	Ending Year	Contract Identification	Role of Tenderer
		Contract name: Brief Description of the Works performed by the Tenderer: Amount of contract: _____ Name of Procuring Entity: _____ Address:	
		Contract name: Brief Description of the Works performed by the Tenderer: Amount of contract: _____ Name of Procuring Entity: _____ Address:	
		Contract name:	

		Brief Description of the Works performed by the Tenderer: Amount of contract: _____ Name of Procuring Entity: _____ Address:	

4.9 FORM EXP - 4.2(a)

Specific Construction and Contract Management Experience

Tenderer's Name: _____

Date: _____

JV Member's Name_____

ITT No. and title: _____

Similar Contract No.	Information			
Contract Identification				
Award date				
Completion date				
Role in Contract	Prime Contractor □	Member in JV □	Management Contractor □	Sub-contractor □
Total Contract Amount			Kenya Shilling	
If member in a JV or sub-contractor, specify participation in total Contract amount				
Procuring Entity's Name:				
Address: Telephone/fax number E-mail:				

4.10 FORM EXP - 4.2 (a) (cont.)

Specific Construction and Contract Management Experience (cont.)

Similar Contract No.	Information
Description of the similarity in accordance with Sub-Factor 4.2(a) of Section III:	
1. Amount	
2. Physical size of required works items	
3. Complexity	
4. Methods/Technology	
5. Construction rate for key activities	
6. Other Characteristics	

4.11 FORM EXP - 4.2(b)

Construction Experience in Key Activities

Tenderer's Name: _____

Date: _____

Tenderer's JV Member Name: _____

Sub-contractor's Name (as per ITT 34): _____

ITT No. and title: _____

All Sub-contractors for key activities must complete the information in this form as per ITT 34 and Section III, Evaluation and Qualification Criteria, Sub-Factor 4.2.

1. Key Activity No One: _

	Information			
Contract Identification				
Award date				
Completion date				
Role in Contract	Prime Contractor ☐	Member in JV ☐	Management Contractor ☐	Sub-contractor ☐
Total Contract Amount			Kenya Shilling	
Quantity (Volume, number or rate of production, as applicable) performed under the contract per year or part of the year	Total quantity in the contract (i)	Percentage participation (ii)		Actual Quantity Performed (i) x (ii)
Year 1				
Year 2				
Year 3				
Year 4				
Procuring Entity's Name:				
Address: Telephone/fax number E-mail:				

	Information
Description of the key activities in accordance with Sub-Factor 4.2(b) of Section III:	

2. Activity No. Two
3. ……

LOCAL CONTENT FORM

The bidder shall fill this form as part of demonstration of components of this project that the bidding firm/consortium shall give to/engage specific local content in terms of goods/works/services during this project execution as per Sec. 3(i), 89(f) and 157(9) of the Public procurement and Disposal of Asset Act (PPADA, 2015). NOTE:

This shall be part of preliminary evaluation criteria

Particulars	Amount	Remarks
Total Tender Sum		
Value of works proposed to include local content		
Estimated Value of materials and equipment to be sourced locally		
Total		

FORM OF TENDER

(Amended and issued pursuant to PPRA CIRCULAR No. 02/2022)

INSTRUCTIONS TO TENDERERS

i) All italicized text is to help the Tenderer in preparing this form.

ii) The Tenderer must prepare this Form of Tender on stationery with its letterhead clearly showing the Tenderer's complete name and business address. Tenderers are reminded that this is a mandatory requirement.

iii) Tenderer must complete and sign CERTIFICATE OF INDEPENDENT TENDER DETERMINATION and the SELF DECLARATION FORMS OF THE TENDERER as listed under (s) below.

Date of this Tender submission:.....*[insert date (as day, month and year) of Tender submission]* **Tender Name and Identification**:.....*[insert identification]* **Alternative No.**:.....*[insert identification No if this is a Tender for an alternative]*

To: ..... *[Insert complete name of Procuring Entity]*

a) **No reservations:** We have examined and have no reservations to the tendering document, including Addenda issued in accordance with ITT9;

b) **Eligibility**: We meet the eligibility requirements and have no conflict of interest in accordance with ITT4;

c) **Tender-Securing Declaration:** We have not been suspended nor declared ineligible by the Procuring Entity based on execution of a Tender-Securing Declaration or Proposal-Securing Declaration in Kenya in accordance with ITT21;

d) **Conformity:** We offer to provide the Non-Consulting Services inconformity with the tendering document of the following:[*insert a brief description of the Non-Consulting Services*];

e) **Tender Price:** The total price of our Tender, excluding any discounts offered in item(f) below is: *[Insert one of the options below as appropriate]*

Option1,in case of one lot: Total price is:[*insert the total price of the Tender in words and figures, indicating the various amounts and the respective currencies*];

Or

Option 2, in case of multiple lots:(a)Total price of each lot[*insert the total price of each lot in words and figures, indicating the various amounts and the respective currencies*]; and (b) Total price of all lots

(sum of all lots) [*insert the total price of all lots in words and figures, indicating the various amounts and the respective currencies*];

f) **Discounts:** The discounts offered and the methodology for their application are:

i) The discounts offered are: [*Specify in detail each discount offered.*]

ii) The exact method of calculations to determine the net price after application of discounts is shown below: [*Specify in detail the method that shall be used to apply the discounts*];

g) **Tender Validity Period:** Our Tender shall be valid for the period specified in TDS 19.1 (as amended if applicable) from the date fixed for the Tender submission deadline (specified in TDS 23.1(as amended if applicable),and it shall remain binding upon us and may be accepted at any time before the expiration of that period;

h) **Performance Security:** If our Tender is accepted, we commit to obtain a Performance Security in accordance with the tendering document;

i) **One Tender Per Tenderer:** We are not submitting any other Tender(s) as an individual Tenderer, and we are not participating in any other Tender(s) a s a Joint Venture member or as a subcontractor, and meet the requirements of ITT4.3, other than alternative Tenders submitted in accordance with ITT14;

j) **Suspension and Debarment**: We, along with any of our subcontractors, suppliers, consultants, manufacturers,orserviceprovidersforanypartofthecontract,arenotsubjectto,and not controlled by any entity or individual that is subject to, a temporary suspension or a debarment imposed by the PPRA. Further, we are not ineligible under Kenya's official regulations or pursuant to a decision of the United Nations Security Council;

k) **State-owned enterprise or institution**: [*select the appropriate option and delete the other*] [*We are not a state-owned enterprise or institution*] / [*We are a state-owned enterprise or institution but meet the requirements of ITT 4.6*];

l) **Commissions, gratuities and fees**: We have paid, or will pay the following commissions, gratuities, or fees with respect to the Tendering process or execution of the Contract: *[insert complete name of each Recipient, its full address, r gratuity].*

Name of Recipient	Address	Reason	Amount

(If none has been paid or is to be paid, indicate "none.")

a) *[Delete if not appropriate, or amend to suit]*We confirm that we understand the provisions relating to Standstill Period as described in this tendering document and the Procurement Regulations.

m) **Binding Contract**: We understand that this Tender, together with your written acceptance thereof included in your Form of Acceptance, shall constitute a binding contract between us, until a formal contract is prepared and executed;

n) **Not Bound to Accept:** We understand that you are not bound to accept the lowest evaluated cost Tender, the Best Evaluated Tender or any other Tender that you may receive; and

o) **Fraud and Corruption:** We hereby certify that we have taken steps to ensure that no person acting for us or on our behalf engages in any type of Fraud and Corruption.

p) **Collusive practices**: We hereby certify and confirm that the tender is genuine, non-collusive and made with the intention of accepting the contract if awarded. To this effect we have signed the "Certificate of Independent tender Determination" attached below.

q) **Code of Ethical Conduct:** We undertake to adhere by the Code of Ethics for Persons Participating in Public Procurement and Asset Disposal, copy available from__(*specify website*) during the procurement process and the execution of any resulting contract.

r) We, the Tenderer, have completed fully and signed the following Forms as part of our Tender:

i) Tenderer's Eligibility; Confidential Business Questionnaire–to establish we are not in any conflict to interest.

ii) Certificate of Independent Tender Determination–to declare that we completed the tender without colluding with other tenderers.

iii) Self-Declaration of the Tenderer–to declare that we will, if awarded a contract, not engage in any form of fraud and corruption.

iv) Declaration and commitment to the Code of Ethics for Persons Participating in Public Procurement and Asset Disposal.

Further, we confirm that we have read and understood the full content and scope of fraud and corruption as informed in **"Appendix 1- Fraud and Corruption**" attached to the Form of Tender.

Name of the Tenderer:..... *[*insert complete name of person signing the Tender*]

Name of the person duly authorized to sign the Tender on behalf of the Tenderer:.....**[*insert complete name of person duly authorized to sign the Tender*]

Title of the person signing the Tender:..... [*insert complete title of the person signing the Tender*]

Signature of the person named above: .....[*insert signature of person whose name and capacity are shown above*]

Date signed..... [*insert date of signing*] **day of** .....[*insert month*], [*insert year*]

A. *A* TENDERER'S ELIGIBILITY- CONFIDENTIAL BUSINESS QUESTIONNAIRE

Instruction to Tenderer

Tender is instructed to complete the particulars required in this Form, *one form for each entity if Tender is a JV*. Tenderer is further reminded that it is an offence to give false information on this Form.

(a) **Tenderer's details**

	ITEM	DESCRIPTION
1	Name of the Procuring Entity	
2	Reference Number of the Tender	
3	Date and Time of Tender Opening	
4	Name of the Tenderer	
5	Full Address and Contact Details of the Tenderer.	1. Country 2. City 3. Location 4. Building 5. Floor 6. Postal Address 7. Name and email of contact person.
6	Current Trade License Registration Number and Expiring date	
7	Name, country and full address (*postal and physical addresses, email, and telephone number*) of Registering Body/Agency	
8	Description of Nature of Business	
9	Maximum value of business which the Tenderer handles.	
10	State if Tenders Company is listed in stock exchange, give name and full address (*postal and physical addresses, email, and telephone number*) of state which stock exchange	

General and Specific Details

b) **Sole Proprietor,** provide the following details.

Name in full_____Age_____
Nationality_____Country of Origin_____
Citizenship _____

c) **Partnership,** provide the following details.

	Names of Partners	Nationality	Citizenship	% Shares owned
1				
2				
3				

d) Registered Company, provide the following details.

i) Private or public Company_____

ii) State the nominal and issued capital of the Company_____

Nominal Kenya Shillings (Equivalent).....

Issued Kenya Shillings (Equivalent).....

iii) Give details of Directors as follows.

	Names of Director	Nationality	Citizenship	% Shares owned
1				
2				
3				

(e) DISCLOSURE OF INTEREST- Interest of the Firm in the Procuring Entity.

i) Are there any person/persons in …… …… (*Name of Procuring Entity)* who has/have an interest or relationship in this firm? Yes/No……

If yes, provide details as follows.

	Names of Person	Designation in the Procuring Entity	Interest or Relationship with Tenderer
1			
2			
3			

ii) Conflict of interest disclosure

	Type of Conflict	Disclosure YES OR NO	If YES provide details of the relationship with Tenderer
1	Tenderer is directly or indirectly controls, is controlled by or is under common control with another tenderer.		
2	Tenderer receives or has received any direct or indirect subsidy from another tenderer.		
3	Tenderer has the same legal representative as another		

	Type of Conflict	Disclosure YES OR NO	If YES provide details of the relationship with Tenderer
	tenderer		
4	Tender has a relationship with another tenderer, directly or through common third parties, that puts it in a position to influence the tender of another tenderer, or influence the decisions of the Procuring Entity regarding this tendering process.		
5	Any of the Tenderer's affiliates participated as a consultant in the preparation of the design or technical specifications of the works that are the subject of the tender.		
6	Tenderer would be providing goods, works, non-consulting services or consulting services during implementation of the contract specified in this Tender Document.		
7	Tenderer has a close business or family relationship with a professional staff of the Procuring Entity who are directly or indirectly involved in the preparation of the Tender document or specifications of the Contract, and/or the Tender evaluation process of such contract.		
8	Tenderer has a close business or family relationship with a professional staff of the Procuring Entity who would be involved in the implementation or supervision of the such Contract.		
9	Has the conflict stemming from such relationship stated in item 7 and 8 above been resolved in a manner acceptable to the Procuring Entity throughout the tendering process and execution of the Contract.		

f) Certification

On behalf of the Tenderer, I certify that the information given above is complete, current and accurate as at the date of submission.

Full Name_____ Title

or Designation_____

_____ _____

(Signature) *(Date)*

B CERTIFICATE OF INDEPENDENT TENDER DETERMINATION

I, the undersigned, in submitting the accompanying Letter of Tender to the_____[Name of Procuring Entity] for:_____[Name and number of tender] in response to the request for tenders made by:___

_____ _____[Name of Tenderer] do hereby make the following statements that I certify to be true and complete in every respect:

I certify, on behalf of _____[Name of Tenderer] that:

1. I have read and I understand the contents of this Certificate;

2. I understand that the Tender will be disqualified if this Certificate is found not to be true and complete in every respect;

3. I am the authorized representative of the Tenderer with authority to sign this Certificate, and to submit the Tender on behalf of the Tenderer;

4. For the purposes of this Certificate and the Tender, I understand that the word "competitor" shall include any individual or organization, other than the Tenderer, whether or not affiliated with the Tenderer, who:
   a) has been requested to submit a Tender in response to this request for tenders;

   b) could potentially submit a tender in response to this request for tenders, based on their qualifications, abilities or experience;

5. The Tenderer discloses that [check one of the following, as applicable:
   a) The Tenderer has arrived at the Tender independently from, and without consultation, communication, agreement or arrangement with, any competitor;

   b) the Tenderer has entered into consultations, communications, agreements or arrangements with one or more competitors regarding this request for tenders, and the Tenderer discloses, in the attached document(s), complete details thereof, including the names of the competitors and the nature of, and reasons for, such consultations, communications, agreements or arrangements;

6. In particular, without limiting the generality of paragraphs (5)(a) or (5)(b) above, there has been no consultation, communication, agreement or arrangement with any competitor regarding:
   a) prices;
   b) methods, factors or formulas used to calculate prices;
   c) the intention or decision to submit, or not to submit, a tender; or
   d) the submission of a tender which does not meet the specifications of the request for Tenders; except as specifically disclosed pursuant to paragraph (5)(b) above;

7. In addition, there has been no consultation, communication, agreement or arrangement with any competitor regarding the quality, quantity, specifications or delivery particulars of the works or services to which this request for tenders relates, except as specifically authorized by the procuring authority or as specifically disclosed pursuant to paragraph (5)(b) above;
8. the terms of the Tender have not been, and will not be, knowingly disclosed by the Tenderer, directly or indirectly, to any competitor, prior to the date and time of the official tender opening, or of the awarding of the Contract, whichever comes first, unless otherwise

   required by law or as specifically disclosed pursuant to paragraph (5)(b) above.
   Name_____

Title_____

Date _____

[Name, title and signature of authorized agent of Tenderer and Date].

C. SELF-DECLARATION FORMS

FORM SD1

SELF DECLARATION THAT THE PERSON/TENDERER IS NOT DEBARRED IN THE MATTER OF THE PUBLIC PROCUREMENT AND ASSET DISPOSAL ACT 2015.

I ..... of Post Office Box.....being a resident of ..... in the Republic of.....do hereby make a statement as follows:-

1. THAT I am the Company Secretary/ Chief Executive/Managing Director/Principal Officer/Director of ..... (insert name of the Company) who is a Bidder in respect of Tender No. ..... for..... (insert tender title/description) for.....(insert name of the Procuring entity) and duly authorized and competent to make this statement.

2. THAT the aforesaid Bidder, its Directors and subcontractors have not been debarred from participating in procurement proceeding under Part IV of the Act.

3. THAT what is deponed to herein above is true to the best of my knowledge, information and belief.

……. ……..…. ……
(Title) (Signature) (Date)

Bidder Official Stamp

FORM SD2

SELF DECLARATION THAT THE PERSON/TENDERER WILL NOT ENGAGE IN ANY CORRUPT OR FRAUDULENT PRACTICE

I, ……..... of P.O. Box.....being a resident of..... in the Republic of ..... do hereby make a statement as follows:-

1. THAT I am the Chief Executive/Managing Director/Principal Officer/Director of.....……...…… (insert name of the Company) who is a Bidder in respect of Tender No. ..... for..... (Insert tender title/description) for..... (insert name of the Procuring entity) and duly authorized and competent to make this statement.

2. THAT the aforesaid Bidder, its servants and/or agents /subcontractors will not engage in any corrupt or fraudulent practice and has not been requested to pay any inducement to any member of the Board, Management, Staff and/or employees and/or agents of ……..(insert name of the Procuring entity) which is the procuring entity.

3. THAT the aforesaid Bidder, its servants and/or agents /subcontractors have not offered any inducement to any member of the Board, Management, Staff and/or employees and/or agents of ……..(name of the procuring entity).

4. THAT the aforesaid Bidder will not engage/has not engaged in any corrosive practice with other bidders participating in the subject tender.

5. THAT what is deponed to herein above is true to the best of my knowledge information and belief.

……...… ……..
(Title) (Signature) (Date)

Bidder's Official Stamp

FORMAT OF POWER OF ATTORNEY

We..... (name and address of the registered office) do hereby constitute, appoint and authorize Mr. / Mrs. / Ms ..... (name and residential address) who is presently employed with us and holding the position of ..... as our attorney, to do in our name and on our behalf, all such acts, deeds and things necessary in connection with or incidental to our proposal for the project/goods/works/services“.....”, including signing and submission of all documents and providing information / responses to the Kenya Electricity Generating Company PLC, ("KenGen"), representing us in all matters before KenGen, and generally dealing with KenGen in all matters in connection with our Proposal for the said project/goods/works/services.

We hereby agree to ratify all acts, deeds and things lawfully done by our said attorney pursuant to this Power of Attorney and that all acts, deeds and things done by our aforesaid attorney shall and shall always be deemed to have been done by us

..... (Signature) (Name, Title and Address)

Accepted

..... (Signature) (Name, Title and Address of the Attorney)

DECLARATION AND COMMITMENT TO THE CODE OF ETHICS

I ……..……. (person) on behalf of (Name of the Business/ Company/Firm) ……. declare that I have read and fully understood the contents of the Public Procurement & Asset Disposal Act, 2015, Regulations and the Code of Ethics for persons participating in Public Procurement and Asset Disposal and my responsibilities under the Code.

I do hereby commit to abide by the provisions of the Code of Ethics for persons participating in Public Procurement and Asset Disposal.

Name of Authorized signatory…….....Sign…….....

Position…….....…….....

Office address……Telephone…….....……

E-mail……..…….....….....…

Name of the Firm/Company…… … …….....…

Date…….....….

(Company Seal/ Rubber Stamp where applicable)

Witness

Name ……..... Sign.....

Date……

D APPENDIX 1- FRAUD AND CORRUPTION

(Appendix 1 shall not be modified)

1 Purpose

2 The Government of Kenya's Anti-Corruption and Economic Crime laws and their sanction's policies and procedures, Public Procurement and Asset Disposal Act (no. 33 of 2015) and its Regulation, and any other Kenya's Acts or Regulations related to Fraud and Corruption, and similar offences, shall apply with respect to Public Procurement Processes and Contracts that are governed by the laws of Kenya.

3 Requirements

The Government of Kenya requires that all parties including Procuring Entities, Tenderers, (applicants/proposers), Consultants, Contractors and Suppliers; any Sub-contractors, Sub-consultants, Service providers or Suppliers; any Agents (whether declared or not); and any of their Personnel, involved and engaged in procurement under Kenya's Laws and Regulation, observe the highest standard of ethics during the procurement process, selection and contract execution of all contracts, and refrain from Fraud and Corruption and fully comply with Kenya's laws and Regulations as per paragraphs 1.1 above.

Kenya's public procurement and asset disposal act (no. 33 of 2015) under Section 66 describes rules to be followed and actions to be taken in dealing with Corrupt, Coercive, Obstructive, Collusive or Fraudulent practices, and Conflicts of Interest in procurement including consequences for offences committed. A few of the provisions noted below highlight Kenya's policy of no tolerance for such practices and behavior: -

1) a person to whom this Act applies shall not be involved in any corrupt, coercive, obstructive, collusive or fraudulent practice; or conflicts of interest in any procurement or asset disposal proceeding;
2) A person referred to under subsection (1) who contravenes the provisions of that sub-section commits an offence;
3) Without limiting the generality of the subsection (1) and (2), the person shall be: -
   a) disqualified from entering into a contract for a procurement or asset disposal proceeding; or
   b) if a contract has already been entered into with the person, the contract shall be voidable;
4) The voiding of a contract by the procuring entity under subsection (7) does not limit any legal remedy the procuring entity may have;
5) An employee or agent of the procuring entity or a member of the Board or committee of the procuring entity who has a conflict of interest with respect to a procurement: -
   a) shall not take part in the procurement proceedings;
   b) shall not, after a procurement contract has been entered into, take part in any decision relating to the procurement or contract; and
   c) shall not be a subcontractor for the bidder to whom was awarded contract, or a member of the group of bidders to whom the contract was awarded, but the subcontractor appointed shall meet all the requirements of this Act.

6) An employee, agent or member described in subsection (1) who refrains from doing anything prohibited under that subsection, but for that subsection, would have been within his or her duties shall disclose the conflict of interest to the procuring entity;

7) If a person contravenes subsection (1) with respect to a conflict of interest described in subsection (5)(a) and the contract is awarded to the person or his relative or to another person in whom one of them had a direct or indirect pecuniary interest, the contract shall be terminated and all costs incurred by the public entity shall be made good by the awarding officer. Etc.

In compliance with Kenya's laws, regulations and policies mentioned above, the Procuring Entity:

a) Defines broadly, for the purposes of the above provisions, the terms set forth below as follows:

i. "corrupt practice" is the offering, giving, receiving, or soliciting, directly or indirectly, of anything of value to influence improperly the actions of another party;

ii. "fraudulent practice" is any act or omission, including misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, a party to obtain financial or other benefit or to avoid an obligation;

iii. "collusive practice" is an arrangement between two or more parties designed to achieve an improper purpose, including to influence improperly the actions of another party

iv. "coercive practice" is impairing or harming, or threatening to impair or harm, directly or indirectly, any party or the property of the party to influence improperly the actions of a party;

v. "obstructive practice" is:

- deliberately destroying, falsifying, altering, or concealing of evidence material to the investigation or making false statements to investigators in order to materially impede investigation by Public Procurement Regulatory Authority (PPRA) or any other appropriate authority appointed by Government of Kenya 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; or
- acts intended to materially impede the exercise of the PPRA's or the appointed authority's inspection and audit rights provided for under paragraph 2.3 e. below.

b) Defines more specifically, in accordance with the above procurement Act provisions set forth for fraudulent and collusive practices as follows:

"fraudulent practice" includes a misrepresentation of fact in order to influence a procurement or disposal process or the exercise of a contract to the detriment of the procuring entity or the tenderer or the contractor, and includes collusive practices amongst 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.

c) Rejects a proposal for award[1] of a contract if PPRA determines that the firm or individual recommended for award, any of its personnel, or its agents, or its sub-consultants, sub-contractors, service providers, suppliers and/ or their employees, has, directly or indirectly, engaged in corrupt, fraudulent, collusive, coercive, or obstructive practices in competing for the contract in question;

d) Pursuant to the Kenya's above stated Acts and Regulations, may sanction or recommend to appropriate authority (ies) for sanctioning and debarment of a firm or individual, as applicable under the Acts and Regulations;

e) Requires that a clause be included in Tender documents and Request for Proposal documents requiring (i) Tenderers (applicants/proposers), Consultants, Contractors, and Suppliers, and their Sub-contractors, Sub-consultants, Service providers, Suppliers, Agents personnel, permit the PPRA or any other appropriate authority appointed by Government of Kenya to inspect[2] all accounts, records and other documents relating to the procurement process, selection and/or contract execution, and to have them audited by auditors appointed by the PPRA or any other appropriate authority appointed by Government of Kenya; and

f) Pursuant to Section 62 of the above Act, requires Applicants/Tenderers to submit along with their Applications/Tenders/Proposals a "Self-Declaration Form" as included in the procurement document declaring that they and all parties involved in the procurement process and contract execution have not engaged/will not engage in any corrupt or fraudulent practices.

[1]For the avoidance of doubt, a party's ineligibility to be awarded a contract shall include, without limitation, (i) applying for pre-qualification, expressing interest in a consultancy, and tendering, either directly or as a nominated sub-contractor, nominated consultant, nominated manufacturer or supplier, or nominated service provider, in respect of such contract, and (ii) entering into an addendum or amendment introducing a material modification to any existing contract.

[2]Inspections in this context usually are investigative (i.e., forensic) in nature. They involve fact-finding activities undertaken by the Investigating Authority or persons appointed by the Procuring Entity to address specific matters related to investigations/audits, such as evaluating the veracity of an allegation of possible Fraud and Corruption, through the appropriate mechanisms. Such activity includes but is not limited to: accessing and examining a firm's or individual's financial records and information, and making copies thereof as relevant; accessing and examining any other documents, data and information (whether in hard copy or electronic format) deemed relevant for the investigation/audit, and making copies thereof as relevant; interviewing staff and other relevant individuals; performing physical inspections and site visits; and obtaining third party verification of information.

FORM OF TENDER SECURITY-[Option 1–Demand Bank Guarantee] -NOT APPLICABLIE

Beneficiary:_____

Request forTenders No: _____

Date: _____

TENDER GUARANTEE No.: _____

Guarantor: _____

1) We have been informed that _____(here inafter called "the Applicant") has submitted or will submit to the Beneficiary its Tender (here inafter called" the Tender") for the execution of _____ under Request for Tenders No. ("the ITT").

2) Furthermore, we understand that, according to the Beneficiary's conditions, Tenders must be supported by a Tender guarantee.

3) At the request of the Applicant, we, as Guarantor, hereby irrevocably undertake to pay the Beneficiary any sum or sums not exceeding in total an amount of (_____) upon receipt by us of the Beneficiary's complying demand, supported by the Beneficiary's statement, whether in the demand itself or a separate signed document accompanying or identifying the demand, stating that either the Applicant:

   (a) has withdrawn its Tender during the period of Tender validity set forth in the Applicant's Letter of Tender ("the Tender Validity Period"), or any extension thereto provided by the Applicant; or

   (b) having been notified of the acceptance of its Tender by the Beneficiary during the Tender Validity Period or any extension there to provided by the Applicant, (i) has failed to execute the contract agreement, or (ii) has failed to furnish the Performance.

4) This guarantee will expire: (a) if the Applicant is the successful Tenderer, upon our receipt of copies of the contract agreement signed by the Applicant and the Performance Security and, or (b) if the Applicant is not the successful Tenderer, upon the earlier of (i) our receipt of a copy of the Beneficiary's notification to the Applicant of the results of the Tendering process; or (ii) thirty days after the end of the Tender Validity Period.

5) Consequently, any demand for payment under this guarantee must be received by us at the office indicated above onor before that date.

_____

[signature(s)]

FORMAT OF TENDER SECURITY [Option 2–Insurance Guarantee] NOT APPLICABLIE

TENDER GUARANTEE No.: _____

1) 1.Whereas …… [Name of the tenderer] (hereinafter called "the tenderer") has submitted its tender dated ……..…… [Date of submission of tender] for the …… …..…… [Name and/or description of the tender] (hereinafter called "the Tender") for the execution of under Request for Tenders No. ……..("the ITT").

2) KNOW ALL PEOPLE by these presents that WE …… of …… [Name of Insurance Company] having our registered office at ……..…… (hereinafter called "the Guarantor"), are bound unto ……..……..…….. [Name of Procuring Entity] (hereinafter called "the Procuring Entity") in the sum of ……..…… (Currency and guarantee amount) for which payment well and truly to be made to the said Procuring Entity, the Guarantor binds itself, its successors and assigns, jointly and severally, firmly by these presents.

   Sealed with the Common Seal of the said Guarantor this ____day of _____ 20 ____.

3) NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION is such that if the Applicant:

   a. has withdrawn its Tender during the period of Tender validity set forth in the Principal's Letter of Tender ("the Tender Validity Period"), or any extension thereto provided by the Principal; or

   b. having been notified of the acceptance of its Tender by the Procuring Entity during the Tender Validity Period or any extension thereto provided by the Principal; (i) failed to execute the Contract agreement; or (ii) has failed to furnish the Performance Security, in accordance with the Instructions to tenderers ("ITT") of the Procuring Entity's Tendering document.

   then the guarantee undertakes to immediately pay to the Procuring Entity up to the above amount upon receipt of the Procuring Entity's first written demand, without the Procuring Entity having to substantiate its demand, provided that in its demand the Procuring Entity shall state that the demand arises from the occurrence of any of the above events, specifying which event(s) has occurred.

4) This guarantee will expire: (a) if the Applicant is the successful Tenderer, upon our receipt of copies of the contract agreement signed by the Applicant and the Performance Security and, or (b) if the Applicant is not the successful Tenderer, upon the earlier of (i) our receipt of a copy of the Beneficiary's notification to the Applicant of the results of the Tendering process; or (ii)twenty-eight days after the end of the Tender Validity Period.

5) Consequently, any demand for payment under this guarantee must be received by us at the office indicated above on or before that date.

[Date]	[Signature of the Guarantor]
[Witness]	[Seal]

TENDER-SECURING DECLARATION FORM

[The Bidder shall complete this Form in accordance with the instructions indicated]

Date:.....[insert date (as day, month and year) of Tender Submission]

Tender No.:.....[insert number of tendering process]

To:..... [insert complete name of Purchaser]

I/We, the undersigned, declare that:

1) I/We understand that, according to your conditions, bids must be supported by a Tender-Securing Declaration.

2) I/We accept that I/we will automatically be suspended from being eligible for tendering in any contract with the Purchaser for the period of time of [Two years] starting on [Closing date], if we are in breach of our obligation(s)under the bid conditions, because we – (a) have withdrawn our tender during the period of tender validity specified by us in the Tendering Data Sheet; or (b) having been notified of the acceptance of our Bid by the Purchaser during the period of bid validity, (i) fail or refuse to execute the Contract, if required, or (ii) fail or refuse to furnish the Performance Security, in accordance with the instructions to tenders.
3) I/We understand that this Tender Securing Declaration shall expire if we are not the successful Tenderer(s), upon the earlier of:

    a. our receipt of a copy of your notification of the name of the successful Tenderer; or
    b. thirty days after the expiration of our Tender.

4) I/We understand that if I am/we are/in a Joint Venture, the Tender Securing Declaration must be in the name of the Joint Venture that submits the bid, and the Joint Venture has not been legally constituted at the time of bidding, the Tender Securing Declaration shall be in the names of all future partners as named in the letter of intent.

Signed:……..……..…..

Capacity / title (director or partner or sole proprietor, etc.) …….…….....…….

Name: ……..

Duly authorized to sign the bid for and on behalf of: ……[insert complete name of Tenderer]

Dated on ……. day of ……..……. [Insert date of signing]

Seal or stamp……..

APPENDIX TO TENDER

Schedule of Currency requirements

Summary of currencies of the Tender for_____[insert name of Section of the Works]

Name of currency	Amounts payable
Local currency: _____	
Foreign currency #1: _____	
Foreign currency #2: _____	
Foreign currency #3: _____	
Provisional sums expressed in local currency _____	[To be entered by the Procuring Entity]

SECTION IV – CONDITIONS OF CONTRACT

PART I – GENERAL CONDITIONS OF CONTRACT

The following General conditions of Contract shall supplement those in the Special Conditions of Contract as provided for by Conditions of Contract for Construction, For Building and Engineering works Designed by the Employer, First Edition 1999, prepared by **Federation Internationale des Ingenieurs-Conseils (FIDIC).** Whenever there is a conflict, the provisions **Federation Internationale des Ingenieurs-Conseils (FIDIC) Special Conditions of Contract,** shall prevail.

1. Definitions

1.1 In this Contract, except where context otherwise requires, the following terms shall be interpreted as indicated;

"Bills of Quantities" means the priced and completed Bill of Quantities forming part of the tender [where applicable].

"Schedule of Rates" means the priced Schedule of Rates forming part of the tender [where applicable].

"The Completion Date" means the date of completion of the Works as certified by the Employer's Representative.

"The Contract" means the agreement entered into by the Employer and the Contractor as recorded in the Agreement Form and signed by the parties.

"The Contractor" refers to the person or corporate body whose tender to carry out the Works has been accepted by the Employer.

"The Contractor's Tender" i s the completed tendering document submitted by the Contractor to the Employer.

"The Contract Price" is the price stated in the Notification of award.

"Days" are calendar days; "Months" are calendar months.

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

"The Defects Liability Certificate" is the certificate issued by Employer's Representative upon correction of defects by the Contractor.

"The Defects Liability Period" is the period named in the Appendix to Conditions of Contract and calculated from the Completion Date.

"Drawings" include calculations and other information provided or approved by the Employer's Representative for the execution of the Contract.

"Employer" means Kenya Electricity Generating Company Limited and 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 for the execution of the Works.

"Site" means the place or places where the permanent Works are to be carried out including workshops where the same is being prepared.

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

"Employer's Representative" is the person appointed by the Employer and notified to the Contractor for the purpose of supervision of the Works.

"Specification" means the Specification of the Works included in the Contract.

"Start Date" is the date when the Contractor shall commence execution of the Works.

"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 which a r e needed for construction or installation of the Works.

"A Variation" is an instruction given by the Employer's Representative which varies the Works.

"The Works" are what the Contract requires the Contractor to construct, install, and turnover to the Employer.

2. Contract Documents

2.1 The following documents shall constitute the Contract documents and shall be interpreted in the following order of priority;

(1) Contract Agreement,
(2) Notification of award
(3) Letter of Acceptance,
(4) Conditions of Contract
(5) Technical Specifications
(6) Drawings,
(7) Bills of Quantities or Schedule of Rates [whichever is applicable)

(8) Contractor's Tender,
(9) Applicable Addenda and Clarifications

3. Employer's Representative's Decisions

3.1 Except where otherwise specifically stated, the Employer's Representative will decide contractual matters between the Employer and the Contractor in the role representing the Employer.

4. Works, Language and Law of Contract

4.1 The Contractor shall construct and install the Works in accordance with the Contract documents. The Works may commence on the Start Date and shall be carried out in accordance with the Program submitted by the Contractor, as updated with the approval of the Employer's Representative, and complete them by the Intended Completion Date.

4.2 The ruling language of the Contract shall be English language and the law governing the Contract shall be the law of the Republic of Kenya.

5. Safety, Temporary works and Discoveries

5.1 The Contractor shall be responsible for design of temporary works and shall obtain approval of third parties to the design of the temporary works where required.

5.2 The Contractor shall be responsible for the safety of all activities on the Site.

5.3 Anything of historical or other interest or significant value unexpectedly discovered on the Site shall be the property of the Employer. The Contractor shall notify the Employer's Representative of such discoveries and carry out the Employer's Representative's instructions for dealing with them.

6 Work Program and Sub-contracting

6.1 Within seven days after Site possession date, the Contractor shall submit to the Employer's Representative for approval a program showing the general methods, arrangements, order and timing for all the activities in the Works.

6.2 The Contractor may sub-contract the Works (but only to a maximum of 25 percent of the Contract Price) with the approval of the Employer's Representative. However, he shall not assign the Contract without the approval of the Employer in writing. Sub-contracting shall not alter the Contractor's obligations.

7 The site

7.1 The Employer shall give possession of all parts of the Site to the Contractor.

7.2 The Contractor shall allow the Employer's Representative and any other person authorised by the Employer's Representative, 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.

8 Instructions

8.1 The Contractor shall carry out all instructions of the Employer's Representative which are in accordance with the Contract.

9 Extension of Completion Date

9.1 The Employer's Representative shall extend the Completion Date if an occurrence arises which makes it impossible for completion to be achieved by the Intended Completion Date. The Employer's Representative shall decide whether and by how much to extend the Completion Date.

9.2 For the purposes of this clause, the following occurrences shall be valid for consideration;

Delay by:-

(a) Force majeure, or
(b) Reason of any exceptionally adverse weather conditions, or

(c) reason of civil commotion, strike or lockout affecting any of the trades employed upon the Works or any of the trades engaged in the preparation, manufacture or transportation of any of the goods or materials required for the Works, or

(d) Reason of the Employer's Representative's instructions issued under these Conditions, or

(e) reason of the contractor not having received in due time necessary instructions, drawings, details or levels from the Employer's Representative for which he specifically applied in writing on a date which having regard to the date for Completion stated in the appendix to these Conditions or to any extension of time then fixed under this clause was neither unreasonably distant from nor unreasonably close to the date on which it was necessary for him to receive the same, or

(f) delay on the part of artists, tradesmen or others engaged by the Employer in executing work not forming part of this Contract, or

(g) reason of delay by statutory or other services providers or similar bodies engaged directly by the Employer, or

(h) reason of opening up for inspection of any Work covered up or of the testing or any of the Work, materials or goods in accordance with these conditions unless the inspection or test showed that the Work, materials or goods were not in accordance with this Contract, or

(i) reason of delay in appointing a replacement, Employer's Representative, or

(j) reason of delay caused by the late supply of goods or materials or in executing Work for which the Employer or his agents are contractually obliged to supply or to execute as the case may be, or

(k) delay in receiving possession of or access to the Site.

10 Management Meetings

10.1 A Contract management meeting shall be held regularly and attended by the Employer's Representative and the Contractor. Its business shall be to review the plans for the remaining Work. The Employer's Representative shall record the business of management meetings and provide copies of the record to those attending the meeting and the Employer. The responsibility of the parties for actions to be taken shall be decided by the Employer's Representative either at the management meeting or after the management meeting and stated in writing to all who attend the meeting.

10.2 Communication between parties shall be effective only when in writing.

11 Defects

11.1 The Employer's Representative shall inspect the Contractor's work and notify the Contractor of any defects that are found. Such inspection shall not affect the Contractor's responsibilities. The Employer's Representative may instruct the Contractor to search for a defect and to uncover and test any Work that the Employer's Representative considers may have a defect. Should the defect be found, the cost of uncovering and making good shall be borne by the Contractor. However if there is no defect found, the cost of uncovering and making good shall be treated as a variation and added to the Contract Price.

11.2 The Employer's Representative 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 Appendix to Conditions of Contract.

11.3 Every time notice of a defect is given, the Contractor shall correct the notified defect within the length of time specified by the Employer's Representative's notice. If the Contractor has not corrected a defect within the time specified in the Employer's Representative's notice, the Employer's Representative will assess the cost of having the defect corrected by other parties and such cost shall be treated as a variation and be deducted from the Contract Price.

12 Bills of Quantities/Schedule of Rates

12.1 The Bills of Quantities/Schedule of Rates shall contain items for the construction, installation, testing and commissioning of the Work to be done by the Contractor. The Contractor will be paid for the quantity of the Work done at the rates in the Bills of Quantities/Schedule of Rates for each item. Items against which no rate is entered by the Tenderer will not be paid for when executed and shall be deemed covered by the rates for other items in the Bills of Quantities/Schedule of Rates.

12.2 Where Bills of Quantities do not form part of the Contract, the Contract Price shall be a lump sum (which shall be deemed to have been based on the rates in the Schedule of Rates forming part of the tender) and shall be subject to re-measurement after each stage.

13 Variations

13.1 The Contractor shall provide the Employer's Representative with a quotation for carrying out the variations when requested to do so. The Employer's Representative shall assess the quotation and shall obtain the necessary authority from the Employer before the variation is ordered.

13.2 If the Work in the variation corresponds with an item description in the Bill of Quantities/Schedule of Rates, the rate in the Bill of Quantities/Schedule of Rates shall be used to calculate the value of the variation. If the nature of the Work in the variation does not correspond with items in the Bill of Quantities/Schedule of Rates, the quotation by the Contractor shall be in the form of new rates for the relevant items of Work.

13.3 If the Contractor's quotation is unreasonable, the Employer's Representative may order the variation and make a change to the Contract Price, which shall be based on the Employer's Representative's own forecast of the effects of the variation on the Contractor's costs.

14 Payment Certificates and Final Account

14.1 The Contractor shall be paid after each of the following stages of Work listed here below (subject to re-measurement by the Employer's Representative of the Work done in each stage before payment is made).

In case of lump-sum Contracts, the valuation for each stage shall be based on the quantities so obtained in the re-measurement and the rates in the Schedule of Rates.

14.2 Upon deciding that Works included in a particular stage are complete, the Contractor shall submit to the Employer's Representative his application for payment.

The Employer's Representative shall check, adjust if necessary and certify the amount to be paid to the Contractor within 21 days of receipt of the Contractor's application .The Employer shall pay

the Contractor the amounts so certified within 30 days of the date of issue of each Interim Certificate.

14.3 The Contractor shall supply the Employer's Representative with a detailed final account of the total amount that the Contractor considers payable under the Contract before the end of the Defects Liability Period.

The Employer's Representative shall issue a Defect Liability Certificate and certify any final payment that is due to the Contractor within 30 days of receiving the Contractor's account if it is correct and complete. If it is not, the Employer's Representative shall issue within 21 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 Employer's Representative shall decide on the amount payable to the Contractor and issue a Final Payment Certificate.

The Employer shall pay the Contractor the amount so certified within 60 days of the issue of the Final Payment Certificate.

14.4 If the period laid down for payment to the Contractor upon each of the Employer's Representative's Certificate by the Employer has been exceeded, the Contractor shall be entitled to claim simple interest calculated pro-rata on the basis of the number of days delayed at the Central Bank of Kenya's average base lending rate prevailing on the first day the payment becomes overdue.

The Contractor will be required to notify the Employer within 15 days of receipt of delayed payments of his intentions to claim interest.

15. Insurance

15.1 The Contractor shall be responsible for and shall take out appropriate cover against, among other risks, personal injury; loss of or damage to the Works, materials and plant; and loss of or damage to property.

16. Liquidated Damages

16.1 The Contractor shall pay liquidated damages to the Employer at the rate 0.1 per cent of the Contract price per day for each day that the actual Completion Date is later than the Intended Completion Date except in the case of any of the occurrences listed under clause

16.2 The Employer may deduct liquidated damages from payments due to the Contractor. Payment of liquidated damages shall not affect the Contractor's liabilities.

17. Completion and Taking Over

17.1 Upon deciding that the Work is complete the Contractor shall request the Employer's Representative to issue a Certificate of Completion of the Works.

The Employer shall take over the Site and the Works within seven days of the Employer's Representative issuing a Certificate of Completion.

18. Termination

18.1 The Employer or the Contractor may terminate the Contract if the other party causes fundamental breach of the Contract. These fundamental breaches of Contract shall include, but shall not be limited to, the following;

a) the Contractor stops Work for 30 days continuously without reasonable cause or authority from the Employer's Representative;

b) the Contractor is declared bankrupt or goes into liquidation other than for a reconstruction or amalgamation;

c) a payment certified by the Employer's Representative is not paid by the Employer to the Contractor within 30 days after the expiry of the payment periods stated in sub clauses 14.2 and 14.3 hereinabove.

d) the Employer's Representative 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.

18.2 If the Contract is terminated, the Contractor shall stop Work immediately, and leave the Site as soon as reasonably possible. The Employer's Representative shall immediately thereafter arrange for a meeting for the purpose of taking record of the Works executed and materials, goods, equipment and temporary buildings on Site.

19. Payment upon Termination

19.1 The Employer may employ and pay other persons to carry out and complete the Works and to rectify any defects and may enter upon the Works and use all materials on Site, plant, equipment and temporary works.

19.2 The Contractor shall, during the execution or after the completion of the Works under this clause, remove from the Site as and when required within such reasonable time as the Employer's Representative may in writing specify any temporary buildings, plant, machinery, appliances, goods or materials belonging to him, and in default thereof , the Employer may (without being responsible for any loss or damage) remove and sell any such property of the Contractor, holding the proceeds less all costs incurred to the credit of the Contractor.

19.3 Until after completion of the Works under this clause, the Employer shall not be bound by any other provision of this Contract to make any payment to the Contractor, but upon such completion as aforesaid and the verification within a reasonable time of the accounts therefore the Employer's Representative shall certify the amount of expenses properly incurred by the Employer and, if such amount added to the money paid to the Contractor before such determination exceeds the total amount which would have been payable on due completion in accordance with this Contract, the difference shall be a debt payable to the Employer by the Contractor; and if the said amount added to the said money be less than the said total amount, the difference shall be a debt payable by the Employer to the Contractor.

19.4 In the event that an advance payment is granted, the following shall apply:-

a) On signature of the Contract, the Contractor shall at his request, and without furnishing proof of expenditure, be entitled to an advance of 10% (ten percent) of the original amount of the Contract. The advance shall not be subject to retention money.

b) No advance payment may be made before the Contractor has submitted proof of the establishment of deposit or a directly liable guarantee satisfactory to the Employer in the amount of the advance payment. The guarantee shall be in the same currency as the advance.

c) Reimbursement of the lump sum advance shall be made by deductions from the Interim payments and where applicable from the balance owing to the Contractor. Reimbursement shall begin when the amount of the sums due under the Contract reaches 20% of the original amount of the Contract. It shall have been completed by the time 80% of this amount is reached

The amount to be repaid by way of successive deductions shall be calculated by means of the formula:

$$R = A\frac{(x1 - x11)}{80 - 20}$$

Where:

R = the amount to be reimbursed

A = the amount of the advance which has been granted

X1 = the amount of proposed cumulative payments as a percentage of the original amount of the Contract. This figure will exceed 20% but not exceed 80%.

X11 = the amount of the previous cumulative payments as a percentage of the original amount of the Contract. This figure will be below 80%but not less than 20%.

d) With each reimbursement the counterpart of the directly liable, Guarantee may be reduced accordingly.

20. Corrupt Gifts and Payments of Commission

20.1 The Contractor shall not;

(a) Offer or give or agree to give to any person in the service of the Employer any gifts or consideration of any kind as an inducement or reward for doing or forbearing to do or for having done or forborne to do any act in relation to the obtaining or execution of this or any other contract with the Employer or for showing or forbearing to show favour or dis-favour to any person in relation to this or any other contract with the Employer.

(b) Any breach of this Condition by the Contractor or by anyone employed by him or acting on his behalf (whether with or without the knowledge of the Contractor) shall be an offence under the Laws of Kenya.

21. Settlement of Disputes

21.1 Any dispute arising out of the Contract which cannot be amicably settled between the parties shall be referred by either party to the arbitration and final decision of a person to be agreed between the parties. Failing agreement to concur in the appointment of an Arbitrator, the Arbitrator shall be appointed by the chairman of the Chartered Institute of Arbitrators, Kenya branch, on the request of the applying party.

22 Taxes

22.1 **"Taxes"** means all present and future taxes, levies, duties, charges, assessments, deductions or withholdings whatsoever, including any interest thereon, and any penalties and fines with respect thereto, wherever imposed, levied, collected, or withheld pursuant to any regulation having the force of law and "Taxation" shall be construed accordingly.

22.2 Local Taxation

Nothing in the Contract shall relieve the Contractor and/or his Sub-Contractors from their responsibility to pay any taxes, statutory contributions and levies that may be levied on them in Kenya in respect of the Contract. The Contract Price shall include all applicable taxes and shall not be adjusted for any of these taxes.

22.3 The Contractor shall be deemed to be familiar with the tax laws in the Employer's Country and satisfied themselves with the requirements for all taxes, statutory contributions and duties to which they may be subjected during the term of the Contract.

22.4 In instances where discussions are held between the Employer and the Contractor regarding tax matters, this shall not be deemed to constitute competent advice and hence does not absolve the Contractor of their responsibility in relation to due diligence on the tax

issue as per 3.21.2 above.

Tax Deduction

22.5 If the Employer is required to make a tax deduction by Law, then the deduction shall be made from payments due to the Contractor and paid directly to the Kenya Revenue Authority. The Employer shall upon remitting the tax to Kenya Revenue Authority furnish the Contractor with the relevant tax deduction certificates.

22.7 Where the Contractor is paid directly by the Financiers and the Employer is not able to deduct tax, then the Contractor will be required to pay the tax deduction to Kenya Revenue Authority in the name of the Employer and furnish the Employer with an original receipt thereof as evidence of such payment. In absence of the said evidence, the Employer will not process any subsequent payments to the Contractor.

Tax Indemnity

22.8 The Contractor shall indemnify and hold the Employer harmless from and against any and all liabilities, which the Employer may incur for any reason of failure by the Contractor to comply with any tax laws arising from the execution of the Contract whether during the term of the Contract or after its expiry.

22.9 The Contractor warrants to pay the Employer (within fourteen (14) days of demand by the Employer), an amount equal to the loss, liability or cost which the Employer determines has been (directly or indirectly) suffered by the Employer for or on account of the Contractor's Tax liability arising from the Contract.

22.10 Where the amount in 3.21.8 above remains unpaid after the end of the fourteen (14) days moratorium, the Employer shall be entitled to compensation for financing charges.

PART II – SPECIAL CONDITIONS OF CONTRACT

The conditions of Contract – Special Conditions, shall be those forming Conditions of Contract for Construction, For Building and Engineering works Designed by the Employer, First Edition 1999, prepared by **Federation Internationale des Ingenieurs-Conseils (FIDIC).**

Where in conflict, the provisions of these special conditions of contract shall prevail over those provided for in Part 1 – General Conditions of Contract

NOTE:

i. The Contractor, through the Association of Consulting Engineers of Kenya (ACEK), shall be deemed to have procured a copy for his own use from: -

FIDIC Secretariate
P.O. Box 86, 1000 Lausanne 12
Switzerland
Fax: 41 21 653 5432
Telephone: 41 21 653 5003

ii. These Conditions are subject to the variations set out in Part III hereof entitled "Conditions of Particular Application".

iii. The Conditions of Particular Application take precedence over those of General and Special Conditions of Contract.

PART III - CONDITIONS OF PARTICULAR APPLICATION

The following Conditions of Particular Application shall supplement the FIDIC Special Conditions of Contract. Whenever there is a conflict, the provisions herein shall prevail over those in the General and Special Conditions of Contract. The Particular Condition is preceded by the corresponding clause number of the FIDIC Special Conditions of Contract to which it relates.

CLAUSE	SUB-CLAUSE IN CONDITIONS OF CONTRACT	DETAILS
1.1.1.8	Tender	Delete Sub-clause 1.1.1.8 and substitute with: "The word "Tender" and all other documents which the Contractor will submit shall also mean "Bid" and the word "Contractor" shall also mean "Bidder"
1.5	Priority of Documents	Delete Sub-clause 1.5 and substitute with: For purposes of interpretation, the priority of documents shall be according to the following order 1. Contract Agreement 2. Letter of Acceptance 3. Letter of Award 4. Form of Tender 5. Particular Conditions of Contract 6. General Conditions of Contract 7. Technical Specifications 8. Eurocode and British Applicable Design Manuals 9. Drawings 10. The Priced Bill of Quantities
1.6	Contract agreement	21 Days
1.9	Delayed Drawings and Instructions	Drawings and Instructions are to be issued within 5 days of request by the Contractor in writing.
2.1	Right of access to site	Site will be handed over upon agreement by both parties at the kick-off meeting
2.4	Employer's Financial Arrangements	Delete this sub-clause.
3.1	Engineer's Duties and Authority	The scope of Engineer's duties authorized by the Employer will be furnished to the Contractor by the Employer.
3.4	Replacement of the Engineer	Delete "42 days" and substitute with "7days"

CLAUSE	SUB-CLAUSE IN CONDITIONS OF CONTRACT	DETAILS
4.2	Performance Security	Delete the paragraph 1 Sub-clause 4.2 and substitute with: "The Contractor shall obtain at his cost a Performance Security of Ten (10%) percent of the Contract Price as stated in the Form of Agreement. The guarantee shall be in the form of an On-demand and irrevocable bond **from a reputable bank licensed by the Central Bank of Kenya acceptable to the Employer**
	Project Delivery terms	**This project is Procurement and Construction (PC) nature.** The contractor will therefore be responsible for execution of the project, including all material procurement, with a view of handing over a fully operational plant after the works. In this tender document, the employer has comprehensively provided the definitions of intended purposes of the Works, as well as the criteria for the testing and performance of the completed Works. The employer shall, however, not be responsible for any error, inaccuracy, or omission of any kind in the employer's requirements as originally stated in the tender document and shall not be deemed to have given any representation of error free accuracy or completeness of any data or information. Any information provided by the employer therefore shall not relieve the contractor from his responsibility for the execution of the works and handover of an operational plant with the requisite functional guarantees. The contractor shall complete the whole of the Works and/or each section within the prescribed Time for Completion including: a) Achieving the passing of the *Tests on Completion (clause 8.2)*, and *b)* Completing all work which is stated in the tender as being required for the Works or section to be considered to be complete for the purposes of *Taking Over*
	Materials delivery terms	The contractor shall supply all the materials for incorporation into the project under **Delivered at Place (DAP) Olkaria (Incoterms 2010)**. KenGen (the Employer) shall be responsible for import clearance and any applicable local

CLAUSE	SUB-CLAUSE IN CONDITIONS OF CONTRACT	DETAILS
		taxes or import duties. The contractor shall therefore be relieved of the tax obligations relating to materials supply as these shall be paid for by KenGen either directly or in the form of tax exemption. All the logistics for material delivery to site shall, however, be the responsibility of the contractor.
4.4	Subcontractors	Delete Sub-clause 4.4 and substitute with: "The Contractor shall not sub-contract more than 30% of the Contract Work by value. Such sub-contractors shall be engaged upon prior written consent from the Employer".
4.8	Safety Procedures	Delete Sub-clause 4.8 and substitute with: "The Contractor shall prepare and submit to the Engineer a **SAFETY MANAGEMENT PLAN** within 28 days after signing of the contract for the Engineer's concurrence. The Contractor shall deploy on site a qualified safety officer at all times".
4.18	Protection of the Environment	Delete Sub-clause 4.18 and substitute with: In addition, the Contractor shall prepare and submit to the Engineer an **ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)** within 28 days after signing of the contract for the Engineer's concurrence. The Contractor shall deploy on site a qualified environmental officer at all times whose duties shall include management of the ESMP".
6.1	Engagement of Staff and Labour	At the end of sub-clause 6.1 insert: "In addition, any unskilled labour required by the Contractor for Works shall be recruited from the local community except where there is no response upon advertisement at the KenGen's Liaison office, Olkaria".
6.2	Rates of Wages and Conditions of Labour	At the end of sub-clause 6.2 insert: "The payroll records shall be available at all times for inspection by the Engineer and authorized Government officers at all times".
6.5	Working Hours	Delete the phrase; "stated in the Appendix to Tender" At the end of sub-clause 6.5 insert:

CLAUSE	SUB-CLAUSE IN CONDITIONS OF CONTRACT	DETAILS
		In the event of the Engineer consenting to work being carried out outside normal working hours, the contractor shall be responsible for payment of any additional costs incurred by the Engineer for supervision. Working hours for the Engineer are **8:00am** to **5:00pm** from Monday to Saturday except for Sundays and the following public holidays • New year's day (1st January) • Good Friday • Easter Monday • International Labour day (1st May) • Madaraka day (1st June) • Idd-Ul-Fitr • Mashujaa day (20th October) • Jamhuri day (12th December) • Christmas day (25th December) • Boxing Day (26th December) Other gazetted Public holidays (Assume 2 per year)
8.1	Commencement of Works	Delete "Letter of Acceptance" and substitute with; "Notification of Award" Delete paragraph 2 sub-clause 8.1 and substitute with: "The Contractor shall commence the execution of the Works as soon as is reasonably practicable after signing of the Contract Agreement and the order to commence Works but not later than 28 days after receipt of such order and Contract Agreement whichever is later. The Contractor shall then proceed with the Works with due expedition and without delay."
8.2	Time for Completion	Delete sub-clause 8.2 and substitute with: The Contractor shall complete the whole of the Works, and each Section , (if any), **within Three hundred and sixty five (365)days** , including Sundays and Public Holidays, calculated from receipt of the Engineer's Order to Commence works including:

CLAUSE	SUB-CLAUSE IN CONDITIONS OF CONTRACT	DETAILS
		a) Achieving the passing of the Tests on Completion, and b) Completing all work which is stated in the Contract as being required for the Works or Section to be considered to be completed for the purpose of taking-over under Section 10.1 (Taking over the Works and Sections).
8.3	Programme	Delete paragraph 1 sub-clause 8.3 and substitute with: "The Contractor shall submit a detailed programme of works to the Engineer for comments and concurrence. This shall be submitted within Fourteen (14) days after issuance of the letter of commencement. The Contractor shall also submit an updated programme on a 14-day basis as an attachment to the Application for Payment. The Contractor shall however, remain responsible for the programme". The amount to be withheld by the Engineer in case the contractor does not submit an updated programme is: **FULL AMOUNT of the Interim Certificate amount**. This amount shall be withheld until the same satisfactory updated programme and cash flow projections have been issued. **At other all times, the period for Programs update is 14 days without delay** The Contractor shall not be eligible for any extension of time without an accepted updated programme and detailed report showing cause for delay and need for the extension thereof. .
8.7	Liquidated / Delay Damages	Delete 2nd Sentence in paragraph 1 sub-clause 8.7 and substitute with: "These Delay Damages shall be 0.1% of the Contract price per day up to a maximum of 10% of the Contract Sum, upon which, the Employer shall commence termination of the project due to substantial project delay."
11	Defects Liability Period	Delete the phrase: "…or as soon as practicable thereafter.." and substitute with: (Six (6) consecutive calendar Months after the issuance of the Taking Over Certificate)

CLAUSE	SUB-CLAUSE IN CONDITIONS OF CONTRACT	DETAILS
		NOTE: All EQUIPMENT/ELECTRICAL/MECHANICAL INSTALLATIONS shall have a minimum of 1 (one) year warranty. The Bidder may be called to undertake 3 (three) years maintenance period after expiry of warranty period and if called upon to do so by the employer.
13.8	Adjustments for Changes in cost	Delete Sub-clause 13.8 in its entirety and substitute with: "there shall be no cost adjustments applicable to this tender"
14.2	Amount of Advance Payment	There shall be no advance payment.
14.3	Payment Certificates and Final Account	Minimum payment shall be 20% of delivered contract amount up to a maximum of 90% of delivered contract amount. The remainder 10% shall be paid after Defects Liability Period. (i) First stage (define stage) _____ (ii) Second stage (define stage)_____ (iii) Third stage (define stage) _____ (iv) After defects liability period – 10 % (The above shall be discussed during kick off meeting)
14.3 (c)	Amount of Retention Money	Ten (10) per cent of the total amount of each Interim Payment.
14.4	Schedule of Payments	Delete the last paragraph and replace with: "The contractor shall submit non-binding estimates of the payments which he expects to become due during Submitted Request for Payments. The first estimate shall be submitted within 14 days after the commencement date. Revised estimates shall be submitted at intervals to be discussed at Kick Off Meeting as an attachment to the Application for payment until the Taking Over Certificate has been issued for the works."

CLAUSE	SUB-CLAUSE IN CONDITIONS OF CONTRACT	DETAILS
		The Engineer will reject the Application for payment for failure to submit a Schedule of Payment. In addition to SCC 14.4 of FIDIC, the following documents shall form part of interim payment certificates:- 1. Detailed valuation of works to date 2. Updated Program of Works 3. Detailed Progress Report to Date 4. Updated Cash Flow Program The amount to be withheld for non or late submission of these vital documents is **FULL CERTIFICATE**
14.6	Minimum Amount of Interim Payment Certificates	Minimum amount of interim payment shall be 20% of the contract sum.
14.7	Terms of Payment	Direct payment through Telegraphic Transfer (RTGS).
14.7	Time for Honouring Payment Certificate	Delete part (a)
14.8	Delayed Payment	Delete second paragraph and replace with: "The financing charges shall be calculated at the annual discount rate of the Central Bank of Kenya".
14.15	Currencies of payments	The currencies acceptable for this tender and contract shall only be Kenya Shillings.
16.2 (a)	Termination	Delete sub-clause 16.2 (a).
18.3	Indemnities & Insurance	The contractor shall take full responsibility for care of the Works and Goods from the Commencement Date until the Taking Over certificate is issued, when the responsibility for the care of the works and functionality shall pass to the employer. **In addition, the insurance below shall be taken out by the Contractor.** a) Cargo insurance: Covering loss or damage occurring, while in transit from the supplier's or manufacturer's works or stores until arrival at the Site

CLAUSE	SUB-CLAUSE IN CONDITIONS OF CONTRACT	DETAILS
		b) Installation All Risks Insurance: Covering physical loss or damage to the Facilities at the Site up to the defect liability period while the Contractor is on the Site for the purpose of performing its obligations during the defect liability period. c) Professional liability insurance; at least 110% of the Contract Price d) Equipment insurance covering loss of or physical damage to all equipment acquired, used, provided or paid for by the Employer within the context of this Contract; - 100% of the value e) Motor vehicle third party liability insurance and motor vehicle comprehensive insurance for the vehicles acquired in connection with this Contract. f) Client's liability and workers' compensation insurance in respect of the Personnel of the Consultant and of any Sub-Consultant, in accordance with the relevant provisions of the Applicable Law
21.	Progress Meetings	The Engineer will require the Contractor to attend monthly progress meetings in order to evaluate the progress of on-going works. The Engineer shall record the business of the progress meetings and supply copies of the record to those attending the meeting and to the Employer. In the record, responsibilities for any actions to be taken shall be in accordance with the Contract.
MATERIAL IMPORTATION ARRANGEMENTS		
	Materials master list	The contractor shall submit a master list of all relevant materials that will be incorporated into the Works, in the format required by the Employer. The master list shall clearly indicate the quantities, the unit and the total CIF prices. KenGen shall use the master list to seek for tax exemption for the goods or materials to be imported by the contractor. The contractor shall be required to submit the master list within two (2) months from commencement. **For locally procured materials, the contractor shall be required to provide a separate list for such with the VAT**

CLAUSE	SUB-CLAUSE IN CONDITIONS OF CONTRACT	DETAILS
		exclusive prices.
	Importation Documents	The contractor shall be responsible for obtaining the Import Declaration Form required under Kenyan law for declaration of the imports of all goods being supplied from outside Kenya. The initial IDF fees shall be paid by the contractor and reimbursed by the Employer at cost. The contractor shall be responsible for all other costs associated with this process including but not limited to clearing agent's fees and other import administration costs.
	Preshipment Verification of Conformity (PVoC)	All consignments subject to PVoC must obtain a Certificate of Conformity (CoC) issued by PVoC Country Offices prior to shipment. The CoC is a mandatory Customs Clearance document in Kenya; consignments arriving at Kenyan Ports without this document will be denied entry into the country. In exceptional cases, at the sole discretion of the Kenya Bureau of Standards, specific consignments may be allowed to undergo destination inspections after receiving the appropriate application from importers. Such consignments will be subject to a penalty of 15% of CIF value of the Goods plus 15% bond and the inspection costs, payable by the importer. All other expenses incurred at destination will be borne by the importer. The names of the Inspection Agencies appointed by the Kenyan authorities through KEBS to act under this Contract will be obtained by the contractor from the KEBS website on the Import Declaration Forms. The Contractor shall be responsible for procuring the necessary pre-shipment inspection. The Contractor shall be responsible for all the costs and penalties associated with the inspection. The cost of presentation of the Plant, Materials, Contractor's Equipment and Temporary Works to the Inspection Agencies, unpacking, handling etc. together with the cost of the Inspection Agencies' Fees shall be paid by the Contractor.
	Shipping documents	Upon shipment, the Contractor shall notify the Engineer or the Employer, by email, telex or facsimile, the full details of the shipment including contract number, description of Goods, quantity, the vessel, the bill of lading number and date,

CLAUSE	SUB-CLAUSE IN CONDITIONS OF CONTRACT	DETAILS
		port of loading, date of shipment, port of discharge, etc. The Contractor shall mail or courier copies of the following documents in four copies to the Employer through the Engineer: i. The Contractor's invoice showing Goods description, quantity, unit price, total amount (CIF); ii. Non-negotiable Bill of Lading, or Airway Bill iii. Packing list identifying contents of each package; iv. Copy of Insurance Certificate; v. Inspection certificate (Certificate of Conformity) issued by the nominated inspection agency; and vi. Certificate of Origin. vii. Factory Inspection Certificate – for machines /Equipment The Contractor shall be required to submit the above documents to the Employer (with original to the Contractor's Clearing Agent) not later than twenty-one days **(21)** prior to the arrival of the shipment at the port of Mombasa. This will enable the Engineer or the Employer to obtain tax exemption if applicable for Plant and Materials specified in the Price Schedules and each specific invoice. If the required documents are not received, the Contractor will be responsible for any consequent costs and expenses (including any demurrage). Failure to provide the documents within the prescribed period shall be at the Contractor's risk.
	Processing of customs duties	The Contractor's Clearing Agent shall thereafter submit copy of the Invoice to the Engineer or the Employer with the necessary processed customs declaration documents of the Import Tax due for each shipment at the latest one (1) day upon the arrival of the ship at the Port. Failure to submit the documents within the provided time

CLAUSE	SUB-CLAUSE IN CONDITIONS OF CONTRACT	DETAILS
		frame shall be at the Contractor's risk. For any airfreighted goods, the Contractor shall seek for approval from the Engineer or the Employer. All the air freight consignment shall be cleared on customs bond (CB1A) and this shall be the responsibility of the contractor. For low valued consignments agreed in writing with the Employer, the Contractor shall pay all the applicable import taxes and thereafter seek re-imbursement from the Employer
	Port clearance of goods	The Employer shall ensure all the necessary arrangements for payment of applicable taxes are in place. In the event that the specific exemption for each shipment under clearance has not been obtained, the Contractor shall clear such goods by putting in place the necessary customs bonds at the latest five (5) days from the date of arrival of the Ship at the Port. The cost of obtaining the CB1A bonds shall be reimbursed by the Employer upon application by the Contractor. The Contractor (or his Agent) shall be responsible for clearing the Goods from the Port. The Contractor shall facilitate the expeditious clearance of goods through the importation formalities, including raising all applicable customs clearance bonds. The contractor shall be responsible for the cancellation of all the bonds executed during the project. The Employer shall not be responsible for demurrage claims arising from late execution of the Bonds.
	Impact of delays	The Parties herein shall cooperate to ensure that the goods are cleared in a timely manner in accordance to the Contract to avoid delays in the implementation of the Contract. To the extent possible and subject to expediency, the Employer may request the Contractor to make payments of any import taxes and thereafter seek reimbursement from the Employer. The Contractor shall be responsible for planning the shipment to avoid any Contract delays, by allowing reasonable lead times for clearance of the Goods by the Contractor's Clearing Agent.

CLAUSE	SUB-CLAUSE IN CONDITIONS OF CONTRACT	DETAILS
		Where the Employer delays to obtain Tax Exemptions or to take any required steps, the Contractor shall clear the goods without delay and claim refund for the costs incurred in raising Custom Bonds.

FORM No 1: NOTIFICATION OF INTENTION TO AWARD

This Notification of Intention to Award shall be sent to each Tenderer that submitted a Tender. Send this Notification to the Tenderer's Authorized Representative named in the Tender Information Form on the format below.
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FORMAT

1 For the attention of Tenderer's Authorized Representative

i) Name: ______________________________

ii) Address: ______________________________

iii) Telephone: ______________________________

iv) Email Address: ______________________________

[IMPORTANT: insert the date that this Notification is transmitted to Tenderers. The Notification must be sent to all Tenderers simultaneously. This means on the same date and as close to the same time as possible.]

2 Date of transmission: ________________[email] on ______________[date] (local time)

This Notification is sent by (Name and designation) ______________________________

3 Notification of Intention to Award

i) Procuring Entity: ______________________________

ii) Project: ______________________________

iii) Contract title: ______________________________

iv) Country: ______________________________

v) ITT No: ______________________________

This Notification of Intention to Award (Notification) notifies you of our decision to award the above contract. The transmission of this Notification begins the Standstill Period. During the Standstill Period, you may:

4 Request a debriefing in relation to the evaluation of your tender

Submit a Procurement-related Complaint in relation to the decision to award the contract.

a) The successful tenderer
   i. Name of successful Tender ______________________________
   ii. Address of the successful Tender ______________________________
   iii. Contract price of the successful Tender Kenya Shillings ______________
   ___ (in words ______________________________)
~~~~~~

b) Other Tenderers

Names of all Tenderers that submitted a Tender. If the Tender's price was evaluated include the evaluated price as well as the Tender price as read out. For Tenders not evaluated, give one main reason the Tender was unsuccessful.

SNo	Name of Tender	Tender Price as read out	Tender's evaluated price (Note a)	One Reason Why not Evaluated
1				
2				
3				
4				
5				

(Note a) State NE if not evaluated

5 How to request a debriefing

a) DEADLINE: The deadline to request a debriefing expires at midnight on _____[insert date] (local time).

b) You may request a debriefing in relation to the results of the evaluation of your Tender. If you decide to request a debriefing your written request must be made within three (5) Business Days of receipt of this Notification of Intention to Award.

c) Provide the contract name, reference number, name of the Tenderer, contact details; and address the request for debriefing as follows:

i) Attention: _____[insert full name of person, if applicable]

ii) Title/position: _____[insert title/position]

iii) Agency: _____[insert name of Procuring Entity]

iv) Email address: _____[insert email address]

d) If your request for a debriefing is received within the 3 Days deadline, we will provide the debriefing within five (3) Business Days of receipt of your request. If we are unable to provide the debriefing within this period, the Standstill Period shall be extended by five (3) Days after the date that the debriefing is provided. If this happens, we will notify you and confirm the date that the extended Standstill Period will end.

e) The debriefing may be in writing, by phone, video conference call or in person. We shall promptly advise you in writing how the debriefing will take place and confirm the date and time.

f) If the deadline to request a debriefing has expired, you may still request a debriefing. In this case, we will provide the debriefing as soon as practicable, and

normally no later than fifteen (15) Days from the date of publication of the Contract

Award Notice.

6 How to make a complaint

g) Period: Procurement-related Complaint challenging the decision to award shall be submitted by midnight, _____[insert date] (local time).

h) Provide the contract name, reference number, name of the Tenderer, contact details; and address the Procurement-related Complaint as follows:

i) Attention: _____[insert full name of person, if applicable]

ii) Title/position: _____[insert title/position]

iii) Agency: _____[insert name of Procuring Entity]

iv) Email address: _____[insert email address]

i) At this point in the procurement process, you may submit a Procurement-related Complaint challenging the decision to award the contract. You do not need to have requested, or received, a debriefing before making this complaint. Your complaint must be submitted within the Standstill Period and received by us before the Standstill Period ends.

j) Further information: For more information refer to the Public Procurement and Disposals Act 2015 and its Regulations available from the Website info@ppra.go.ke or complaints@ppra.go.ke.
You should read these documents before preparing and submitting your complaint.

k) There are four essential requirements:

i) You must be an 'interested party'. In this case, that means a Tenderer who submitted a Tender in this tendering process, and is the recipient of a Notification of Intention to Award.

ii) The complaint can only challenge the decision to award the contract.

iii) You must submit the complaint within the period stated above.

iv) You must include, in your complaint, all of the information required to support your complaint.

7 Standstill Period

i) DEADLINE: The Standstill Period is due to end at midnight on _____[insert date] (local time).

ii) The Standstill Period lasts ten (14) Days after the date of transmission of this Notification of Intention to Award.

iii) The Standstill Period may be extended as stated in paragraph Section 5 (d) above.

If you have any questions regarding this Notification please do not hesitate to contact us. On behalf of the Procuring Entity:

Signature:_____ Name:_____

Title/position:_____ Telephone:_____ Email: _____

FORM NO. 2 - REQUEST FOR REVIEW

FORM FOR REVIEW(r.203(1))

PUBLIC PROCUREMENT ADMINISTRATIVE REVIEW BOARD

APPLICATION NO…….OF……..….20……...

BETWEEN

……...…….APPLICANT

AND

……RESPONDENT (Procuring Entity)

Request for review of the decision of the…… (Name of the Procuring Entity of ……dated the…day of ……20…….in the matter of Tender No……..…of ……..20….. for .....(Tender description).

REQUEST FOR REVIEW

I/We……,the above named Applicant(s), of address: Physical address…….P. O. Box 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.

By this memorandum, the Applicant requests the Board for an order/orders that:
1.
2.

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

FORM NO 3: LETTER OF AWARD

[letterhead paper of the Procuring Entity] [date]

To: [name and address of the Contractor]

This is to notify you that your Tender dated [date] for execution of the [name of the Contract and identification number, as given in the Contract Data] for the Accepted Contract Amount [amount in numbers and words] [name of currency], as corrected and modified in accordance with the Instructions to Tenderers, is hereby accepted by …… (name of Procuring Entity).

You are requested to furnish the Performance Security within 30 days in accordance with the Conditions of Contract, using, for that purpose, one of the Performance Security Forms included in Section VIII, Contract Forms, of the Tender Document.

Authorized Signature:.....

Name and Title of Signatory:.....

Name of Procuring Entity.....

Attachment: Contract Agreement.....

FORM NO 4: CONTRACT AGREEMENT

THIS AGREEMENT made the_____day of , 20 , between

_____ _____

_____of _____(hereinafter "the Procuring Entity"), of the one part, and_____of_____(hereinafter "the Contractor"), of the other part:

WHEREAS the Procuring Entity desires that the Works known as_____should be executed by the Contractor, and has accepted a Tender by the Contractor for the execution and completion of these Works and the remedying of any defects therein,

The Procuring Entity and the Contractor agree as follows:

1. In this Agreement words and expressions shall have the same meanings as are respectively assigned to them in the Contract documents referred to.

2. The following documents shall be deemed to form and be read and construed as part of this Agreement. This Agreement shall prevail over all other Contract documents.
   a. the Letter of Acceptance
   b. the Letter of Tender
   c. the addenda Nos (if any)
   d. the Special Conditions of Contract
   e. the General Conditions of Contract;
   f. the Specifications
   g. the Drawings; and
   h. the completed Schedules and any other documents forming part of the contract.

3. In consideration of the payments to be made by the Procuring Entity to the Contractor as specified in this Agreement, the Contractor hereby covenants with the Procuring Entity to execute the Works and to remedy defects therein in conformity in all respects with the provisions of the Contract.

4. The Procuring Entity hereby covenants to pay the 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 hereto have caused this Agreement to be executed in accordance with the Laws of Kenya on the day, month and year specified above.

Signed and sealed by_____(for the Procuring Entity)

Signed and sealed by_____(for the Contractor).

FORM NO. 5 - PERFORMANCE SECURITY

[Option 1 - Unconditional Demand Bank Guarantee]

[Guarantor letterhead]

Bene**fi**ciary:_____[insert name and Address of Procuring Entity]

Date:_____[Insert date of issue]

Guarantor:_____[Insert name and address of place of issue, unless indicated in the letterhead]

1. We have been informed that_____(hereinafter called "the Contractor") has entered into Contract No._____dated_____with (name of Procuring Entity)_____(the

   Procuring Entity as the Beneficiary), for the execution of_____(hereinafter called "the Contract").

2. Furthermore, we understand that, according to the conditions of the Contract, a performance guarantee is required.

3. At the request of the Contractor, we as Guarantor, hereby irrevocably undertake to pay the Beneficiary any sum or sums not exceeding in total an amount of _____ (in words),1 such sum being payable in the types and proportions of currencies in which the Contract Price is payable, upon receipt by us of the Beneficiary's complying demand supported by the Beneficiary's statement, whether in the demand itself or in a separate signed document accompanying or identifying the demand, stating that the Applicant is in breach of its obligation(s) under the Contract, without the Beneficiary needing to prove or to show grounds for your demand or the sum specified therein.

4. This guarantee shall expire, no later than the …….. Day of ……..…, 20.....…, and any demand for payment under it must be received by us at the office indicated above on or before that date.

5. The Guarantor agrees to a one-time extension of this guarantee for a period not to exceed [six months] [one year], in response to the Beneficiary's written request for such extension, such request to be presented to the Guarantor before the expiry of the guarantee."

[Name of Authorized Of*fi*cial, signature(s) and seals/stamps].

Note: All italicized text (including footnotes) is for use in preparing this form and shall be deleted from the *fi*nal product.

[1]The Guarantor shall insert an amount representing the percentage of the Accepted Contract Amount speci*fi*ed in the Letter of Acceptance, less provisional sums, if any, and denominated either in the currency of the Contract or a freely convertible currency acceptable to the Bene*fi*ciary.

[2]Insert the date twenty-eight days after the expected completion date as described in GC Clause 11.9. The Procuring Entity should note that in the event of an extension of this date for completion of the Contract, the Procuring Entity would need to request an extension of this guarantee from the Guarantor. Such request must be in writing and must be made prior to the expiration date established in the guarantee.

FORM No. 6 - PERFORMANCE SECURITY

[Option 2– Performance Bond]

[Note: Procuring Entities are advised to use Performance Security – Unconditional Demand Bank Guarantee instead of Performance Bond due to difficulties involved in calling Bond holder to action]

[Guarantor letterhead or SWIFT identifier code]

Beneficiary:_____[insert name and Address of Procuring Entity]

Date:_____[Insert date of issue].

PERFORMANCE BOND No.:_____

Guarantor: _____ [Insert name and address of place of issue, unless indicated in the letterhead]

1. By this Bond_____as Principal (hereinafter called "the Contractor") and_____] as Surety (hereinafter called "the Surety"), are held and firmly bound unto _____] as Obligee (hereinafter called "the Procuring Entity") in the amount of_____for the payment of which sum well and truly to be made in the types and proportions of currencies in which the Contract Price is payable, the Contractor and the Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

2. WHEREAS the Contractor has entered into a written Agreement with the Procuring Entity dated the _____day of _____ , 20_____ , for _____ in accordance

with the documents, plans, specifications, and amendments thereto, which to the extent herein provided for, are by reference made part hereof and are hereinafter referred to as the Contract.

3. NOW, THEREFORE, the Condition of this Obligation is such that, if the Contractor shall promptly and faithfully perform the said Contract (including any amendments thereto), then this obligation shall be null and void; otherwise, it shall remain in full force and effect. Whenever the Contractor shall be, and declared by the Procuring Entity to be, in default under the Contract, the Procuring Entity having performed the Procuring Entity's obligations thereunder, the Surety may promptly remedy the default, or shall promptly:

   1) complete the Contract in accordance with its terms and conditions; or

   2) obtain a tender or tenders from qualified tenderers for submission to the Procuring Entity for completing the Contract in accordance with its terms and conditions, and upon determination by the Procuring Entity and the Surety of the lowest responsive Tenderers, arrange for a Contract between such Tenderer, and Procuring Entity and make available as work progresses (even though there should be a default or a succession of defaults under the Contract or Contracts of completion arranged under this paragraph) sufficient funds to pay the cost of completion less the Balance of the Contract Price; but not exceeding, including other costs and damages for which the Surety may be liable hereunder, the amount set forth in the first paragraph hereof. The term "Balance of the Contract Price," as used in this paragraph, shall mean the total amount payable by Procuring Entity to Contractor under the Contract, less the amount properly paid by Procuring Entity to Contractor; or
   3) pay the Procuring Entity the amount required by Procuring Entity to complete the Contract in accordance with its terms and conditions up to a total not exceeding the amount of this Bond.

4. The Surety shall not be liable for a greater sum than the specified penalty of this Bond.

5. Any suit under this Bond must be instituted before the expiration of one year from the date of the issuing of the Taking-Over Certificate. No right of action shall accrue on this Bond to or for the use of any person or corporation other than the Procuring Entity named herein or the heirs, executors, administrators, successors, and assigns of the Procuring Entity.

6. In testimony whereof, the Contractor has hereunto set his hand and affixed his seal, and the Surety has caused these presents to be sealed with his corporate seal duly attested by the signature of his legal representative, this day_____ of _____ 20_____ .

SIGNED ON_____on behalf of _____

By_____in the capacity of _____

In the presence of_____

SIGNED ON_____on behalf of_____

By_____in the capacity of_____

In the presence of _____

FORM NO. 7 - ADVANCE PAYMENT SECURITY

[Demand Bank Guarantee]

[Guarantor letterhead]

Bene**fi**ciary:_____[Insert name and Address of Procuring Entity]

Date:_____[Insert date of issue]

ADVANCE PAYMENT GUARANTEE No.:_____[Insert guarantee reference number]

Guarantor:_____[Insert name and address of place of issue, unless indicated in the letterhead]

1. We have been informed that_____(hereinafter called "the Contractor") has entered into Contract No._____dated with the Beneficiary, for the execution of

_____ (hereinafter called "the Contract").

2. Furthermore, we understand that, according to the conditions of the Contract, an advance payment in the sum _____ (in words) is to be made against an advance payment guarantee.
3. At the request of the Contractor, we as Guarantor, hereby irrevocably undertake to pay the Beneficiary any sum or sums not exceeding in total an amount of _____ (in words _____)[1] upon receipt by us of the Beneficiary's complying demand supported by the Beneficiary's statement, whether in the demand itself or in a separate signed document accompanying or identifying the demand, stating either that the Applicant:

   a. has used the advance payment for purposes other than the costs of mobilization in respect of the Works; or
   b. has failed to repay the advance payment in accordance with the Contract conditions, specifying the amount which the Applicant has failed to repay.
4. A demand under this guarantee may be presented as from the presentation to the Guarantor of a certificate from the Beneficiary's bank stating that the advance payment referred to above has been credited to the Contractor on its account number _____ at _____.
5. The maximum amount of this guarantee shall be progressively reduced by the amount of the advance payment repaid by the Contractor as specified in copies of interim statements or payment certificates which shall be presented to us. This guarantee shall expire, at the latest, upon our receipt of a copy of the interim payment certificate indicating that ninety (90) percent of the Accepted Contract Amount, less provisional sums, has been certified for payment, or on the _____ day of _____, 20_____, whichever is earlier. Consequently, any demand for payment under this guarantee must be received by us at this office on or before that date.
6. The Guarantor agrees to a one-time extension of this guarantee for a period not to exceed [six months][one year], in response to the Beneficiary's written request for such extension, such request to be presented to the Guarantor before the expiry of the guarantee.

[Name of Authorized Official, signature(s) and seals/stamps]

Note: All italicized text (including footnotes) is for use in preparing this form and shall be deleted from the final product.

1The Guarantor shall insert an amount representing the amount of the advance payment and denominated either in the currency of the advance payment as specified in the Contract.

2Insert the expected expiration date of the Time for Completion. The Procuring Entity should note that in the event of an extension of the time for completion of the Contract, the Procuring Entity would need to request an extension of this guarantee from the Guarantor. Such request must be in writing and must be made prior to the expiration date established in the guarantee.

FORM NO. 8 - RETENTION MONEY SECURITY

[Demand Bank Guarantee]

[Guarantor letterhead]

Bene**fi**ciary:_____[Insert name and Address of Procuring Entity]

Date:_____[Insert date of issue]

Advance payment guarantee no. _____[Insert guarantee reference number]

Guarantor: _____[Insert name and address of place of issue, unless indicated in the letterhead]

1. We have been informed that_____[insert name of Contractor, which in the case of a joint venture shall be the name of the joint venture] (hereinafter called "the Contractor") has entered into Contract No._____[insert reference number of the contract] dated_____ with the Beneficiary, for the execution of_____[insert name of contract and brief description of Works] (hereinafter called "the Contract").

2. Furthermore, we understand that, according to the conditions of the Contract, the Beneficiary retains moneys up to the limit set forth in the Contract ("the Retention Money"), and that when the Taking-Over Certificate has been issued under the Contract and the first half of the Retention Money has been certified for payment, and payment of [insert the second half of the Retention Money] is to be made against a Retention Money guarantee.

3. At the request of the Contractor, we, as Guarantor, hereby irrevocably undertake to pay the Beneficiary any sum or sums not exceeding in total an amount of _____ [insert amount in *fi*gures] _____ ([insert amount in words__]) 1 upon receipt by us of the Beneficiary's complying demand supported by the Beneficiary's statement, whether in the demand itself or in a separate signed document accompanying or identifying the demand, stating that the Contractor is in breach of its obligation(s) under the Contract, without your needing to prove or show grounds for your demand or the sum specified therein.

4. A demand under this guarantee may be presented as from the presentation to the Guarantor of a certificate from the Beneficiary's bank stating that the second half of the Retention Money as referred to above has been credited to the Contractor on its account number_____at _____[insert name and address of Applicant's bank].

5. This guarantee shall expire no later than the …..... Day of ….....……, 2.....…[2], and any demand for payment under it must be received by us at the office indicated above on or before that date.

6. The Guarantor agrees to a one-time extension of this guarantee for a period not to exceed _____[six months] [one year], in response to the Beneficiary's written request for such extension, such request to be presented to the Guarantor before the expiry of the guarantee.

[Name of Authorized Of*fi*cial, signature(s) and seals/stamps]

Note: All italicized text (including footnotes) is for use in preparing this form and shall be deleted from the ***fi***nal product.

_____

FORM NO. 9 **BENEFICIAL OWNERSHIP DISCLOSURE FORM**

INSTRUCTIONS TO TENDERERS: DELETE THIS BOX ONCE YOU HAVE COMPLETED THE FORM

This Beneficial Ownership Disclosure Form ("Form") is to be completed by the successful tenderer. In case of joint venture, the tenderer must submit a separate Form for each member. The beneficial ownership information to be submitted in this Form shall be current as of the date of its submission.

For the purposes of this Form, a Beneficial Owner of a Tenderer is any natural person who ultimately owns or controls the Tenderer by meeting one or more of the following conditions:

- *Directly or indirectly holding 25% or more of the shares.*
- *Directly or in directly holding 25% or more of the voting rights.*
- *Directly or indirectly having the right to appoint a majority of the board of directors or equivalent governing body of the Tenderer.*

Tender Reference No.:_____[*insert identification no*] Name of the Tender Title/Description:_____*[insert name of the assignment]* to:_____*[insert complete name of Procuring Entity]*

In response to the requirement in your notification of award dated *[insert date of notification of award]* to furnish additional information on beneficial ownership:_____*[select one option as applicable and delete the options that are not applicable]*

I) We here by provide the following beneficial ownership information.

Details of beneficial ownership

	Details of all Beneficial Owners		**% of shares a person holds in the company Directly or indirectly**	**% of voting rights a person holds in the company**	**Whether a person directly or indirectly holds a right to appoint or remove a member of the board of directors of the company or an equivalent governing body of the Tenderer** (Yes / No)	**Whether a person directly or indirectly exercises significant influence or control over the Company (tenderer) (Yes / No)**
1.	Full Name		Directly---------- % of shares	Directly…….% of voting rights Indirectly--------	1. Having the right to appoint a majority of the board of the directors or an equivalent	1. Exercises significant influence or control over the Company
	National identity card number or Passport number					
	Personal					

	Details of all Beneficial Owners		**% of shares a person holds in the company Directly or indirectly**	**% of voting rights a person holds in the company**	**Whether a person directly or indirectly holds a right to appoint or remove a member of the board of directors of the company or an equivalent governing body of the Tenderer** (Yes / No)	**Whether a person directly or indirectly exercises significant influence or control over the Company (tenderer) (Yes / No)**
	Identification Number (where applicable)		Indirectly---------- % of shares	--% of voting rights	governing body of the Tenderer: Yes -----No---- 2. Is this right held directly or indirectly?: Direct…… …… Indirect…… ……...	body of the Company (tenderer) Yes -----No---- 2. Is this influence or control exercised directly or indirectly? Direct…… …….. Indirect…… ……
	Nationality					
	Date of birth *[dd/mm/yyyy]*					
	Postal address					
	Residential address					
	Telephone number					
	Email address					
	Occupation or profession					
2.	Full Name		Directly---------- % of shares Indirectly---------- % of shares	Directly…… …….% of voting rights Indirectly----------% of voting rights	1. Having the right to appoint a majority of the board of the directors or an equivalent governing body of the Tenderer: Yes -----No---- 2. Is this right held directly or indirectly?: Direct……	1. Exercises significant influence or control over the Company body of the Company (tenderer) Yes ----- No---- 2. Is this influence or control
	National identity card number or Passport number					
	Personal Identification Number (where applicable)					
	Nationality(ies)					
	Date of birth *[dd/mm/yyyy]*					
	Postal address					

	Details of all Beneficial Owners		**% of shares a person holds in the company Directly or indirectly**	**% of voting rights a person holds in the company**	**Whether a person directly or indirectly holds a right to appoint or remove a member of the board of directors of the company or an equivalent governing body of the Tenderer** (Yes / No)	**Whether a person directly or indirectly exercises significant influence or control over the Company (tenderer) (Yes / No)**
	Residential address				…… Indirect…… ……...	exercised directly or indirectly? Direct…… …….. Indirect…… ……
	Telephone number					
	Email address					
	Occupation or profession					
3.						
e.t.c						

II) Am fully aware that beneficial ownership information above shall be reported to the Public Procurement Regulatory Authority together with other details in relation to contract awards and shall be maintained in the Government Portal, published and made publicly available pursuant to Regulation 13(5) of the Companies (Beneficial Ownership Information) Regulations, 2020.(Notwithstanding this paragraph Personally Identifiable Information in line with the Data Protection Act shall not be published or made public). *Note that Personally Identifiable Information (PII) is defined as any information that can be used to distinguish one person from another and can be used to deanonymize previously anonymous data. This information includes National identity card number or Passport number, Personal Identification Number, Date of birth, Residential address, email address and Telephone number.*

III) In determining who meets the threshold of who a beneficial owner is, the Tenderer must consider a natural person who in relation to the company:

(a) holds at least ten percent of the issued shares in the company either directly or indirectly;

(b) exercises at least ten percent of the voting rights in the company either directly or indirectly;

(c) holds a right, directly or indirectly, to appoint or remove a director of the company; or

(d) exercises significant influence or control, directly or indirectly, over the company.

IV) What is stated to herein above is true to the best of my knowledge, information and belief.

Name of the Tenderer: .....[insert complete name of the Tenderer]*_____

*Name of the person duly authorized to sign the Tender on behalf of the Tenderer: ** [insert complete name of person duly authorized to sign the Tender]*

Designation of the person signing the Tender: ..... [insert complete title of the person signing the Tender]

Signature of the person named above: ..... [insert signature of person whose name and capacity are shown above]

Date this ..... [insert date of signing] day of..... [Insert month], [insert year]

Bidder Official Stamp

SECTION VI- TENDER SPECIFICATIONS

Notes for preparing Specifications

1 Specifications must be drafted to present a clear and precise statement of the required standards of materials, and workmanship for tenderers to respond realistically and competitively to the requirements of the Procuring Entity and ensure responsiveness of tenders. The Specifications should require that all materials, plant, and other supplies to be permanently incorporated in the Works be new, unused, of the most recent or current models, and incorporating all recent improvements in design and materials unless provided otherwise in the Contract. Where the Contractor is responsible for the design of any part of the permanent Works, the extent of his obligations must be stated.

2 Specifications from previous similar projects are useful and may not be necessary to re-write specifications for every Works Contract.

3 There are considerable advantages in standardizing General Specifications for repetitive Works in recognized public sectors, such as highways, urban housing, irrigation and water supply. The General Specifications should cover all classes of workmanship, materials and equipment commonly involved in constructions, although not necessarily to be used in a particular works contract. Deletions or addenda should then adapt the General Specifications to the particular Works.

4 Care must be taken in drafting Specifications to ensure they are not restrictive. In the Specifications of standards for materials, plant and workmanship, existing Kenya Standards should be used as much as possible, otherwise recognized international standards may also be used.

5 The Procuring Entity should decide whether technical solutions to specified parts of the Works are to be permitted. Alternatives are appropriate in cases where obvious (and potentially less costly) alternatives are possible to the technical solutions indicated in tender documents for certain elements of the Works, taking into consideration the comparative specialized advantage of potential tenderers.

6 The Procuring Entity should provide a description of the selected parts of the Works with appropriate reference to Drawings, Specifications, Bills of Quantities, and Design or Performance criteria, stating that the alternative solutions shall be at least structurally and functionally equivalent to the basic design parameters and Specifications.

Such alternative solutions shall be accompanied by all information necessary for a complete evaluation by the Procuring Entity, including drawings, design calculations, technical specifications, breakdown of prices, proposed construction methodology, and other relevant details. Technical alternatives permitted in this manner shall be considered by the Procuring Entity each on its own merits and independently of whether the tenderer has priced the item as described in the Procuring Entity's design included with the tender documents.

PART A: GENERAL TECHNICAL REQUIREMENTS

1.0 INTRODUCTION

Kenya Electricity Generating Company intends to connect Three (3) geothermal make-up wells namely: OW-50A, OW-50B and OW-50C to Olkaria IAU power plant to sustain its electricity generation. This is to compensate the natural decline in pressure in two of the wells that had been connected to the power plant and which can no longer deliver steam to the power plant.

The works will involve installation of (i) two-phase piping and their respective fittings from wells OW-50A, OW-50B and OW-50C and connecting to a new separator, (ii) Steam and brine pipelines and their respective fittings, Separator, flash tanks, associated Electrical and I&C and associated Civil works.

2.0 SCOPE OF WORKS

Contractor's Scope of Work shall include all mechanical, electrical, and civil works as well as any ancillary works/services required to complete the whole project.

Consequently the Work consists of furnishing/providing all plant, labour and materials, construction of plant, temporary works, equipment, auxiliaries and accessories as well as all associated works, special equipment, tools and tackles, spare parts, consumables and providing any equipment/work and services required for design, fabrication, furnishing, testing in manufacturer's workshop, packing for export, shipping, loading and unloading, transport from docks to stores, delivery to Site, preservation at Site, installing/erecting, constructing, interfacing, finishing, painting, Tests on Completion, putting into operation and handing over of the complete plant all in strict accordance with the Contract.

The Contract also includes all obligations for the Warranty Period of the complete Works.

The Work shall be performed in accordance with the Contract, Employer's Requirements, Specification, Schedules and Drawings contained herein.

The Work further consists of furnishing all documents and any information required including operation and maintenance manuals in order to enable the Employer to operate and maintain the plant reliably and safely. General drawings and design calculations shall be furnished complete with parts lists and exploded view drawings of all equipment and "As Built" drawings of all plant and equipment installed civil, architectural and structural work.

Generally the tender documents describe the complete project so to give a good understanding of it to Bidders and the Contractor.

All work not expressly called for in the Employer's Requirements, but necessary for making the Works complete in every respect including proper operation of all the equipment supplied shall be provided by the Contractor at no additional cost to the Employer. Work shown upon the drawings and not mentioned or described in the Specification and work described in the Specification and not shown on the drawings will nevertheless be considered to be included in this Contract. All plant, equipment, materials and work shall be provided to complete the installation ready for commercial operation whether or not specifically called for herein.

At no time during the Contract, the Contractor shall consider or imply that any work, other than that explicitly stated in the Contract, but required for the execution of the Works is to be carried out by Employer's departments or to be paid for extra by the Employer.

3.0 CONSTRUCTION REQUIREMENTS

3.1 General

All materials and equipment furnished shall be:

- New and undamaged when installed or otherwise incorporated in the Works
- Properly identified by appropriate stampings and markings
- Accompanied with original manufacturer's documentation where appropriate
- Industrial type suited for their intended function, specifically geothermal service
- Resistant to the type of corrosion generally encountered in geothermal facilities
- Successfully used in a similar geothermal application within the past 10 years and have demonstrated satisfactory service

All plant items and corresponding parts performing similar duties shall be interchangeable in order to minimize the stocking of spare parts. Contractor shall also provide interchangeability as well as standardized equipment within packages.

No departure from the specification shall be made subsequent to the Contract without the written approval of the Employer.

In the event of there being any direct conflict in the technical requirements specified in the various parts of these specifications, the most stringent requirement shall apply.

3.2 Material Substitution

Substitution of a specified material will only be accepted if the proposed material is satisfactorily demonstrated to be equal in all respects or superior to the original on which the design was based. Recycling and/or reconstitution of solders is not permitted without written approval from the Employer.

3.3 Material Quality Control

The Contractor is responsible for the quality of the machinery and parts, which are supplied under the Contract including those, supplied by their subcontractors.

All material forms including but not confined to forgings, castings, welding and wrought products shall be free from flaws and defects to the standards necessary to comply with the requirements of the appropriate design code or specification, with the requirements of this specification and with the functional requirements of their intended use.

Repairs to materials and/or components are not permitted without full agreement by the Employer/Engineer and all planned operations, which may affect the condition and/or properties of the material such as welding, brazing, manipulation process and heat treatments, are subject to Employer's approval.

3.4 Common Equipment and Services

The Engineering services refer to the complete specified plant.

The Contractor shall actively participate in drawing-up of all required licensing applications. Furthermore all other required advanced services to meet the agreed project time schedule of Contract shall be executed.

The following supplies and services are to be included in the corresponding section prices.

3.4.1 General

- Material and personnel costs for tests and inspections which are mandated in legislation,
- Material costs for site inspections,
- All as-built documents (on data carriers; data formats as requested by the Employer),
- Quality control plan and safety plan,
- Complete documentation as set out in the Tender Specification,
- Operating manual in summary form,
- Detailed operating and maintenance instructions,
- A maintenance program for all equipment of the Plant,
- Housekeeping during construction,
- Staff facilities during construction,
- Fire protection during construction

3.4.2 Mechanical

- All necessary pipelines, vessels, valves, instruments, and actuators,
- All required line warm-up systems,
- All connection and adaptation works for tie-in into general supply systems,
- All necessary vents and drains
- All connection elements, screws, bolts, nuts, including gaskets and seals as necessary,
- All temporary installations required
- All temporary pipework as required during connection measures,
- Check of required existing structures, plant components and systems and their rehabilitation where they lie within the scope of supply, or definition of required measures in good time if they lie outside of the scope of supply,
- All necessary support structures, hangers etc.,
- All necessary base frames, mounting plates, grouted in parts, rag bolts, covers, etc.,
- All required steel parts embedded in concrete,
- All couplings and coupling guards for electric motors and other drives,
- All necessary lifting equipment and hoists (for repair work where loads exceed 20 kg),
- Required safety equipment, pressure relief valves, etc.,
- All thermal and noise insulation including cladding as well as any other noise attenuation measures,
- Stairways, ladders, platforms, galleries and walkways to all plant components, including escape routes as necessary,
- All necessary steel structures, stairs, ladders on platforms, weather protection,
- All necessary corrosion protection measures for plant components and equipment stored or mounted on site up to the time of reliability test run,
- Complete primer and top coatings conforming to colour code, clarified with Employer,
- Necessary noise abatements measures,
- Complete labelling of all plant components according to Employers system and in plain language,
- All fire protection measures,
- All necessary lubrication systems,
- Provision of all connections and temporary pipework for steam purging of the steam line,

- Flushing of all other lines including disposal of the effluents; protection with wood and/or plastic at all instrumentation and appendages to be installed during construction,
- All standard accessories and auxiliary equipment which normally form part of the scope of supplies,
- All necessary tests, inspections and works acceptances as well as all certificates and reports of these,
- Valve trims for purging and subsequent exchange,
- Removal of any unused material,
- Scaffolding for all work above ground level, and
- Insurances as necessary.

3.4.3 Electrical, Instrumentation and Control

- All local measurements and field control loops (thermometers, pressure gauges, local regulating devices, etc.) as well as all instruments for reliability test and checks,
- All necessary electrical drives, complete installation material, that is wiring, cabling and piping material, all needed fastenings, conduits, brackets and other supports, including the cable trays, required junction boxes and cubicles, and all field control boxes.
- All instruments mounted on instrumentation racks,
- All cables and cable supporting,
- Outdoor lighting,
- Lightning protection,
- Electrical earthling of the equipment,
- Clarification of all logic interconnections: sequence, interlocking, protection, safeguarding for coordinated operation/start-up/shut down of individual items of equipment.

3.4.4 Civil

- All necessary surveying works, investigation and studies
- Preparation of site, demolition works, removal of underground obstacles,
- Earthworks, drainage, excavation and refilling works,
- Temporary concrete and reinforced concrete works, masonry and earthing,
- Temporary water proofing works for pressing and non-pressing water,
- Storm water drainages
- Security fencing
- Access roads for construction works
- Transport of all dumping material to dump locations,
- Interpretation of soil bearing test
- Temporary fencing of construction site
- Temporary protection of works
- Temporary supports

- Making good the disturbed areas.

3.4.5 Packaging and Transportation

- Suitable packaging and transportation of the entire scope of supplies
- Free construction site, on-site transportation and temporary storage including inspections and, if necessary, ensuring the prerequisites for transportation,
- Transport insurance,
- Disposal of packing and transportation material,
- Customs clearance,
- Crane or hoisting facilities at seaport and site,
- Transportation to site and Unloading at site.

3.4.6 Erection, Commissioning and Testing

- Complete erection of the scope of supply up to operational readiness; this includes mobilization and provision of the required supervisory staff, skilled and unskilled personnel, as well as of installation scaffolding, cranes, hoists, equipment and materials, personnel accommodation, prescribed tests and inspections,
- Commissioning and optimization of all plant components as well as conducting all necessary measurements,
- Supervision of erection, commissioning and Reliability Test Run of complete supplied equipment, and
- All testing as specified.

3.4.8 Further Obligations of the Contractor

3.4.8.1 General

The Contractor shall be solely responsible for all mechanical, electrical,

I&C as well as civil works in regard of the equipment and systems provided by him for the plant in the frame of his Contract Package.

The Contractor's obligations shall further consist of, but shall not be limited to, the items listed below. All other materials, services, etc. as required shall be provided whether or not these are enumerated below in order to provide a full operational plant and to fulfil the requirements stated in any part of this Specification.

a. The Contractor shall provide staff, test, operate and maintain the Works, i.e.

   Steamfield, being provided under the Contract, at various loads including the maximum continuous rating in part and as a whole in order to demonstrate that the plant can be operated in a safe, reliable and efficient manner up to and including the date of Taking Over.

b. Thereafter he shall be responsible for maintaining sufficient qualified and experienced staff at site to deal with any matter for which the Contractor is responsible during the Warranty Period after the unit Take Over Date. During the Warranty Period all defects arising in the plant shall be notified to the Contractor through "Notification of Defect" (NOD)/work request documents. The Contractor is responsible for the immediate and speedy rectification of defects covered under the NODs.

The Contractor shall also rectify promptly the Take Over Defects informed to him when the Provisional Acceptance Certificate (PAC) is issued. The Warranty Period for the defects rectified shall recommence from the date of acceptance by the Employer/Engineer of such rectification. All specialist engineers, supervisors, etc. required during annual maintenance and or overhauls during the Warranty Period shall be provided within the Contract.

c. The Contractor shall submit all necessary drawings and documents to the relevant local authorities and shall obtain their approval, before submitting the documents to the Employer/Engineer. It is the obligation of the Contractor to find out the approvals required and to submit all necessary information and to get approvals from all competent local authorities.

Prior to commencement of works at Site, the Contractor shall obtain Permits and approvals for all Works under the scope of the Contract, including but not limited to building permits, works within the National Park (Kenya Wildlife Service), etc., which are required by all relevant local Authorities, at his own cost, before submitting the documents to the Employer/Engineer.

The Contractor shall submit detailed design calculation, architectural details, firefighting system, service drawings etc. to enable the Authority to issue building permits.

The Contractor shall consider the time required to obtain all those permits and approvals in his time schedule. The fact that the release of the relevant authority has been obtained shall be conspicuously indicated on the document submitted.

d. The Contractor shall follow the Employer's Safety Procedures, HSE Policy and strictly adhere to it. The method statement of any work shall include risk assessment.

The Contractor shall report all accidents and near misses (near hits) and the follow-up actions in the prescribed format. The monthly accident/incident report which shall be submitted by the Contractor shall include Accident Frequency Rates (AFR), Accident Severity Rate (ASR).

The Contractor shall co-operate fully with Employer/Engineers Safety Section in providing information and at the site inspection.

The Personal Protection Equipment (PPE's) used by the Contractor's personnel shall comply with the International Codes and Standards or approved standard by the concerned authority.

The Contractor's safety policy covering all the above points in addition to the Contractor's own safety rules shall be submitted for review and approval eight (8) weeks prior to the start of the site work.

e. Providing computerized Document Management System (DMS).

f. Providing of warehouses, receiving of equipment, marine and local transport, unloading of delivered equipment, keeping the equipment under custody at site until the Plant or part thereof will be handed over to the Employer.

g. Performance of all specified and all necessary inspections and tests.

h. Handling of all insurance claims in relation with Contractor's works.

i. Participation in co-ordination and progress meetings and in Site meetings.

j. Preparation and submission of work and time schedules showing the critical path, like overall project schedule and detailed project/work schedules together with the monthly progress reports.

k. Preparation and submission of monthly progress reports including site photos.

l. Providing Warranty and Service Engineers and services during the Warranty Period.

m. Preparation and performing Employer's staff site/overseas training.

n. Providing spare parts, special equipment, tools and tackles as well as consumables.

o. Providing O&M Manuals and final As-Built drawings.

3.4.8.2 Waste Handling and Disposal

Construction wastes shall segregated and be disposed of in strict accordance

with the provisions of the ESIA study and the local rules and regulations:

- Scrap metal – The Contractor shall transport the scrap metal to designated areas within Olkaria as directed by the Employer/Engineer
- Timber - The Contractor shall transport the timber to designated areas within Olkaria as directed by the Employer/Engineer
- The Contractor shall engage transporters who are licensed by NEMA to collect cementations slurry wastes and dump it in licensed sites.
- The Contractor shall engage transporters who are NEMA licensed hazardous waste handlers, to collect hazardous materials and dispose such off in strict accordance with local regulations.
- Waste other than scrap metal, cementations slurries and hazardous materials shall also be collected by transporters who are licensed by NEMA and dumped it in licensed sites.

3.5 Bidder to inform himself fully

The Bidder shall inform himself fully and shall be deemed to have carefully examined the Tender Documents, the site and the existing installations as applicable and to have satisfied himself as to the nature and character of the work to be executed, the prevailing meteorological conditions as well as the relevant local rules and regulations and as well as any other relevant matters and details.

A site visit prior to submitting the bid is mandatory.

Any information received from the Employer/Engineer shall not in any way relieve the Contractor from his responsibility for supplying the equipment and material and executing his work in terms of the Contract including all details as well as incidental work and provision of all accessories or apparatus which may not be specifically mentioned in the contract but are necessary for ensuring to complete the installation and to operate in a safe and reliable manner under all operation conditions of the plant.

Thus, the contractor shall be held responsible for any delay arising out of non- compliance with these requirements. He shall also be held responsible for any delay in case he has not informed the Employer /Engineer about any discrepancy in time.

3.6 Contract planning Requirements and Reporting

3.6.1 General

The Contractor shall produce three types of planning schedules.

1. A **"start-up" Schedule** as an interim plan covering those activities due to take place in the first three months of the Contract.

2. A **Contract Schedule** which shall cover the whole of the Contract period in summary form and include all major activities.

3. A **Project Control Schedule** (Working Program) which embodies all the major activities in the Contract Schedule with the addition of all other activities in a computer based Critical Path Network.

3.6.2 Project Start up Schedule

Within 10 working days of Contract Award, the Contractor shall provide a Project Start Up schedule.

The start-up schedule shall be of bar chart format, covering all activities scheduled for the first 3 months from Contract Award.

The start-up schedule shall be used for progress reporting during the interim period whilst the Contract Schedule is being produced and shall be updated regularly to indicate progress achieved.

The start-up schedule shall be submitted as part of the Contractor's monthly progress report until replaced by the Contract Schedule.

3.6.3 Contract Schedule

Within 30 working days of Contract Award the Contractor shall revise and re-issue to the Employer/Engineer for review the tender submission overall summary schedule. After satisfactory review, this schedule shall become the Contract Schedule.

All subsequent networks and schedules produced by the Contractor shall directly relate to the time scales of the Contract Schedule.

The Contract Schedule may be presented in bar chart format with interdependencies clearly shown and all milestones and Contract interfaces identified. It shall show only major activities as required by the Employer/Engineer to provide a level 2 program.

The Contract Schedule shall be marked up by the Contractor monthly to indicate the progress achieved against each activity, and submitted as part of the Contractor's monthly progress report. All reports on the Contract Schedule shall show the original planned activities, duration and dates without change as well as any agreed modifications.

3.6.4 Project Control Schedule (Working program)

General requirements

Within 120 working days of Contract Award the Contractor shall produce and issue for review a Project Control Schedule using the Critical Path Network (CPN) method. It shall run on a computer using proprietary software such as Primavera or similar.

The Contractor shall produce reports from the schedule and reports deemed necessary by the Employer/Engineer to show the status of project, delayed and critical activities, etc. Three (3) copies of these reports shall be submitted to the Employer. The Contractor shall maintain the Project Control Schedule to reflect the current state of Contract progress and shall issue the required reports and data with each monthly progress report.

The Contract Schedule shall indicate for each item of the Works the various phases of the work from the commencement of the Contract to its final completion, e.g. ordering of materials, manufacture, delivery, erection, construction, commissioning and testing.

The Contractor shall inform himself and make allowance in his schedule for National Holidays.

If at any time during the execution of the Contract it is found necessary to modify the approved schedules, the Contractor shall inform the Employer/Engineer and submit the modified schedules for his approval. Any approval of changes to the approved schedules shall not constitute approval of an extension to the guaranteed completion date.

The report on material procurement shall give the date and details of order placed and indicate the delivery quoted by the manufacturer, and in respect of the agreed Contract Schedule. If any delivery has an adverse effect on the Contract Schedule the Contractor shall state the remedial action taken to ensure that delays do not occur.

The shipping of each order or part order shall be monitored on the progress report giving the date by which the equipment will be available for shipping, the estimated time of arrival on site and the actually achieved dates.

The sites erection portion of the progress report shall be segregated into the main and ancillary items of civil, mechanical, electrical and control and instrumentation work and each item of work shall be monitored giving the percentage completion and the projected completion date of the work in accordance with the agreed Contract Schedule.

Any delay which will affect the completion, testing and commissioning dates of any item of the plant shall be detailed by the Contractor who shall state the action he is taking to effect completion to the Contract Schedule. The Contractor shall report in respect of the various sections of the works the erection equipment in use or held in readiness, a return of labour and supervisory staff, and details of any matters arising which may generally affect the progress of site work.

The Contractor shall give a summary of the detailed progress report giving the position with regard to the agreed Contract Schedule.

The progress reports shall be set out in a format to the approval of the Employer/Engineer, and forwarded promptly so that on receipt the information contained therein is not more than one month prior to the end of the month to which the report relates. Copies of the progress report shall be distributed as shown below:

- 3 copies progress report - Employer

If during the execution of the Contract the Employer/Engineer considers the progress position of any section of the work to be unsatisfactory or for any other reason relating to the Contract, he will be at liberty to convene a special meeting and the Contractor's Representatives shall attend such meetings. In addition, regular monthly project meetings will be held throughout the project design and construction period and the Contractor's representatives shall attend.

The Contractor's Site Office shall prepare and submit copies of a weekly progress the Employer. This report shall summarize site activities and record any details where difficulties in maintaining the agreed program are being experienced or are likely to cause subsequent delay.

The Contractor shall be responsible for expediting the delivery of all material and equipment to be provided by him and his sub-Contractors.

Access to the Contractor's and Sub-Contractor's Works shall be granted to the Employer/Engineer or their Representative at any reasonable time for the purpose of ascertaining progress.

Particular Requirements

Upon award of the Contract, the Contractor shall maintain at the project site, hardware, software and qualified staff to prepare and manage the detailed project schedule (Working program) updates and logic changes as maybe required during the contract duration using relevant software

The working program shall be used to plan, organize and execute the procurement, manufacturing, construction and commissioning work, record and report actual performance and progress and show how the Contractor plans to complete the project as of the end of each progress reporting period (weekly and monthly).

The Contractor shall enclose in his offer soft and colour coded hard copy of detailed project working program (Revision 0) for Employer's approval, covering accurate procurement, and manufacturing and civil construction activities. The approved working program shall form the baseline of the project. In doing so, the Contractor shall incorporate sub vendors and civil sub-contractor's schedules as evidence for Engineer and Employer's verification. This revision shall also include a tentative construction and commissioning schedule.

The Contractor shall submit within 14 days following the award of the Contract color-coded soft and hard copy of the updated detailed project- working program (Revision 1) for Engineer and Employer's approval including accurate construction and commissioning activities. The approved working program shall form the baseline of the project.

The Contractor shall submit on weekly basis as part of the weekly progress report the updated soft and color-coded hard copy working programs, revisions 0 or 1 as applicable. The soft copies shall mainly enable the Employer to examine the Working Breakdown Structure (WBS), duration, relations/logics, activity weighting, percentages, etc. involved. The Contractor need not to disclose confidential cost details.

Layouts of the detailed working program shall cover as minimum, the physical and structural breakdown of the project, contract millstones, completion dates, type of work to be performed and labour trades involved. The Organization Breakdown Structure (OBS) shall also cover key personnel of Contractor and subcontractors. The Contractor shall weekly perform mathematical computer analysis of the detailed working program and the tabulation for each activity, of the hardcopy, shall include as a minimum the following:

1. Activity Identification Number
2. Activity description
3. Activity code(s)
4. Schedule and actual/remaining duration for each activity
5. Earliest start date (by calendar date)
6. Earliest finish date (by calendar date)
7. Actual start date (by calendar date)
8. Actual finish date (by calendar date)
9. Latest start date (by calendar date)
10. Latest finish date (by calendar date)
11. Early start variance
12. Early finish variance
13. Float in calendar days
14. Percentage of activity completed

Contractor shall provide through the weekly and monthly reports color-coded the PRIMAVERA or equivalent software Project progress performance report S-Curves. S- Curves shall cover Project overall, procurement, manufacturing, erection and commissioning activities. Each activity shall be sub-divided into Civil, Mechanical, Electrical and I&C disciplines S-Curves. Overall S-curves of major deliverables shall also be submitted on monthly bases. Each S-curve shall cover procurement, erection and commissioning activities.

Contractor shall report the following weighting percentages when reporting progress of the procurement and manufacturing:

1. 10% for issue of request for quotation (RFQ)
2. 20% for issue of sub-vendor/sub-contractor application for approval.
3. 50% upon approval of sub-vendor/sub-contractor by Employer/Engineer
4. 80% for successful Factory Acceptance Test (FAT)
5. 100% for delivery to site.

3.6.5 Photographs

As soon as work commences on site the Contractor shall provide colour photographs of the Works from positions to be selected by the Employer. Up to 30 photographs per month shall be provided in bound photographic albums.

Each photographic print shall not be less than photos 240×180 mm and bear a printed description, a serial number and the date when taken. Specific photographs shall be enlarged and mounted for wall hanging.

All photographs in digital format shall be held at the Contractor's site office, numbered and handed over to the Employer at the completion of the Contract.

The Contractor shall provide a number of selected photographs for submission with each copy of the monthly progress report as required by the Employer. The Contractor shall also provide from time to time as and when required by the Employer, further photographs of the Works to record or illustrate specific events.

All other albums and photographs shall be distributed to the Employer/Engineer's site office which shall require each month 3 sets of photographs in separately bound albums on dates to be agreed with the Employer/Engineer.

The Contractor shall also supply three copies of an edited video showing the main construction features throughout the construction and commissioning phase of the project.

3.6.6 Project Progress Report & Photographs

The Contractor shall prepare and submit during the whole project to the Employer until the 5th of each calendar month the "Project Progress Report".

The Project Progress reports shall be submitted in hard and soft copies and shall include but not limited to the followings:

1. Table of Content
2. Abbreviations
3. Executive Summary
4. 'S' Curves
    - (Engineering: Project Overall, Civil, Mechanical, Electrical, I&C).
    - (Procurement/Manufacturing: Project Overall).
        - (Construction/Erection: Project Overall, Civil, Mechanical, Electrical, I&C).
    - (Testing/Commissioning of Works
5. Site Photographs
6. Occupational Health & Safety
7. Engineering Status
8. Procurement and Manufacturing Status
9. Factory Test & Inspection & One Month look ahead.
10. Shipment Status

11. Site Activities
12. Quality Assurance
13. Areas of Concern and Measures to Overcome Any Obstacle
14. Invoices and Payment
15. Drawings List
16. Correspondence
17. Project Organization
18. Project Time Schedule
19. List of pending items
20. Vendor approval list.

Colour photographs showing the progress of Works and completion of each structure or major feature (after the first month of construction and continuing every month until completion) shall be included. A full size 35 mm digital camera shall be used and minimum 9cm by 13cm prints shall be furnished with explanations of the subject photograph.

The project progress report shall report about the activities of the previous month, shall document sufficiently the status of the project at the end of each calendar month and give an outlook for the following three months. Any critical events or milestone shall be reported about. Photographs shall also be used to document the progress on Site. The updated detailed progress schedule reduced to A3 or A4 size shall be part of the project

3.7 Meetings and Conferences

The Contractor has to attend all pre-programmed and ad-hoc meetings and conferences with their Project Manager/Site Manager, as well as senior engineers and responsible staff at their own expenses.

3.7.1 Kick-Off Meeting

Not later than thirty (30) days after the Commencement of the Contract the Employer will require a kick off meeting with the Contractor in the Employer's office to start off the project and discuss the project schedule, project manual, basic requirements and procedures, scheduling of drawings, equipment manufacture and installation, other similar items that are essential for the completion of the project.

3.7.2 Site meetings

As long as activities on Site are going on, periodical, weekly Site progress meetings with all parties participating shall be held. These meetings shall be held mainly for the following purposes:

- To review the progress of the Works, discuss measures to be taken to overcome possible delays, establish short and long term programs and to co-ordinate Employer's interface requirements with the Contractor's activities.
- To discuss any construction, installation and commissioning problems and deal with any matter relating to smooth execution of the Works.

The meetings shall be convened by the Employer, who will prepare Minutes of the Meetings and distribute them to all parties concerned.

Beside the periodical meetings the Employer will call for daily briefings to monitor the daily erection & commissioning activities.

In case of necessity, ad hoc meetings shall also be arranged on Site.

3.8 Computer Software

The version and model of the Computer Software to be supplied under this Contract shall be the latest model/version available at the time of shipment and not what is quoted in the Tender documents, at the time of the Proposal.

The version and model availability, commercially, will be judged/based on the manufacturers press notification. If the installation/implementation of the Software as the case may be, is not completed successfully within the stipulated time schedule or six months whichever is earlier and if a higher model/version of the Hardware and/or software becomes available in the market during this period, then the Employer has the right/option to order the Contractor to supply/upgrade to the latest available model/version of the Hardware and/or software.

3.9 Contract Documents

The preparation and compilation of the Contract Documents shall be performed by the Contractor under the direction of the Employer/Engineer. The cost of reproducing the Contract Documents shall be deemed to be included in the Contract price.

The Contractor shall provide to the Employer within 8 (eight) weeks of the date for acceptance of his Proposal 5(five) bound copies of the Contract Documents in the English language based on the original prepared in conjunction with the Employer/Engineer. Additional 5(five bound copies shall be delivered in A5 size.

Each copy shall be accompanied with an electronic copy containing the Contract Documents in *.pdf (Acrobat) format with overall index and Tables of Contents consisting of links to the referenced content.

4.0. REFERENCE SITE DATA

4.1 Site Data

The following information is based on information investigated by the Employer. The Contractor is not relieved from his obligation to carry out all investigations necessary to inform him fully. The information given below shall only be taken as guidance for detailed investigations and studies to be performed by the Contractor.

4.1.1 Site Location

The project of connecting wells OW-50A,OW-50B and OW-50C is to be done in Olkaria which is within the Hells gate National Park.

The project is to be located on a Brownfield area. The area allocated by KenGen for the project is located some 110 km to the north-west of Nairobi inside the Hell's Gate National Park. The nearest town is Naivasha, which is located about 35 km to the north of the site.

4.1.2 Access and transport to the site

The site is accessible by main roads (A104) from Nairobi via Naivasha town.

Heavy plant materials and equipment can be unloaded at the Jomo Kenyatta International Airport, Nairobi or the port of Mombasa (some 600km away) and transported to the site by truck.

Heavy commercial Trucks use B3-C88-Moi Southlake road (Nairobi via Mai Mahiu road).

4.2 Site Conditions

4.2.1 Ambient air temperatures and humidity

Ambient Air Temperatures

Maximum recorded (January)	27.1	°C
Mean daily maximum (March)	18.4	°C
Annual mean	17.1	°C
Mean daily minimum (July)	15.7	°C
Minimum recorded	8.4	°C

Relative Humidity

Maximum ambient humidity	92	%
Average (Midday)	57	%

1.0 HEALTH AND SAFETY AND ENVIRONMENTAL PROTECTION REQUIREMENTS

1.1 General

The Bidder/Contractor shall construct the Plant to meet all applicable environmental regulations, environmental standards and stipulations of the Republic of Kenya and the environmental, health and Safety Guidelines for geothermal power plants. The Contractor shall demonstrate during the construction phase and during the performance tests that the Plant complies with all applicable environmental regulations and standards.

The Contractor is requested to take all environmental protection requirements included in the ESIA study into account as well as all corresponding environmental & social mitigation measures addressed to reduce environmental & social impacts to a low as reasonable possible level. This is specifically applicable for the neighboring protected areas.

Any deviation from the approved environmental & social mitigation measures can only be done with prior written approval to be obtained from the competent environmental authority.

For avoidance of doubt, among others, the most stringent requirements from the following sources shall apply as minimum:

- This employer's requirements
- Kenya's Environmental Management and Co-Coordination Act (EMC

1999)

- Kenya's EMC (Impact Assessment and Audit - Amendment) Regulations (2009)
- Kenya's EMC (Air Quality) Regulations (2014)
- Kenya's EMC (Water Quality) Regulations (2006)
- Kenya's EMC (Waste Management) Regulations (2006)
- Kenya's EMC (Noise and Excessive Vibration Pollution - Control) Regulations (2009)
- Kenya's Occupational Safety and Health Act (2007)
- Kenya's Wildlife Conservation and Management Act (2013)
- Kenya's Wildlife Service Hell's Gate Ecosystem Management Plan (2010-2015)
- Kenya's Wildlife Service Hell's Gate Park Rules
- KenGen's Occupation Health & Safety Policy Statement (2013)
- KenGen's MOU with KWS - Geothermal Development in Hell's Gate and Longonot National Parks (2008)
- KenGen's Hell's Gate Wildlife Movement in Geothermal Field map (2010)
- KenGen's Health and Safety Management System Manual (2015)
- IFC Environmental Health and Safety General Guidelines (EHS 2007)
- IFC EHS for Geothermal Power Plants (2007).

5.2 KWS Park Rules

The Plant is situated and will be built in the Hell's Gate National Park.

Thus, KWS park rules apply. These rules include, among others:

- Stay over or leave before dusk, visitors must vacate the Park between 6.00 p.m. - 6.00 a.m. unless they are camping overnight. Night game driving is not allowed.
- Respect the privacy of the wildlife, this is their habitat.
- Beware of the animals, they are wild and can be unpredictable.
- Don't crowd the animals or make sudden noises or movements.

- Don't feed the animals, it upsets their diet and leads to human dependence.
- Keep quiet, noise disturbs the wildlife and may antagonize your fellow visitors.
- Stay in your vehicle at all times, except at designated picnic or walking areas.
- Keep below the maximum speed limit (40 mph/25 mph).
- Never drive off-road, this severely damages the habitat.
- When viewing wildlife keep to a minimum distance of 20 meters and pull to the side of the road so as to allow others to pass.
- Leave no litter and never leave fires unattended or discard burning objects.
- Respect the cultural heritage of Kenya, never take pictures of the local people or their habitat without asking their permission, respect the cultural traditions of Kenya and always dress with decorum.

This means that all activities related to the project shall be carried out between 6 a.m. to 6 p.m. only. Staying on site overnight, night time driving and night time working is not permitted. Exceptions of these working hours need the upfront approval of KWS. The Owner's Engineer shall be noticed about the request for exemption as well as about the answer of KWS.

5.3 Noise

The project shall guarantee and prove during the performance tests compliance with the following noise pressure levels (compensating for background emissions)

Location	Unit	Design limit (max)
at the wellpad and cluster fences	dB(A)	60
at 1 meter distance of open air installations, equipment or	dB(A)	85
inside buildings	dB(A)	90

Remark:

The noise pressure levels shall be measured according to ISO standards and shall be achieved for the Works compensating for background noise.

To meet the noise level requirements, the plant is required to be equipped with standard noise attenuation features. All machinery which exceeds the permissible noise limits shall be equipped with silencers or with lagging or specially designed acoustic enclosures/buildings.

Upon request and subject to Kenya's National Environmental Management Authority approval the Contractor may exceed the guaranteed noise pressure levels for a limited time.

Exemptions from the guaranteed noise pressure levels are granted for emergency conditions including the following:

- Trip condition

- Emergency shutdown
- Rupture disc operation
- Equipment failures, and
- Alarm sirens/warning devices (e.g. fire, H2S)

5.4 Emissions to Air

The emissions to air shall be regularly monitored according to the requirements of the environmental authorities. The installation of hydrogen sulphide monitoring and warning systems shall be considered. The number and location of monitors should be determined based on an assessment of plant locations prone to hydrogen sulphide emission (e.g. wellpads and separator station).

5.5 Definition of Occupational Health & Safety

Since 1950, the International Labour Organization (ILO) and the World Health Organization (WHO) have shared a common definition of occupational health. It was adopted by the Joint ILO/WHO Committee on Occupational Health at its first session in 1950 and revised at its twelfth session in 1995. The definition reads:

"Occupational health should aim at: the promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations; the prevention amongst workers of departures from health caused by their working conditions; the protection of workers in their employment from risks resulting from factors adverse to health; the placing and maintenance of the worker in an occupational environment adapted to his physiological and psychological capabilities; and, to summarize, the adaptation of work to man and of each man to his job."

"The main focus in occupational health is on three different objectives:

1. The maintenance and promotion of workers' health and working capacity;
2. The improvement of working environment and work to become conducive to safety and health and
3. Development of work organizations and working cultures in a direction which supports health and safety at work and in doing so also promotes a positive social climate and smooth operation and may enhance productivity of the undertakings.

The concept of working culture is intended in this context to mean a reflection of the essential value systems adopted by the undertaking concerned. Such a culture is reflected in practice in the managerial systems, personnel policy, principles for participation, training policies and quality management of the undertaking."

Workers safety has to be understood as the practice of an employer using preventative measures to prevent hazards to the employees' personal safety. This practice includes creating plans and procedures for employees and managers in the workplace. In addition, workplace safety involves creating policies and keeping emergency materials available for employee and manager use while at a work site.

5.6 Applicable Health & Safety Requirements

If not otherwise specified, the following legal health & safety requirements and guidelines should be taken into account while construction of the project:

- The Occupational Safety & Health Act, 2007, together with the following guidelines and statements implemented by KenGen:
- KenGen Occupational Health & Safety Policy Statement
- KenGen Occupational Safety and Health System Manual

Beside the consideration of the above-mentioned legal requirements and company guidelines, the Contractor will be requested to develop and prepare various health & safety deliverables before start of the construction activities.

These deliverables should be subject of review and comment by KenGen and/or the Consultant.

The aim of the deliverables is to evaluate if the Contractor has the correct understanding for the implementation of the health & safety requirements and to assess if all needed health & safety measures are addressed.

The Contractor will be requested to develop and prepare the follow deliverables.

5.7 Health & Safety Plan

The Contractor shall establish an effective project specific H&S Plan. The H&S Plan shall be submitted by the Contractor not later than 4 weeks prior to any commencement of works at site.

Any work at site, incl. mobilization to the site will not be allowed to commence until unconditional approval of the document.

The H&S Plan shall describe how health and safety will be managed at site, incl. mobilization and transport to the site, and how the specified H&S standards will be applied in practice. In addition the Contractor shall ensure adequate communication of these requirements throughout the supply chain, its supervision, and the workers themselves.

The H&S Plan should detail the management arrangements for carrying out the work including but not limited to:

- Overview of the project;
- Clearly identified risks associated with the scope of works;
- Site management and organization;
- Management of sub-contractors;
- Communication, Cooperation and Co-ordination;
- Site security;
- Traffic management;
- Welfare facilities and provision;
- Arrangements for supervision of workers at site;
- Arrangements for information, instruction and training including induction; • Management of hazards on site;
- Arrangements for identification of hazards, assessment of risk and production of Method Statements;

- Arrangements for hazardous undertakings e.g. confined space, work at height, hot work, excavations etc.
- Permit to work system;
- Site rules;
- Arrangements for managing plant and equipment;
- Management or lifting operations (if needed);
- Management of temporary works;
- Arrangements for monitoring and auditing etc.
- Requirements as defined by relevant statutory planning authorities e.g. traffic, noise, working hours etc.
- Incident & accident investigation.
- The H&S Plan should consider as well site rules outlining the H&S Requirements for all workers. The site rules shall include but are not limited to:
    - Site access;
    - Access to and transport on the site;
    - Entering and leaving the site;
    - Use of mobile phones;
    - Smoking;
    - Personal Protective Equipment (PPE) requirements;
    - General behavior
    - Transport to the site;
    - Vehicle traffic within the site area;
    - Access to the site and Working Areas;
    - Restricted areas.

A checklist for the review and approval of project specific Health & Safety Plan will be developed by the Consultant prior to submission of the H&S Plan. The checklist will define the minimum requirements to be met by the Contractor.

5.8 Contractor's Health & Safety Method Statements

The Contractor is requested to develop workplace specific H&S Method Statements. The required content of H&S Method Statements is described below.

Health & Safety Method Statements are part of the project framework for effective H&S management. The H&S Policy states the intention to provide a safe and healthy workplace.

Specific health & safety workplace method statements shall address particular issues or hazards and the measures how to control workplace those identified hazards. The procedures should be used together with other hazard control measures to eliminate or reduce the risks of accidents and incidents and of workplace illness and/or injuries.

H&S Method Statements shall be developed for the following activities expected to be needed during construction:

- Site access control and site security procedure;
- Use of hazardous chemicals;
- Simultaneous activities;
- Shift work, shift rotation and fatigue;

- Risk assessment;

- Job Safety Analysis;
- Working in confined spaces;
- Use of personal protective equipment;
- Excavation works;
- Hot works;
- Welding;
- Emergency response procedure;
- Evacuation procedure (if applicable);
- First aid;
- Use of electrical equipment;

A checklist for the review and approval of project specific Health & Safety Procedures will be developed by the Consultant prior to the first construction activities. The checklist will define the minimum requirements to be met by the Contractor.

5.9 Health & Safety Forms

The Contractor is requested to develop forms, such as checklists, risk assessment form sheet, to support the use of method statements, instructions, audits etc.

These forms must be attached to the respective documents, if applicable, and must be read in closed conjunction with the corresponding document(s).

The checklist shall be subject of an update and revision in case improvements or needed changes were found suitable and required.

The checklist must be subject of project documentation, in the same way and considering the same procedure that is applicable for the project documentation in general.

Examples of Health & Safety Forms are provided below:

- Contractor Audit Questionnaire
- Basic Risk Assessment
- Permit to Work
- Workplace Inspection Checklist
- Accident/Incident Report/Investigation
- Fire Risk Assessment
- Hazardous Substance Risk Assessment

Additional forms might be necessary and should be prepared by the Contractor, e.g. inspection checklists, workplace inspection checklists.

6.0 GENERAL PROCEDURE

6.1 Correspondence

The distribution of the correspondence shall follow the rules as stated in the Project Procedure Manual provided after contract award.

6.2 Submission of Documents and Approval Procedure

6.2.1 Specification Stage

The drawings issued by the Employer together with the Specifications and forming part of the documents for tendering purposes are intended to be descriptive of the character of the works and used in conjunction with the requirements of the specification and shall in no way limit the responsibility of the Contractor to supply all plant equipment, materials and services necessary to provide a complete and functional complex. Any omission from both drawings and the Specification or express reference to any detail or work necessary and obviously intended shall not relieve the Contractor of his responsibility to include such detail or work in his supply.

The final sizes of the structures shown on the specification drawings have not been fixed by the Employer since these are dependent on the size and shape of the Contractor's plant, equipment and materials forming the works and the space required for installation, maintenance, lay down, storage, access etc. They are however to be considered as minimum requirements.

When measurements are affected by conditions already established, the Contractor shall take and be responsible for field measurements notwithstanding any information set forth on the Specification drawings.

The Specification drawings portray the basic layout of the scope of works and the Contractor shall incorporate these requirements into his Proposal.

With regard to the interconnections to and the extensions of existing installations supplied, the drawings and descriptions included in this Specification shall be assumed to be descriptive to the extent necessary for tendering purposes.

After award of contract, the drawings and data of the external installations necessary for determining precisely the locations and design conditions of interconnecting the various systems will be made available through the by the Employer.

The Bidder is at liberty to comment on any document and drawing issued with the Specification within the period of tendering if not stated otherwise in the Instructions to Bidders for the Technical Proposal. After the Proposal has been submitted the Bidder is deemed to have checked all these documents and drawings and they are without any restriction accepted by him. No claim resulting from omissions from or discrepancies in the tender documents will be accepted by the Employer.

6.2.2 Details of Offer & Departure from the Specification

Notwithstanding any description, drawings, or illustrations which may be submitted with the Proposal, it will be deemed that the Contractor complies with the requirements of the Specification.

6.2.3 Documents to be submitted during Construction

After contract signing, Contractor shall submit the detail document transmittal schedule for approval of Employer. Items marked with (A) shall be for approval and (I) for information.

Document	Purpose	Weeks after Commencement	
		Preliminary	Final
• General			
• Works program	A	1	2
• Progress reports	I		every 1 month
• Erection and installation progress reports	I		every 1 month
• List of Subcontractors/manufacturers	A	2	4
• Proposed inspection and testing programs	A	2	every 2 months
• Detailed program for commissioning	I	8 weeks prior to Tests on Completion	4 weeks prior to start of Tests on Completion
• Testing documents/report of results of all tests	I		2 weeks before each test but latest 12 weeks before start of trial
• Training program	A		16
• Health and safety Management system	A		4
• Quality Assurance program	A	2	4
• Preliminary (draft) Operation and maintenance	I		2 months ahead of start of commissioning
• Final Operation and maintenance manual with description of all equipment and facilities	I		2 months in advance of the Taking Over of the plant
• Detailed operation and maintenance instructions	I		2 months ahead of start of commissioning
• As-built documentation including drawings of all equipment	review/ comment		2 month prior to the plant Taking Over

6.2.4 Statutory Regulations

The works and all equipment and materials forming part of this Contract shall comply in all respects with any relevant statutory regulations, by-laws or orders currently in force where the Works are to be erected.

6.3 Documents, Goods, Materials, etc. to be handed over to the Employer

In addition to the requirements of the corresponding clauses of the conditions of Contract on provisional taking over, the Employer receives and issues hand over certificate for construction documents, consumables, chemicals, lubricants, spare parts, as built drawings, O&M manuals, special tools and handling equipment, etc., required by this Specification to be handed over to the Employer other than the permanent works erected on site.

The receipt shall state clearly that all items have been received in a satisfactory condition as required under the Contract. The Contractor shall be responsible for demonstrating the satisfactory condition of all items delivered to the Employer including the repacking for storage on site.

6.4 Sub-contractors & Sub-orders

As soon as practicable after entering into the contract the Contractor shall, having obtained the Employer's consent in accordance with the Conditions of Contract, enter into the subcontracts he considers necessary for the satisfactory completion of the Contract works.

Sub-orders shall include all relevant sections of the Tender Specification, all relevant approved design particulars furnished by the Contractor for the equipment in question, delivery schedule to meet the project control program, all relevant approved drawings, etc. An unpriced copy of such order shall be provided by the Contractor to the Employer. All sub-orders shall be prepared in English. [2]

It is the responsibility of the Contractor that all information requested shall be submitted in sufficient time to allow adequate time for examination and approval.

The Contractor shall take note that subcontractors of main equipment have to be approved by the Employer and no claim shall be allowed if orders have been given by the Contractor without prior approval.

7.0 SITE PROCEDURES

7.1 General Field Construction Regulations

7.1.1 Site Regulations

The Contractor and his employees shall be subject to such rules and regulations for the conduct of the work at the site as the Employer may establish. The Contractor shall be responsible for the enforcement among his employees of the Employer's instructions regarding signs, advertisements, the prevention of fires and accidents, and other general regulations.

The Contractor shall be responsible for the co-ordination of his work with the Employer's staff and with that of other contractors at site, if this will be the case, to prevent delay in the work being performed by others or in the general completion of the project. In this case, wherever required by the Employer, the Contractor shall make adjustments in his construction sequence and schedules to avoid imposing delays on the other contractors. The Contractor shall conduct his work at all times so as to prevent any unnecessary hindrance or interference with other contractors and with the operation of the existing plant.

In case the operation of an existing plant will be affected by the Contractor's intended work, the Contractor shall give adequate notice to the Employer and shall obtain clearance from them before proceeding with

such work. Should any interference occur, the Employer will establish precedence and will decide which work shall be relocated regardless of which work was first done or which equipment was first installed. The relocation shall be carried out by the Contractor at own costs.

7.1.2 Records

The Contractor shall, at all times during the progress of the work, keep at his field office such particulars and data relative to the work done and equipment installed as will permit the Employer's inspection of such records and information as may be required.

7.1.3 Permit to Work System

No work shall be carried out by any person on plant which is electrically charged from the Employer's system, or is operational or which has been taken over, or on the connections of plant to other plant which is so charged and/or operational, or which has been taken over, unless permission has been granted by the issue of a Permit to Work (PTW). If the Contractor is in doubt as to whether authorization is required for any particular area of work, he should consult the Employer/Engineer or his nominated representative for assistance.

The Contractor shall be responsible, with the assistance of the Employer/Engineer as required, for requesting the issue of a relevant Permit to Work outlining the work he proposes to do and giving the name of the competent person to which the Permit to Work should be issued. The Contractor shall ensure that the plant and equipment covered by the Permit to Work meets his requirements and that the period of cover is also adequate.

The Permit to Work shall be submitted in a prescribed format (separate format for the power station and sub-station) to the Employer/Employer. The Permit to Work shall contain detailed method statement outlining the activities with outages of any system, if required.

For works in the power station system the Permit to Work shall be submitted one week and for work in the substation it shall be submitted at least two weeks in advance.

In order to simplify the process and to ensure timely approval of PTWs without compromising the safety the following management of the PTW System shall be taken into consideration:

1. The Contractor submits the PTW through the Employer/Engineer to the relevant department for approval or comments. PTWs will be cleared within one (1) week from the time of receipt.
2. After signing of the PTWs by the Employer/Engineer the Contractor shall do the distribution to concerned Employer's departments.
3. PTWs will be discussed in a meeting 5 (five) days following the receipt of PTWs by the concerned Employer's departments at user department's office attended by the Employer/Engineer/ Contractor/concerned Employer's users departments to discuss the method statement, relevant drawings, personnel involved in the works. During the meeting, Employer/Engineer shall either approve the PTWs or agree on specific/necessary additional requirements, which if fulfilled by the Contractor will result in approval of the PTWs.

4. If additional requirements are raised as per item 3 above, the Contractor shall fulfil the requirements and re-submit the revised PTW to Employer/Engineer. The Employer/Engineer will ensure that all requirements are addressed/fulfilled by Contractor and only then forward the PTWs to the concerned Employer's department through the Contractor for approval within 48 hours.

5. The Contractor is responsible to plan and to ensure that only **once in each month** PTWs are released for approval.

7.1.4 Signboards

The Contractor shall provide, erect and maintain at the entrance to the site an approved painted signboard minimum size 2 m x 1 m, lettered in English giving Employer's, Engineer's and the Contractor's name and the name of the project as approved by the Employer/Engineer.

7.1.5 Installation of Equipment

None of the works which require approval by the local authorities shall be installed before approval has been obtained by the Contractor from the appropriate authorities. The obtaining of such approvals is part of the Contractor's contractual commitments.

7.1.6 Special Conditions

7.1.6.1 Inspection of Site

If required, inspection of work on site can be arranged.

7.1.6.2 Contractor's Superintendence

The Contractor shall provide adequate number of supervisors to ensure proper and timely completion of work. He shall also nominate one responsible person who shall liaison with the Employer on all matters, pertaining to the contract and who will be available at site all through the working hours.

7.1.6.3 Supply of Plant, Materials & Labour

The Contractor shall arrange to provide, install and remove the necessary scaffoldings, staging, safety nets, dollies and platforms as required by his workmen. All tools and consumable shall be supplied by the contractor, except where specifically excluded.

7.1.6.4 Workmanship

The workmanship shall be of the highest standards. Wherever applicable National/International standards will be used.

7.1.6.5 Safety Precautions

The work under this contract shall be carried out with adequate care to prevent spillage and dirtying of plant area, the equipment and floors, where such pillage occur must be immediately cleaned. Any violation to this care will be treated as a serious offence. The job is to be carried out in the operational areas. The Contractor's men shall not touch or operate any of the equipment, switches, controls or instruments. Any such mishandling may lead to failure of power supply.

As power cables, open crane power leads etc., are there in the plant exacting needs of safety precautions will be required. The Contractor shall also ensure the safety of his workmen with breathing filters, life lines, safety belts, goggles etc., and strictly follow advises given by the Employer's Safety Inspector. The additional lead, cables, hoses etc., shall be the responsibility of the Contractor.

The Contractor shall comply with the fire-fighting regulation. Smoking is not allowed within the Site. Wherever scaffoldings are necessary, the same shall be of self-supporting design of robust materials and securely fixed to supports. Any accident or injury to personnel will be entirely to Contractor's responsibility.

As the Steamfield is operational, the Contractor shall inform the Employer's representative every day before commencement and after completion of day's work. The Contractor shall take any such precautionary measures that may be advised by the Employer.

The followings shall be considered and strictly adhered to:

1. Contractor shall strictly adhere to the Employer's Safety Rules, a copy of which be collected prior to the beginning of his work on site.
2. Contractor's to submit a copy of their Safety Policy, prior to starting the work.
3. Contractor's shall produce method statements outlining how they will approach work activities. The method statements shall include risk assessments.
4. Contractor's shall monitor and provide details of accident and near hit performance during the course of the contract.
5. Contractor's shall ensure that visitors to the site are properly made aware of Safety & Emergency procedures during a check-in procedure.
6. Contractor's shall report on their Health & Safety Performance as part of their project progress reporting.
7. Contractor's shall report to Safety Section of the Employer through the concerned Dept. all accidents and near misses (Near Hits) as per procedure and prescribed form. In continuation of which they shall also fill up the Follow up Report form including mentioning their actions.
8. Contractor's shall report quarterly to Safety Section of the Employer through the concerned department, as per procedure, their Accident Frequency Rates (APR), Accident Severity Rates (ASR), other parameters in connection with Safety and Occupational Health.
9. Contractor's shall report quarterly to Safety Section of the Employer through the concerned department as per procedure, Risk Assessment Report with their part of action.
10. Contractor's shall provide the all-necessary information and co- operation to the Safety Section of the Employer and the Employer's staff in inspection, investigation and in other safety and occupational health issues.
11. Contractor's shall co-operate with Safety Section of the Employer during cross checking which the Employer reserves the right for.
12. Contractor's shall take the specification through the concerned department before procuring and after that quality standard clearance of Safety Section of Employer.
13. Contractor's shall take care and take necessary action of all other additional items if found hazardous and risky in nature.

14. Apart from those mentioned above, contractors shall adhere to follow the latest advice and suggestions on Health & Safety issues, during the contract.
15. Contractor shall strictly comply with the Local and Federal Order/Safety Rules.
16. The basic/minimum educational qualification of the Contractor's "Full time Safety Officer" should be "degree/Diploma in Civil Engineering or branch of Engineering works undertaken".

7.1.6.6 Security Precautions

The Contractor shall comply with the Employer's rules regarding security

measures and for this purpose he will submit the names and other details as required to enable the Employer to issue gate passes for the personnel engaged for the job. The list of vehicles, which would be used for transportation of men and materials, shall be provided to the Employer with their registration numbers. The presence of contractor's men shall be restricted to the area of their work.

7.1.6.7 Clean up

The Contractor shall promptly clean up and remove any waste and spills on ground and other parts and leave those items in original shape and condition. All waste disposal shall be in accordance with ISO-14001, and the local NEMA regulations and practices. If any part of the plant is defaced or smeared these shall be cleaned and restored to original condition free of cost by the Contractor. At all times during execution of this contract, the area of work shall be kept neat, clean and tidy. On completion of the job, the place of work shall be cleaned to the satisfaction of the Employer.

7.1.6.8 Reporting Damages

In spite of all the care taken by the Contractor and his workmen if any of the plant items are damaged or defaced or otherwise made in-operational by the Contractor's men, this shall be forthwith reported to Employer/Engineer to avert further damages, breakdown or shutdown of the total plant.

7.1.6.9 Hot Work Permit

In hazardous areas, no machinery, tools and plant used therein shall be moved in without specific clearance from the Employer. The work in the area shall follow absolute safe methods as recognized in international practice for work in hazardous area. No hot work shall be carried out without specific "Hot Work Permit". The requirements for the system have to be agreed upon by the Employer/Engineer.

During the period of this contract, the Contractor's shall ensure that adequate fire protection to equipment and men are available to fight any possible hazardous.

7.1.7 Safety & Security Guidelines for the Contractor

The following safety and security guidelines shall strictly be observed by the Contractor and his sub-contractors who work on the site for the execution of their contracts -where applicable-:

1. Personnel, material, vehicle etc., are subject to security check, when passing through the KWS gate
2. The Contractor's personnel will be admitted to the Site on request, on the basis of the Identity Cards issued by the Contractor. This card shall be withdrawn when the services of the contractor's personnel are terminated. Alternatively, the Employer may issue its gate passes.

3. The Contractor's supervisory/managerial staff who may require access to the operating area or Administration office, Stores, etc., will be provided with Employer security passes for which the Contractor shall apply in prescribed form.
4. Vehicles for transporting personnel will not be allowed to ply on Site. However, personal cars/Engineer's transports may be allowed on Site, after the security check, up the Contractor's site office. This shall be parked only in the designated parking area. However, this will be on a case-by-case basis.

5. The following information shall be provided by the Contractor's:
    a. A list of staff giving names, Identity card/Passport number and nationality.
    b. List of vehicles required to be allowed entry onto Site
    c. Specimen signature of person authorized to sign gate pass, Identity, Cards etc.
6. The Contractor shall bring with him a comprehensive list of materials, tools, and tackles, etc., which he is likely to take back on completion of the job. This list shall be handed over to security for necessary verification.
7. Material transporting vehicles are allowed on site up to the Contractor's work site. Parking of such vehicle shall strictly be restricted to parking area provided.
8. 'Permit to Work' shall be obtained from the Engineer before starting any work in the JEC premises.
9. Strict compliance to the 'No smoking' Warning shall be ensured.
10. Burning of waste material on site is strictly prohibited.
11. The Contractor's shall keep their work site and lay by areas neat and free from hazard.
12. Normally visitors will not be allowed on Site. However, if any visitor is to be taken to a Contractor's office on Site for a particular purpose, the Security personnel at the main gate house shall be contacted who may make necessary arrangements for the same.
13. Visitors are strictly prohibited from the operating areas.
14. Photography is prohibited on Site. However, if for any specific purpose taking photo is necessary, prior permission shall be obtained for the same.
15. The Contractor shall comply with all the government rules and regulations applicable to their works.

16. The Contractor and his sub-contractors shall comply with the British Safety Council/ISO 18000 requirements.

7.1.8 Site Services during Construction & Site Installations

7.1.8.1 Introduction

The Contractor shall include for the following site services in accordance with the appropriate specification included elsewhere in this document.

All buildings and equipment provided in accordance with this requirement shall be made available within 8 weeks following the commencement of the works at the site and must not be removed without the prior approval of the Employer/Engineer.

Following completion of the required period of availability and agreement by the Employer/Engineer, all buildings and equipment, unless specified to the contrary, must be removed from the site to the

Employer/Engineers approval and the site returned to its original state both above and below ground and all resulting debris removed to an approved dump to the Employer/Engineers complete satisfaction.

7.1.8.2 Contractor's Site Buildings

The Employer will provide the Contractor with a limited uncovered area for the storage of plant, equipment and materials during the execution of the Contract.

The Contractor shall be responsible for the off-loading, transporting and handling of all the plant and equipment and materials needed for the purpose of the Contract.

The handling and storage of all plant at the site shall be to the risk of the

Contractor and without responsibility of the Employer.

The Contractor shall protect all material against corrosion, mechanical damage or deterioration during storage and erection on site. The protection shall be to the approval of the Employer/Engineer.

The Bidder shall provide with his Proposal details of his proposals in compliance with the foregoing requirements in respect of stores, laydown areas and other such facilities.

Within the designated area the Contractor shall provide and maintain an office appropriate to the efficient management and control of the project.

Furnishings and office equipment shall be provided by the Contractor as he might consider most appropriate to his efficient completion of the project.

The Contractor shall use proper transport facilities to transport his employees to and from the site to their living quarters. Tractors, cranes, trucks and other such construction vehicles shall not be used to transport personnel.

7.1.8.3 Site Installations

The Bidder shall look for sufficient lay down areas, storage space and facilities, labour camps, parking places, etc. off site. The affected cross transports, inclusive un-loading and uploading, lifts and intermediate storage, shall be included within the Proposal, no extra charge for those transports will be accepted by the Employer. The Contractor shall be responsible for obtaining all No Objection Certificates (NOC) of various authorities. The Contractor shall not be relieved from his obligation to arrange for suitable lay down area and include all respective cost in its Proposal.

For coordination reasons Bidder's site installation plan, shall include all relevant information of the site installation for the complete plant and for all related works and not only for civil works.

7.1.8.4 Site First Aid Post

The Contractor is to provide a site first aid station. The station shall be made available for the use of all personnel who shall be employed on the site for overall project works. The first aid facility shall be suitable for the provision of a first aid service to the number of people expected on this Site.

The Contractor shall collect a copy of the Employer's Safety Rules and strictly adhere to it. The method statement of any work shall include Risk Assessment. The Contractor shall report all accidents and near misses (near hits) and the follow up actions in the prescribed format. The quarterly report, which shall be submitted by the Contractor, shall include Accident Frequency Rate (AFR), Accident Severity Rate (ASR).

The Contractor shall co-operate fully with the Employer's Safety Sections in providing information and at the site inspection. The personal protection equipment for safety (PPES) used by the Contractor personnel shall comply with the International Standards or approved Standards by the concerned Authorities.

The Contractor safety policy covering all the above points in addition to their own shall be submitted for review and approval 8 weeks prior to the start of the site work.

7.1.8.5 Site Fire Protection

Site fire protection services shall be provided to meet with the following specific project requirements:

a) Temporary fire assembly points. The Contract shall include for the provision of clear marker posts at locations around all the various project work sites as defined by the Employer/Engineer.

b) Portable fire extinguishers. The Contract shall include for the provision of 4x10 kg portable dry powder fire extinguishers at each temporary fire assembly point.

The Contractor shall ensure that each extinguisher is tested and maintained in accordance with accepted fire safety requirements and details of the routine tests and completed maintenance works shall be recorded in an approved register.

c) Fire safety instructions. Fire safety instruction in English shall be prepared and displayed at each temporary fire assembly point.

The Site shall be a 'NO SMOKING ZONE' The Contractor and his subcontractors shall be deemed to have made themselves fully aware of this requirement and its implementation by all concerned.

7.1.8.6 Temporary Latrines & Ablutions

Temporary toilets and ablutions shall be provided by the contractor for the use of the

Contractor and his sub-contractors. The Contractor shall also include in his Contract for the treatment or disposal of the sewage resulting from his own temporary toilet and ablution facilities.

7.1.8.7 Temporary Electricity & Water Supplies

The Contractor shall include the supply of the total electricity and water demand for the Contract works. The temporary electricity and water supplies shall be provided by the Contractor. The Contractor shall provide all equipment required to provide the electricity and water supplies to the site. This includes all water required for hydro testing equipment. The employer will provide a designated water dispensing point within the project area. The contractor will apply for the temporary power to Kenya Power.

7.1.8.8 Radios/Walkie-Talkies

The Contractor shall be responsible for obtaining all necessary permits from the relevant authorities for the use of any radio equipment on the site.

7.1.9 Operations at Site

7.1.9.1 Protection

During erection and commissioning, the Contractor shall provide all temporary scaffolding, ladders, platforms with handrails and cover plates for channels, opening, etc. for proper and safe access of workmen and inspectors and has to provide adequate protection against material falling from higher level on personnel and equipment below. In case of damage of equipment, structures, platforms, etc. by other contractors, the Contractor has first to estimate the damage and to clarify with the other contractor(s) concerned the right for compensation. The Employer will assist if deemed necessary.

7.1.9.2 Cleanliness

The Contractor shall keep reasonably clean the site on which he erects or stores equipment and remove all waste material resulting from the work as it accumulates.

7.1.9.3 Material Transport from Site Storage Area to the Erection Spot

The Contractor is obliged to transport only such material to the erection spot, which will be used for installation within the following couple of days. It is not allowed to use the erection areas to store materials.

Whenever possible, the material and equipment shall be transported to the erection spot unpacked.

7.1.10 Erection & Checking At Site

All work at the site shall be carried out in such a manner as not to obstruct the operations of other contractors on the site or interfere with the operation of the Employer's existing installations on the site, and the Contractor shall co-operate with other contractors and the Employer/Engineer to attain this end.

The Contractor shall take all necessary precautions and provide all necessary equipment to protect the existing plant from damage and/or interruption to its commercial operation during the construction period of the Works. Any damage caused to existing plant or installation by the Contractor or Subcontractor's plant, machinery, personnel or vehicles shall be made good by the Contractor at his cost.

The carrying out of all the work included in the Contract shall be supervised by a sufficient number of qualified representatives of the Contractor, and full facilities and assistance shall be afforded for the Employer/Engineer to check the works. The Contractor shall obtain from the Employer/Engineer details of the parts which he proposes to inspect, but such inspection shall in no way exonerate the Contractor from any of his obligations. The Contractor, if requested by the Employer/Engineer, shall open for inspection before erection any equipment, which has been delivered to the site partly assembled.

The Contractor shall keep clean the site on which he erects or stores plant, removing all waste material resulting from the works as it accumulates and as reasonably directed. On completion of the works the site shall be left clean and tidy to the satisfaction of the Employer/Engineer. Any damage done to buildings, structures, plant or property belonging to the Employer shall be made good at the Contractor's expense.

The Contractor shall ensure the correctness of electrical and mechanical connections to all equipment supplied under the Contract before such equipment is commissioned.

During erection and commissioning the Contractor shall provide all temporary scaffolding, ladders, platforms with toe boards and hand-rails essential for proper access of workmen and inspectors, cover or rail off dangerous openings or holes in floors, and afford adequate protection against materials falling from a higher level on to personnel below.

The maximum personal safety must be afforded to personnel either directly engaged on this Contract or who in the normal course of their occupations find it necessary to utilize temporary works erected by the Contractor or to frequent the working area.

The Contractor must take particular precaution to ensure adequate protection of all site personnel during any period when radiographic or X- ray inspection of welding joints is being carried out. Warning notices must be fully displayed and the inspection areas fenced off so that no personnel will at any time be subject to any radiation dosages in excess of the permissible levels quoted for unclassified non-radiation personnel in published statutory limits.

In each and every case involving a connection between the Plant supplied under this Contract and any other existing plant which may or may not be in service the Contractor must make suitable arrangements as regards the time and manner in which the connection is made subject only to the approval of the Engineer and the Employer's Representative who is in charge of the existing plant. Where cases arise involving the operation of the plant or work on plant in operation or whenever required by the Employer's Representative, the Contractor must obtain a written "Permit to Work" signed by a person duly authorized by the Employer and countersigned by the Engineer.

7.1.11 Contract Terminal Points

The Contractor's responsibility for making terminal connections shall be as follows unless otherwise stated in the specification:

a) Where pipework supplied under this Contract connects to equipment already existing or supplied by the Employer or other contractors, the connections shall be made under this contract. All preparatory work for making terminal point connections such as draining, transferring the fluid, shall be undertaken by the Contractor under directives of the Employer. All follow up work such as supply of necessary equipment and tanks, clean up, etc. will be Contractor's responsibility. The Employer will not utilize his resources for such work.

b) All associated switchgear and ancillary electrical apparatus not included in this Contract will be erected and tested under the supervision of the Employer/Engineer.

c) This contract includes the terminating and connecting up of all cables which are supplied under this Contract.

d) All associated cabling not included in the Contract will be installed, connected up to the terminal boards and tested under the supervision of the Employer/Engineer, but it will be the responsibility of the Contractor under this Contract to assist the Employer/Engineer in re-checking all final connections and to ensure the subsequent satisfactory operation of the equipment.

e) Any terminal points not specified or included in the Contract documents but required for safe and reliable operation of the plant shall be deemed to be included in the scope of supply and the Contractor shall make such connections at no extra cost or delay to the Contract.

The Employer/Engineer will be responsible for the general co-ordination of the above work and for supervising all combined testing. The Contractor shall be deemed not to have fulfilled

his obligation insofar as the commissioning of the Plant is concerned until complete end-to-end tests have been carried out to the satisfaction of the Employer/Engineer.

8.0 OPERATION AND MAINTENANCE MANUALS AND AS-BUILT DRAWINGS

All the following requirements shall be fulfilled by the Contractor.

8.1 O&M Manuals

The Contractor shall provide preliminary as well as final sets of O&M manuals containing all information and instructions for the operation and maintenance of the entire plant under his scope including systems and components from packages, consortia and joint venture partners, sub- suppliers, etc. in such number or copies as indicated above.

The information and instructions shall be in the English language and lucid in description. Separate books shall be provided for operation and maintenance.

The first volume shall be common for the O&M manuals and shall include:

- The topic of all O&M manuals
- The drawing list detailing all drawings included in the O&M manuals
- Schedules, curves, tables of performance and operation data of all major equipment and plant.

The O&M manuals are subject to review/approval by the Employer/Engineer. The Contractor shall submit the table of content and the structure of the O&M manuals for review early during the project.

The Contractor has to structure the manuals logically and uniformly independently from the source of origin, like other contractors, sub- suppliers, etc. The instruction shall be supported by drawings, photos and video films in digital media.

Contractor shall ensure that all installation, assembly, test, alignment, lubrication, calibration, pre-commissioning and commissioning records are properly prepared and handed over.

Cross section/exploded views indicating complete lists of parts, drawing references and gauge settings, together with setting dimensions, tolerances, bolt tightening torques, calibration, levels and alignment data, lubrication data and history, site repairs, modifications history, works/site test results, NDT test results including details of items failed on NDT and corrected and bearing pre-loading details and other useful data shall be provided as appropriate.

The information provided shall be complete for main and auxiliary equipment and systems provided by the Contractor. Information that does not contribute to the understanding of the design, operation and maintenance of the equipment shall be excluded from the instruction manuals where appropriate.

All material shall be free from stamps commonly used for identification of customer, order number, etc.

Precautions and warnings relative to the safety of personnel and equipment shall be included where required.

The operation and maintenance manuals and instructions to be provided by the Contractor in respect of plant supplied by him shall be supplied in loose- leaf folders.

Information should always be precise, particularly references to time intervals, which should be clearly defined and not given as 'occasionally' etc.

Suitable storage facility for O&M and As-built drawings shall be provided at agreed delivery locations.

8.1.1 Operation manuals

The operation manuals shall contain the following information:

1. Standard Operating Procedure
2. Pre start-up check list
3. Shut down Check list
4. Shut down standard procedure
5. Running Equipment change over Routine
6. Operational routine tests.
7. Separate standard start-up check list for each item of equipment.
8. Trouble Shooting
9. Monitoring Operation Parameters
10. Log sheets

The operation manual shall be subdivided into different sections as:

1. Introduction
2. Brief general description of the Plant
3. Definition of terms used in the Operation Manuals
4. List of sub-systems and main components dealt with in the Operation Manual
5. Operating Principles as a summary of the technical operation principles of the Plant and main sub-systems
6. Operation Instructions for the purpose of:
7. Initial starting and running up procedures covering cold, warm and hot conditions after various shutdown periods.
8. Automatic and manual operation of the plant systems and plant items under normal running conditions, with all relevant adjustments for safe and efficient operation. Also all necessary annunciation, observations and safety precautions.
9. Normal shutdown and emergency shutdown procedures with relevant safety precautions.
10. Emergency procedures for all fault conditions in manual and/or automatic control,
11. Surveillance and data recording,
12. Periodical tests and checks,
13. Preservation procedures for long and short shutdown periods,
14. Commissioning procedures to be implemented following long and short shutdown periods,

Operation instructions shall be provided for all systems of the Plant and its overall control. The operation instructions shall be divided according to the Control room operator activities, Steamfield operator

activities, Engineering disciplines, the relevant systems, remote and local activities/operations

The description of the control room operation shall always be supported with screen mimics, logs, curves, listings, etc. of the Main-Machine interface.

Logic charts demonstrating the operation shall have the form of basic engineering charts and not computer system programming charts.`

The instructions shall be accurate, easy to understand, and shall contain the sequence of individual manipulations required for operation. The information shall be presented in such a manner that the contents can be used for instructing personnel in the operation of the equipment. Tables, lists and graphic presentations should be used whenever possible for making the description readily understandable.

The entire testing and adjustment procedures required for the Plant during operation shall be described along with an appropriate trouble shooting list.

The manuals shall contain periodical process data protocol sheets. Two kinds of protocol sheets shall be considered and added:

1. Empty form sheets for periodical readings, done manually by the operational staff by patrolling.
2. Sample protocol sheets from hourly protocols printed by the digital control and supervisory system for the concerned system.

8.1.2 Maintenance Manuals

The maintenance manuals shall include all detailed instructions, drawings, documents, descriptive material, equipment and spare parts lists for each equipment of the complete Plant. The maintenance manuals shall enable the Employer to maintain, repair, overhaul and re-commission/test the Plant as required.

These Manuals shall provide information in the simplest and most logical form for the purpose of

- showing the build-up and assembly of systems and plant items,
- Preventive maintenance, including frequency of inspections and cleaning,
- carrying out overhauls,
- locating and rectifying faults.
- ordering replacement parts,
- setting up, testing and adjusting plant systems and plant items.
- analyzing/ interpreting condition monitoring data.

Before any major repair, overhaul, etc. the system shall be isolated and the necessary work permit procedure shall be lanced. After the work was done, the system shall be reactivated and re-commissioned again.

The necessary procedures, forms, labels, etc. shall be contained in the

Operation and Maintenance Manuals like:

- Work Permit Procedure
- Procedure of Isolation of the systems, system limits, marking of limits, isolation points, etc. for each system in the Plant
- Warning labels and procedures
- commissioning procedure for system re-commissioning
- System clearance procedures, etc.

The Maintenance Manuals shall contain also the following information:

- Special tools required for execution of the work
- Detail drawings of spare parts, clearance, allowance, etc.
- Test procedure
- List of valves with all entire components (material, size, clearance, etc.)
- List of pumps with all entire components (material, size, clearance, etc.)

The Contractor may propose his standard procedure, which shall be revised and adapted to the Plant and to the local customs by the Contractor with the co-operation of the Employer's station staff.

8.1.2.1 Preventive Maintenance

The section with the preventive maintenance shall indicate the inspections required at regular intervals, the inspection procedure, the routine cleaning and lubricating operations with lubricating charts, the regular safety checks, the regular instrumentation and control check and calibration activities and similar steps.

The As Built drawings belong to the Maintenance Manuals and shall be referred to, wherever necessary.

The maintenance instructions shall include a tabular summary of the required activities sorted according to:

- Daily
- Weekly
- Quarterly
- Yearly
- Other cycles as applicable and shall be done separately for the different disciplines like mechanical, electrical, I&C, etc.

Any necessary instructions and details shall be included, like tools and procedures or shall be referred to other sections, like spare parts, corrective maintenance, etc.

8.1.2.2 Corrective Maintenance

This document shall provide the maintenance engineers with a brief and yet fully comprehensive information including all references to the applicable, detailed service and maintenance instructions.

Further sections sub-divided in principle according to the structure for the operation manuals. Each sub-division shall include:

- Detail information regarding repair, replacement and adjustment, describing the inspection, fitting and dismantling of parts, fault tracing as well as repair and adjustment procedures, including set points and tolerances.

- Spare part lists, containing all the necessary data for ordering spare parts.

  These lists shall include all spare parts; those to be supplied and those not to be supplied under the present Contract.

- Tool lists, containing all necessary data for identification of tools.

- List of suppliers and alternative suppliers and addresses.

8.1.4 Execution of Manuals

8.1.4.1 General

Operation and Maintenance Instructions shall be prepared in a uniform layout and in a coordinated way. The manuals of the different sub-suppliers shall be coordinated, revised and integrated by the Contractor to ensure such uniform layout and content.

The Employer/Engineer reserve the right to specify the final type of a uniform cover to be used for all O&M manuals. The colour of the covers for the Operation and for the Maintenance volumes shall be slightly different. The Contractor shall not be entitled to claim extra payment for this requirement.

The final size of drawings for the O&M manuals shall be decided by the Employer/Engineer. Catalogue sheets, illustrations and printed specifications, shall be checked and prepared by the Contractor in such a way that the figures, statements and data valid for the delivered sizes and types of the equipment concerned are clearly marked. All figures, statement and data valid for sizes and types not delivered must be crossed out.

Detailed description shall contain a complete and accurate description of the equipment, all components and ancillaries, their assembling and dismantling. An accurate list stating clearances, tolerances, temperatures, fits, etc. shall be included.

In the case of material and equipment for which no drawings are required, the Contractor shall include prospectus giving descriptive data allowing for a proper evaluation of the material or equipment, as

required for maintenance and repair.

8.1.4.2 Form of Manuals

Each Book shall contain a Table of Contents showing

- The comprehensive and complete Table of Contents of ALL Manuals
- Table of Contents of the concerned Book.
- Table of illustrations, drawings

Use of transparent plastic envelopes is to be avoided. All drawings should be in A3 or A4 format, keeping however a good readability.

In case when more pieces of size A3 drawings folded in A4 size are attached to the documents, distance strips shall be inserted between the drawings to avoid getting the description sheets corrugated.

Separation sheets with index tags are to be provided between chapters. Moreover, separation sheets with index tags are to be provided between main parts of one chapter, if necessary, with proper numbers.

The numbering in the chapters should be consequent and uniform in all manuals.

The page numbers shall restart for each chapter. Continuous numbering for a whole Book or Section cannot be accepted.

Any reference to other parts of the Manuals shall contain the whole path description (e.g. Volume-Section-Chapter, as applicable), not only the file name. References to the very same Book should contain e.g. Chapter number and page number.

Pages should always have clear and complete identification. Especially drawings, frequently taken out from the file must have clear designation.

The text should be in grammatically correct and the use of technical terms should follow the known terminology

8.1.4.3 Content of Manuals

The logical segregation of the Operation and Maintenance Manuals shall be carefully planned.

The operation shall mainly concern the proper operation of the systems, including priming, starting, normal operation, emergency operation, shut down, system trouble shooting, re-commissioning and testing of systems. For the digital system the same rules shall be obeyed, e.g. the system engineer's operational task is to operate the system configuration/programming and diagnostic workstation, including reconfiguration of control loops, adding/deleting inputs, signals, etc.

The maintenance is component oriented, and includes the periodical/preventive and corrective maintenance, re-calibration, cleaning, etc., on equipment, further the procedure restoring the original features by repair, like isolation, dismantling/disassembling, repair, assembling, component testing and

reinstallation.

Where any equipment, valve, pump, transmitter, switch, gauge, etc. is mentioned, the Plant identification number shall be added.

Uniform description is to be used for the systems/components following the denominations used in the documents, identification labels, HMI interface, etc. All documents originated by sub-suppliers, etc. shall be revised in this respect.

The abbreviations in the official List of Abbreviations are to be used. The

List of Abbreviations shall be attached to each Volume of the manuals.

Basic documents necessary to the interpretation of the documentation are to be included in the Manuals.

Complete and unabridged manufacturer descriptions/user manuals are to be provided for devices/instruments.

Titles shall be clear and comprehensive.

The system descriptions should always be accompanied by simplified representation of the system, block schemata, etc. in A4 size for easy understanding (e.g. simplified P & I diagram with instrumentation showing also control functions).

For programmable electronic devices the actual setting data with all parameters has to be attached to the Manuals for each application. This includes all positions adjusted on keyboard, position of jumpers, switches, calibration of potentiometers, downloading of programs, etc.

8.1.4.4 Drawings in the Manuals

Documents inserted from the existing approved/As Built documentation may keep their cover page for easy identification. New documents prepared especially for the manuals or non-contractual documents are to be inserted without cover page and without drawing head.

Obviously, all documents in the Manuals taken over from the Plant documentation shall have the Contract As-Built status, shall have received the Approved or for Info status during the approval procedure and shall contain all requested and agreed modifications and shall reflect the actual situation.

In the final As-built drawings and other documents shall already contain all correction and rectification done during the commissioning period (the so-called “redline” corrections).

8.1.4.5 Electronic Files

The O&M Manuals shall also be prepared and submitted on electronic data carrier (CD-ROM) in an interactive software base. One set of CD-ROMs shall be attached to each of the set of the preliminary and to the final submission of the manuals. The software shall allow easy search for information/drawings.

The program used to read the manuals shall allow easy navigation in the documents. Indices on

different levels with on-line links shall provide quick access to the indicated subject. All internal references in the documents shall also have to be linked to the referenced subject with possibility to quick return to the original subject. This shall also be applicable between the

Manuals and different lists of Spare Parts, Lubricants, Consumables, etc. The Manuals shall be linked to the Plant Maintenance and Document Management System.

Further, any list, database, schedule specified as to be available in computerized form shall be available on CD-ROM using the original file format (e.g. EXCEL), like

- List of all measuring points (established list of local and remote measurements, including me /O's, alarms, set points, calibration values, etc.)
- List of valves
- List of cables
- Terminal point lists
- List of consumables
- List of valves
- List of lubricants
- List of Spare parts
- List of consumables

DCS system programs (where applicable) to be downloaded are to be attached to the Manuals on suitable data carrier.

8.2 As-Built Drawings

One (1) month prior to the start-up of the Plant, the Contractor shall submit the list of proposed As-Built drawings to the Employer/Engineer for review/approval.

The Contractor shall provide As-Built drawings of the entire Plant documenting the final design after completion of installation and commissioning. For preparing the As-Built drawings all modifications and changes made during the installation and commissioning phase shall be incorporated into the respective approved design drawings.

The Contractor's Site staff shall incorporate by hand all modifications and changes into the approved design drawings (red-line drawings). Subsequently, these drawings, which shall be considered as Preliminary As- Built drawings, will be reviewed by the Employer's/Engineer's Site staff. Upon receipt of comments, if any, the Contractor shall distribute copies of the preliminary As-Built drawings as per document distribution schedule.

The Final As-Built drawings will be prepared by the Contractor based on the preliminary ones. Once

completed, they shall be incorporated into the O&M manuals and shall be filed in a separate as built drawing book.

The Contractor shall submit CD - ROMs along with all „As-Built "drawings according to the document distribution schedule. The software used shall be compatible with the Employer's existing system for the above purpose.

Nevertheless, the Contractor shall provide to the Employer all necessary hardware facilities and ready installed and customized software program packages in the scope of the present Contract to read and to print the As Built documents, including A4-A3 format colour inkjet printer of professional quality and plotter allowing printing of the full size and reduced site drawings.

Each one set of the Final As-Built drawings shall contain the followings:

- Three (3) sets of reduced size general arrangement P&I diagrams in loosely bound form.
- Nine (9) sets of prints of each drawing.
- Nine (9) sets of CDs.

9.0 QUALITY MANAGEMENT REQUIREMENTS

9.1 General

The Contractor shall carry out the Contract Works in accordance with sound quality management principles, which shall include such controls as are necessary to ensure full compliance with all requirements of the Specification. The Contractor's activities will be monitored by the Employer/Engineer to ensure that they are being implemented correctly.

9.2 Scope

These quality management requirements shall apply to all activity during design, procurement, manufacturing, inspection, testing, packaging, shipping, storage, site erection and commissioning.

The Contractor shall have sole responsibility for ensuring compliance with each of these requirements as applied to the whole of the Contract Works, and shall ensure that subcontractors implement those quality control activities that are appropriate to the extent of their supply.

9.3 Document Submittal

In addition to any document submittals required by other parts of the

Specification, the Contractor shall forward the Quality Control documentation to the Employer/Engineer as indicated in the following items.

Additionally, the following documents shall be submitted with the necessary details during the execution of the Contract.

a) Identification of main items to be supplied, with names of supplier and manufacturer (if different from supplier and location of place of manufacture).

b) Manufacturing programs for each major item of equipment, showing main stages of design, procurement, manufacture, inspection and testing.

c) Site erection and commissioning program, showing all controls, inspections and tests.

9.4 Particular Requirements

These particular requirements identify the elements of quality control considered necessary to ensure compliance with specified Contract requirements and it is these elements that the Employer/Engineer will examine to verify that compliance has been achieved.

Details of the structure and methods used for establishing and implementing these control elements are not stated, since there are many acceptable ways of achieving a satisfactory system of control. Manufacturer's established structure and methods shall be used whenever these are capable of complying with the particular requirements stated in the following Clauses.

9.4.1 Organization

The Contractor shall establish an organization for the control of quality, and all personnel so designated shall have defined responsibilities and the authority to identify and evaluate quality problems, and to ensure that adequate remedial actions are implemented.

The Contractor shall ensure that responsibilities are assigned for advising the Contract requirements to subcontractors and manufacturers, and the monitoring of compliance with those requirements.

9.4.2 Planning

The Contractor, immediately after Award of Contract, shall perform a complete review of the Contract and take timely action to ensure that the necessary quality control procedures and provisions are established in accordance with this Specification, purchase order, applicable codes and standards, or other Contract Documents.

Particular care shall be taken to identify any specified requirements that are different from or additional to a manufacturer's normal design or quality control practice, and to initiate the necessary measures to ensure that such additional requirements are implemented satisfactorily.

The Contractor shall prepare a quality plan for the complete Contract Works, and shall require individual manufacturers to prepare detailed quality plans for all main items of equipment. Quality plans (I&T Program) shall identify all inspections and tests, which are to be carried out, including those necessary to verify compliance with particular specified requirements.

9.4.3 Procurement document control

The Contractor is responsible for ensuring that all procurement documents issued to subcontractors contain or reference all applicable requirements specified in the Specification which are necessary to enable the Contractor to fulfil those requirements. The Contractor shall also verify that all subcontractors' purchase orders onto manufacturers or other suppliers similarly identify all applicable requirements.

9.4.4 Documentation and change control

The Contractor shall establish measures to control all documentation that relates to the quality requirements

specified in the Specification. The measures shall ensure that only current issues of documents are used at all manufacturing and control points.

9.4.5 Control of purchased material, equipment and services

The Contractor shall be responsible for ensuring that all purchased material, equipment and services conform to Contract requirements.

All purchased material or equipment shall be subjected to inspection control by the Contractor, either on receipt, or before dispatch from the manufacturer's works.

No material or component shall be obtained by a Contractor or his Sub-contractors from any source which has not been previously audited by a responsible party and designated as an approved supplier.

The Employer/Engineer may, at his discretion, require evidence that such audits have been satisfactorily made and/or evidence of the competence of the designated supplier to meet the necessary quality requirements.

9.4.6 Control of Inspections & Tests

The Contractor shall ensure that all manufacturer's inspections and tests are satisfactorily carried out, in accordance with the planned program and that the date recorded is acceptable. On completion of manufacture, sufficient inspection and testing shall be carried out to complete the full verification that all equipment conforms to all specified requirements.

9.4.7 Handling, Storage & Delivery

The Contractor shall ensure that adequate and controlled measures are established for cleaning, protection, preservation, packing, handling, storage and shipping, to protect items from damage, deterioration or loss. When the nature of the item dictates the need for special handling equipment, this shall be specified and verified by the Contractor.

The identification, marking and labelling of items of shipping shall comply with contractual requirements, and shall be applied in a manner that will ensure no loss of identity and permit permanent and easy recognition of special handling and storage requirements.

9.4.8 Inspection & Test Status

The Contractor shall ensure that measures are established for all material and items that will provide the ability, at any point of manufacture, to determine that the manufacturer's planned inspections and tests up to that point have been carried out.

9.4.9 Site Installation & Commissioning

The Contractor shall ensure that all Site installation and commissioning controls, inspections and tests, are carried out in accordance with the planned program, and that data recorded is adequate to permit the Employer/Engineer to verify that the whole of the Contract Works are in full compliance with all Contract requirements.

9.4.10 Implementation

In order to achieve the Quality Management Requirements specified above, the Contractor shall designate two senior engineers with sufficient authority who will be solely responsible for the Quality Management of the Project. These engineers shall be independent of any other design, manufacturing, inspection, testing and site erection 'activities associated with this Contract.

One engineer will be responsible for all activities associated with design, procurement, manufacture, inspection, testing, packing and shipping whether undertaken by the Contractor, or by his designated subcontractor or supplier and will normally be resident at the Contractor's Head Office or principal place of Work. The other engineer will be responsible for all activities associated with site erection and will be resident at the Contractor's Site Office.

The main responsibilities of the Quality Management engineers are given below:

9.4.10.1 Head Office

a) Production and implementation of all Quality Manuals (Q.M.), Quality
b) Standards (Q.S.) and test and inspection programs for all materials ordered.
c) Verifying/Certifying that all design and drawings prior to submission to the Employer/Engineer are in accordance with the Specification and all relevant Standards Codes of Practice.

d) That all orders placed for materials are in accordance with (1) above, and that only the latest revisions of approved drawings are used in the course of man.
e) That all manufacturers/suppliers have acceptable Quality Control (Q.C.) procedures and that these have been implemented throughout the execution of the work. All Q.Cs. shall be submitted for approval to the Employer/Engineer prior to their implementation.
f) That all tests and inspections are undertaken to agreed Standards and Codes of Practice.

9.4.10.2 Site Office

a) Production and implementation of all Quality Manuals (Q.M.), Quality Standards (Q.S.) and test and inspection programs for all materials ordered. All Q.Ms. and Q.Ss. and programs shall be submitted for approval to the Employer/Engineer prior to implementation.
b) That only the latest revisions of approved drawings are used during the execution of the work and that no drawings stamped "This Drawing Subject to Approval" is available for use on site.
c) That all orders placed for local materials are in accordance with paragraph (1) for Head Office.
d) That all work is executed in accordance with the requirements of the specification and all relevant Standards/Codes of Practice.
e) That all tests and inspections are undertaken to agreed Standards/Codes of Practice.
f) That all terminal points of supply (interfaces) are taken care of in line with the Specification and according to the Plant requirements.

PART B: TECHNICAL REQUIREMENTS

MECHANICAL EQUIPMENT AND PIPING

1.0 GENERAL

1.1 Statutory Regulations

The Works and all equipment and materials forming part of this Contract shall comply in all respects with any relevant statutory regulations, by-laws or orders currently in force where the Plant is to be erected.

1.2 Geothermal

The Works shall be suitable in all aspects of design and construction for continuous operation in a geothermal environment.

There are elevated levels of H_2S and other contaminants in the surrounding environment and process fluid.

1.3 Civil and Building Works

The requirements for the buildings, foundations and other civil works are described in respective civil Part of this specification.

Where items of mechanical plant are mounted on foundations which are part of the civil engineering works, the CONTRACTOR shall carry out suitable levelling and adjustment of the plant on the civil foundations before the plant is secured in position by suitable non-shrink grouting. The CONTRACTOR shall check the alignment, levelling or positioning of the mechanical plant in question, before and after grouting. The CONTRACTOR shall make records of the alignment, levelling or positional measurement and shall maintain such records until his activities at site are concluded. Where large and complex plant is installed on extensive foundations, a datum shall be established to check for movement or settlement of the foundations.

The building steelwork shall be designed to carry the loads and forces imposed by pipe work, cables and associated fittings which also form part of the works, and all necessary supports and fixings shall be shown on the relevant drawings.

Such supports and fixings may be secured to the steelwork by bolting welding or clamping.

No other supports or fixings shall be subsequently attached to the steelwork nor may any other drilling, cutting or welding be carried out without the prior permission of the Engineer.

1.4 Contractor's Responsibilities

The CONTRACTOR will be deemed to have concurred as a practical

manufacturer with the design and layout of the Works as being sufficient to ensure reliability and safety in operation, freedom from undue stresses and satisfactory performance in all other essentials as a working plant, unless stated specifically to the contrary prior to the award of the Contract with full supporting explanations.

Without affecting the provision of the Conditions of Contract the Contract shall include the whole of the Works which are described in or implied by the specification. All matters omitted from the specification, which may be inferred to be obviously necessary for the efficiency, stability and completion of the works, shall be deemed to be included in the Contract price.

Those items of the works shown upon the drawings and not mentioned or described in the specification and those items of the works described in the specification and not shown on the drawings will nevertheless be held to be included in the same manner as if they had been expressly shown upon the drawings and described in the specification.

The CONTRACTOR shall fully familiarize himself with the existing underground services in the vicinity of the buildings, plant and equipment to be provided under this Contract. The CONTRACTOR shall include in the Contract Price for the modification and re-routing of such services where this is necessary to facilitate the construction of buildings, plant and equipment supplied under this Contract.

1.5 Safety and Security

1.5.1 Noise – general

The plant and equipment supplied under this Contract shall meet the noise level requirements for both general work area limits and neighborhood noise limits as specified herein.

Noise levels measured or calculated from measurements after background and other corrections have been applied and after any appropriate tolerances have been allowed in accordance with the given standards must not exceed the noise limits specified.

The sound level meter used for the tests shall be of the precision type and comply with the British Standard BS EN 61672. The octave band pass filter set shall comply with BS EN 61260. The 'slow' meter response setting shall be used.

1.5.1.1Noise during erection and commissioning

The CONTRACTOR shall take all reasonable measures to minimize noise nuisance arising from construction, erection, pre-commissioning and commissioning activities. If a noise level exceeding 100 dB(A) is likely to occur in any area, suitable warning signs shall be prominently displayed in that area, indicating that a noise hazard exists, and that ear protection muffs should be worn. Any area where noise levels could exceed 115 dB (A) shall be cordoned off to prevent unprotected personnel from entering the area.

1.5.1.2 Permissible noise levels inside buildings during plant operation

The following limits shall not be exceeded with the relevant room or building in its normal mode of use, and hence will generally apply with windows and doors shut and with air-conditioning plant in operation. The CONTRACTOR shall therefore pay due attention in his design to noise contributed by operation of the Contract works outside the room, the noise arising from the air conditioning of the room, and any noise generated by Contract works positioned in the room.

a. (Control rooms and conference rooms. Noise rating (NR): 45
b. (Offices, mess and rest rooms, security/firefighting watch rooms NR 50
c. (Inside all buildings with extended occupancy by operation and maintenance staff, unless otherwise specified NR 60
d. (Interior of all buildings and enclosures unless otherwise specified or unless those enclosures are themselves provided to prevent the irradiation of noise to the site NR 80.

1.5.1.3 Work area limits

The un-weighted octave band sound pressure levels in dB measured at the 9 Centre frequencies from 31.1 Hz to 8 kHz in any position in the work area, including the noisiest position, 1 meter from the surface of the equipment or equipment package or at the operators work position shall not exceed in any band, the levels given by the ISO NR 80 noise rating curve when all the equipment is operating at 100% base load.

The above limits apply to broad-band noise only. If any narrow band components of the noise is present it shall be suppressed below the actual broad band noise levels (as calculated or measured) by the amounts given in the following Table:

Octave band	63	125	250	500	1K	2K	4K	8K HZ
Required Suppression	0	0	0	4	6	7	7	3 (DB)

Any impulsion noise components shall not exceed 80 dBA.

1.5.1.4 Neighborhood noise limits

Silencing equipment shall be provided for the plant, as may be necessary, to ensure that the sound pressure levels, as measured 1.25 meters above ground level at any point 125 meters from the plant when all the equipment is operating at its maximum base load rating or any other operational condition, shall not exceed the following values, which correspond to ISO noise rating no.45:

Octave bands	1	2	3	4	5	6	7	8
Centre Frequency (Hz)	63	125	250	500	1000	2000	4000	8000
Sound	71.2	61.1	53.6	48.6	45	43.3	42.2	38.3

Pressure level dB (ref.0.0002 micro bar)

1.5.1.5 Guarantees

If measurements on site show that the above sound pressure levels are exceeded the CONTRACTOR shall undertake approved modifications in order to meet the specified requirements at no extra cost to the Employer.

1.5.1.6 Noise suppression enclosures

In order to meet the foregoing noise limitations, the CONTRACTOR shall request Employer/Engineer's approval to provide noise suppression enclosures or buildings around any noisy plant items, such as for example, the main turbines, pumps and their drive equipment large electric motors. These noise

suppression enclosures may also serve as weather protection for the respective plant item. The "cells", formed around transformers for protection from fire or transformer rupture may also be considered to act as noise suppression enclosures.

Within any enclosure, building, earth bank or other civil works intended to suppress noise it will not be necessary to achieve the noise limits specified. The CONTRACTOR's design shall, however, include reasonable measures to restrict noise. In no case shall the noise exceed 115 dB(A) if operating staff are able to enter the enclosure with the plant in operation,

unless the CONTRACTOR has previously demonstrated to Employer/Engineer's satisfaction that it is not practicable within the current "best practice" to avoid breaking this limit.

Where operating staff may have to enter noise suppression buildings or enclosures for supervisory purposes or minor repair work with the plant running, the access doors shall be clearly marked to indicate a noise hazard and with a symbol to show that ear protection muffs should be worn.

The CONTRACTOR shall pay particular attention to the control of noise arising in the reduction of pressure.

1.5.1.7 Noise survey

When all normally operating equipment or plant is operational, the CONTRACTOR shall carry out a noise survey of the site, to check at agreed locations and in agreed buildings that each of the aforementioned noise limits are not being exceeded. The CONTRACTOR shall arrange with the Engineer to carry out the survey with Guarantee Case steam flow through the Vent Station or at other such condition as the Engineer may select. The Engineer may instruct the CONTRACTOR to include in this survey measurements in specific places.

The CONTRACTOR shall submit a report to the Engineer summarizing the results of the noise survey. If the specified noise limits are exceeded, the

CONTRACTOR shall modify the plant or provide additional noise control features, and re-measure the noise levels in the area in question.

1.5.2 Hazardous areas

The CONTRACTOR shall take full account of any special requirements concerning the nature, handling and storage of all oils, gases and chemicals etc., including gases present in the atmosphere such as H_2S, and provide plant, equipment, buildings and other services accordingly including all facilities to ensure the safety of the operating and maintenance personnel.

The CONTRACTOR shall provide a report describing the principles of explosion protection and drawings and action procedures to define all the hazardous zones taking account of all sources of hazards under normal and abnormal operating conditions, (regardless of whether or not these areas are specifically listed in the specification). The zoning philosophy shall be in accordance with International Standards and subject to the approval of the Employer/Engineer.

In particular, equipment directly concerned with plant which may give rise to a hazardous situation shall be designed to IEC 60079 Zone 1 or 2 requirements with electrical connection safety barriers or intrinsically safe equipment equivalent to IEC 60079-11 Type Exi or equal and approved by the Employer. Where required by the Engineer, certification shall be provided to confirm the suitability of the equipment and devices.

Electrical equipment shall not be installed in Zone 0 areas without the approval of the Employer/Engineer, though this does not preclude cables passing through such areas.

The CONTRACTOR shall be responsible for ensuring that all electrical equipment installed in any hazardous zone is designed and tested to suit the relevant zone classification and shall be to the approval of the Employer/Engineer. Cables shall not be laid in trenches etc. with fuel pipe work.

1.5.3 Access for operation & maintenance

The CONTRACTOR shall supply and erect sufficiently large safe platforms, galleries, stairways and access ways necessary for providing safe and easy access to all the plant items for operation and maintenance.

The CONTRACTOR shall ensure that the whole of the access ways are of uniform design and pattern throughout the works.

Ladders are only to be provided as an extra means of escape.

Access ladder and large platforms shall be provided for access to all equipment, components, valves, instruments etc. complete for operation & maintenance use irrespective of the frequency for operating and maintaining them.

The maintenance platforms shall be strong enough and large enough to place disassembled components and all tools during maintenance.

Vehicle access shall be provided to all mechanical, electrical and instrumentation equipment.

1.5.4 Interlocks

A complete system of interlocks and safety devices shall be provided so that the following requirements and any other condition necessary for the safe and continuous operation of the plant are provided:

a. Safety of personnel engaged on operational and maintenance work on the plant.
b. Correct sequence of operation of the plant during starting up and shutting down periods.
c. Safety of the plant when operating under normal or emergency conditions.

Interlocks shall be preventive, as distinct from corrective in operation. Where plant supplied under this Contract forms the whole or a part of a system for which one or more interlocking schemes are required, the

CONTRACTOR shall be responsible for all interlocking schemes to the

Employer/Engineer's approval. General descriptions of interlocking requirements are given in the requirements but the CONTRACTOR shall include for any other interlocks he considers necessary.

1.5.5 Guards

All moving parts, shafts, couplings, flywheels, bare conductors and hot or cold surfaces shall be adequately and securely guarded in accordance with the prescribed legislation and to Employer/Engineer's approval so as to afford complete safety to all personnel.

1.5.6 Locks, padlocks & key cabinets

The CONTRACTOR shall provide padlocks, locks, chains or other locking devices for the locking of all equipment cubicles, electrical isolating switches, selector switches, valves etc. to the approval of the Employer/Engineer.

Multi lock systems shall be in accordance to the requirements of the British Safety Council.

All locking devices and chains shall be manufactured from corrosion resistant material suitable for the site. All mechanisms shall be provided with a cover to minimize entry of water or dust.

Certain locks may be required to conform to a master keying feature to be agreed with the Engineer for groups of equipment.

All locks shall have individual high integrity locks and shall be provided with three keys.

Each key shall be provided with a label.

The CONTRACTOR will supply and fit key cabinets equipped with labelled hooks, each identified with its appropriate key. Every cabinet shall be provided with a nameplate identifying the cabinet with its respective item or items of plant. Sufficient cabinets will be provided to store all keys supplied under this Contract.

The CONTRACTOR shall provide comprehensive lock and key schedules to readily permit identification with equipment and doors. Such schedules are not required for loose padlocks.

The CONTRACTOR shall supply a suitable shear cutter for cutting padlocks in case padlock keys fail to open the locks during any emergency.

Every kind of hinged door in switchboards panels, control panels, cubicles and boxes as well as withdrawable chassis shall be secured by means of a suitable lock. As a general rule, the following methods of locking shall be adopted:

- Electrical distribution boards, local power or control boards and boxes shall be equipped - dependent on their size - with one or more carriage locks having a square plug and key being the same throughout the plant.
- All explosion-proof equipment is to be provided with the same type of lock, however, with triangle plug and key.
- All boards, boxes and cubicles containing electronic type equipment shall be provided with tumbler locks and each type of cubicle shall receive its own key which will fit throughout.
- Key operated selector switches are to be provided with a tumbler lock for locking in the neutral position or in any other position as per requirements. Such keys shall fit a group of switches of similar kind and purpose and the key system shall be the same as stated above.

All keys in the Plant shall follow a uniform Master Key system. The CONTRACTOR shall prepare a comprehensive key system proposing the individual group and master keys and the quantity of the same. The organization of the key system is subject to Employer's / Engineer's approval.

Each key lock shall be supplied with at least three keys. At least three keys shall be provided for on each master key level.

All keys are to be handed over to the Employer in properly sized and labelled key box for wall mounting installed in approved locations.

A key cabinet shall be provided in each electrical/ electronic room for storing the relevant keys.

The keys for cubicles/ equipment located outside electrical rooms as well as the keys of the individual key cabinet doors shall be stored in a central key cabinet, located in the central control room.

For the key cabinet doors additional six master keys shall be provided, each suitable to open any key cabinet door.

Each key shall have an identification label with the same denomination as fixed above the key hanging hook inside the cabinet.

For padlocks a similar master key system shall be provided, not necessarily combined with the master key system of the cubicles, cabinets and panels.

1.5.7 Safety measures

The CONTRACTOR shall ensure all safety measures in accordance with the safety manual as per Project Procedure Manual during the period of the Contract. The CONTRACTOR shall not in the performance of the Contract in any manner endanger safety or unlawfully interfere with the convenience of the public or jeopardize the operation or security of the Employer's existing system.

If any damage is caused to existing plant/system, the Engineer shall have the right to stop any construction/commissioning works carried out by the CONTRACTOR which jeopardize safety of personnel and plant/system at his discretion.

If any damage is caused to existing plant or building/installation by the CONTRACTOR's or his Subcontractor's plant, machinery, personnel or vehicles, it shall be the responsibility of the CONTRACTOR to make good damage at his own cost to Employer/Engineer's satisfaction.

1.5.8 Fire protection provisions

Unless otherwise specified or agreed with the Employer or the Engineer, the following design principles should be observed as minimum fire prevention requirements as well as all standards specified under **Section VI part A**

- Pipeline insulation and the infills of cable and pipeline wall penetrations are to be of non-combustible material.
- Covered floor ducts must be easily accessible for inspection and cleaning.
- All parts of plant and equipment are to be arranged so that no corners or pits that would be difficult to inspect and clean and in which flammable matter could collect are formed.
- Non-combustible materials which do not give off noxious or toxic fumes must be used for wall and ceiling paneling, for floor covering, and for cubicles and cabinets.

1.5.9 Maintenance isolation

All major equipment shall be arranged to facilitate safe isolation from all hazards for maintenance purposes. In addition all valves must be capable of being locked either in the open or closed position by means of a chain and padlock.

Non return valves are not acceptable as a means of isolation.

Sufficient draining & depressurizing valves for isolation maintenance shall be provided.

1.5.10 Signs

1.5.10.1 General

Safety colours, safety symbols and safety signs must comply in construction, geometrical form, colour and meaning with the ISO 3864-1:2011 and ISO 7010:2011.

Signs of plant identification during the erection period must be to the Employer's approval.

The signs should be of a material which is weather resistant and of sufficient durability for the conditions prevailing on site.

All Emergency exits, fire exits and other warning signs shall be illuminated signboards.

1.5.10.2 Mounting & Installation

The positions for the signs must be chosen so that they are within the field of vision of the persons to whom they apply. The signs should be permanently attached. Temporarily dangerous areas (e.g. construction sites, assembly areas) may also be marked by movable signs.

The safety signs must be mounted or installed in such a manner that there is no possibility of misunderstanding.

1.5.10.3 Information signs

Information signs should supply the necessary information to acquaint

personnel with the physical arrangement and structure of site, buildings and equipment, e.g. floor numbers, load carrying capacities including marking of floor areas, working loads of cranes, lifting gear and lifts, room identification, etc. The routing of underground pipes and cables is to be indicated by substantial marker blocks showing the relevant identification numbers.

In the choice of information signs in situations not covered by ISO standards the possibility of using pictograms should be considered. Pictograms are particularly suitable for the identification of rooms, areas and buildings in the non-technical areas of the plant, sanitary and amenities buildings, etc.

1.5.10.4 Emergency signs

In the event of accidents, all necessary information should be available immediately to those affected. Thus, a sufficient number of signs of appropriate size should be installed, e.g. escape routes (including marking of floor areas), emergency exits, fire alarms, fire extinguishers, instructions for special fire extinguishing agents, warnings against fire extinguishing agents (CO_2), first aid equipment, first aid points, accident reporting points, telephones, etc.

1.5.10.5 Mandatory signs

Signs indicating obligatory actions must be provided installed wherever certain action is necessary, e.g. do not obstruct the entrance; keep right, etc.

Signs should also indicate when the wearing of protective clothing and equipment is necessary and obligatory, e.g., protective goggles, protective clothing, helmets, head guards, breathing equipment, ear muffs, etc.

1.5.10.6 Warning signs

Warning signs should refer to the existence or possible existence of danger, e.g., flammable substances, explosive substances, corrosive or noxious substances, suspended loads, general danger, width/height restriction, steps, risk of trapping, slipping, falling, etc.

In addition to warning signs, appropriate black yellow strip markings should also be used where necessary.

1.6 Labels, Plates and Tags

1.6.1 General

The CONTRACTOR shall supply and install all labels, name ratings, instruction and warning plates necessary for the identification and safe operation of the Works. Samples shall be submitted for the approval of the Employer/Engineer.

The CONTRACTOR shall prior to take over of each Section of the Works, submit a detailed breakdown list of the complete plant of that Section together with description, location and value for the purpose of updating the Employer's Fixed Assets records. This list may be reformatted by the Employer and given to the CONTRACTOR with Fixed Asset identification numbers allotted to each item and the CONTRACTOR shall thereafter incorporate such asset number in the appropriate number plates used for the corresponding equipment identification under the contract.

The following general requirements shall apply for the labels, plates and tags of the power plant:

All plant, components shall be provided with sufficient labels, tags, plates, etc. so as to allow correct operation, easy testing and efficient maintenance. In order to distinguish amongst the variety of plates for the various purposes, a classification is given herewith below:

- Rating plates (A) according to IEC/National/Manufacturer's standard.
- Designation plates (B) to characterize the kind and nature of a self-contained installation by brief description and/or plant I.D. number.
- Operation/service plates (C) to characterize the functions of control elements or instruments.
- Equipment -/cable-/tray tags (D) with embossed or printed code description for identification with reference documents.
- Alarm windows (E).
- Instruction plates (F) for operation, maintenance, inclusive warning plates from electrical hazards.
- Orientation plates (G).

All plates, tags, etc. shall be properly arranged, duly sized and being produced that the intended purpose without getting faded or deteriorated can be met. The material used shall be in accordance with the following selection guide:

- Outdoor: stainless steel
- Indoor: stainless or aluminum with translucent coating or dual colored laminated plastic
- All plastic material must be heat resistant, no PVC material is permitted.
- The writing is to be engraved, embossed or durably printed to suit perfectly the purpose.
- The writing is to be provided in the English language. Labels, warning and name plates shall all be in English language.
- Material and size of all categories of plates etc. shall be described in one comprehensive document. All such documents shall be prepared by the CONTRACTOR and submitted to the Employer for approval.
- Tags for Equipment, Cables, etc.

Every electrical and I&C component as part of a self-contained equipment such panels, desks, boards etc. is to receive a tag with printed or embossed code numbers in compliance with the reference drawing. Such tag may be of the adhesive plastic type. When completely installed, every individual cable as well as cable tray shall at each end and at intermediate positions (approx. every 50 m) receive metal tag with engraved or embossed code numbers.

- Instruction Plates (F) shall be of descriptive nature and bear symbols such as danger signal for high voltage. Writing or symbols shall appear black on yellow plate surface.
- "*High Voltage*" hazard plates are to be provided for all installations of 600 *V* and above and shall be directly attached to the respective equipment as well as to doors, walls, fences, surrounding such installations.

- Orientation Plates (G) Such plates bearing only a symbol (pictogram) or plant I.D. number are intended to support orientation in widespread or complex installations. Plates shall be of same pattern as specified for type (F) plates, and shall be provided wherever requested by the Employer.
- Single-Line Diagrams: Every switchgear room compartment shall be furnished with a copy of the final as built single-line diagram detailing all electrical data and denominations, separate for each individual switchgear distribution board/MCC, put under glass and aluminum frame and mounted on the wall.

- DCS Cubicles: Every and each DCS cubicle shall be furnished with a copy of the final as built terminal diagram, put under glass and aluminum frame and mounted on the wall.
- Door Labels: Door labels for numbering, designation for offices, toilets and other occupied areas as well as technical rooms shall be provided by the CONTRACTOR.

1.6.2 Piping identification & flow direction arrows

A piping identification system shall be applied for the plant piping, using colour strips around the pipes. These colour strips shall be painted, adhesive plastic material colour strips shall not be accepted.

Flow directions arrows and identification inscription shall be arranged in important place as well as at the inlet branch connections, downstream of each valves and dampers and in the vicinity of branching-off connections.

The CONTRACTOR shall propose, for the Employer's / Engineer's approval, a colour scheme for the pipe work included within this Contract. The colours employed shall be based on the Employer's existing scheme to be advised after award of contract, with any necessary amendments to suit the equipment provided.

Colour bands shall be painted on each side of all valves and equipment in the piping systems. The use of adhesive-backed colour bands shall not be permitted.

Valve labels shall be circular and fitted under the hand wheel captive nut. For check valves and small valves the CONTRACTOR may provide rectangular labels fitted to the valve or secured close by the valve.

The inscription or "name" on each valve label shall summarize the duty of the valve, and the number shown on each valve label shall be the number in the unified plant valve numbering scheme as specified for the Plant. The name plate shall be made from stainless steel with proper fastening arrangements.

Where the direction of flow through a valve or other device is an important requirement for correct functioning, the body of the valve or device shall be legibly marked with a cast on, or alternatively, a properly secured arrow, showing the direction of flow.

Pipe work shall be provided with plentiful large painted arrows or other secure and durable arrow markings to allow the flows of fluids around the plant to be readily understood.

In addition to the colour band coding, pipe work and vessels shall be liberally labelled, in large painted letters on the exterior of the insulation cladding, stating the fluid conveyed or contained.

1.6.3 Plant identification labels and tags

Every and each equipment and device, mechanical, electrical, I&C or other shall be provided with labels (engraved), tags, plates, etc. so as to allow easy testing, efficient maintenance and correct operation locally and from the Central Control Room. The inscription of the labels, tags, plates, etc. shall include the KKS number of the equipment.

The very same identification numbers and clear text descriptors shall be used in any documentation, in the control system database, on the screen representations and on the printed logs and protocols. Labels, warning and name plates shall be in English.

The following rules shall be considered.

Location/Item to be labelled	ID No.	Clear text	Remarks
Minor process equipment, like valves, etc.	X		

Major process equipment, like tanks, motors, etc.	X	X	
Tapping points	X	X	
Tapping points for local indicating instruments	X	-	If close to the tapping point
Thermocouples, PT100	X	X	
Transmitters, switches, local controllers	X	X	Fixed on the Rack, Cubicle,
Transmitters, switches, local controllers	X	-	Fixed on the instrument (non- removable part)
Local indicating instruments, level gauges	X	X	Fixed on the Rack or on the Hook up, but not on the dial
Local cabinets, cubicles and boxes	X	X	

Local panels, main label	X	X	Panels for operation
Electronic Room cubicles	X	X	
Control Room Desk and Panels	X	-	
Process computers, couplers, Gateways, Hubs, Switches, Printers, etc.	X	-	
Cubicle, panel internals	X	-	According to the wiring, diagram etc.

Push buttons and other operating elements	X	X	ID No. is not to be repeated for groups
Alarm windows	X	X	
Major I&C installation	X	X	E.g., Packages, Plants
Printed protocols	X	X	

1.6.4 Warning plates & inscriptions

Individual plant items and all relevant areas within the contract works where a danger to personnel exists shall be proved with plentiful, prominent and clear warning notices.

These warning notices shall draw attention to the danger or risk with words in English which attract attention and summarize the type of risk or danger The notices shall also carry a large symbol which graphically depicts the type of risk.

LV switchboards located outside electrical rooms shall have yellow labels, with 5 cm black letters reading "ATTENTION ... V".

Transformer boxes shall have red labels with 7.5 cm white letters reading

"ATTENTION HIGH VOLTAGE ... kV".

Labels (lettering as before) shall also be fixed at switchgear room doors. Battery rooms shall be

provided with a white label reading "BATTERY

ROOM", engraved in black.

1.6.5 Identification & warning plates for civil works

Traffic signs for the roads have been specified under **section VI part 5** Civil and structural

Information plates for underground services shall be in compliance with Employer's and /or Local rules and regulations

1.6.6 Size & material of labels, plates & inscriptions

The fixtures shall be of non-corrosive material. The fixation shall be done rigidly. Labels on chains, wires or glued labels (except cubicle inside minor elements) will not be accepted. Labels shall be fixed on non-removable parts.

1.7 Outdoor Plant Rating, Weather Protection and Sunshades

Outdoor plant shall be rated and constructed so that its performance, operation, reliability, maintenance, or life shall meet the specified design and operating conditions.

Where personnel have to be in attendance frequently or maintenance has to be regularly carried out,

permanent minimum weather protection or sunshades shall be provided.

Where the performance reliability or life of the plant would be adversely affected by solar radiation, including the effects of prolonged exposure to ultraviolet light, suitable sunshades shall be provided. Such sunshades shall be constructed from fibre-glass which is able to withstand the effects of the ambient conditions on site without suffering any deterioration in material strength or effectiveness.

Sunshades need not be provided on outdoor plant or equipment provided the manufacturer can show that no materials employed will be adversely

affected or the temperature rise due to internal heat generation plus that due to solar radiation does not exceed the equipment design temperature.

Sunshades shall protect plant and personnel when the sun is more than 45 degrees above the horizon. They shall not impede the operation or maintenance of the plant or the movement of ventilating air. Facilities such as lighting and lifting beams and rainwater drainage shall be provided wherever necessary to the approval of the Employer/Engineer as an integral part of the sunshade structure.

1.8 Vibration and Balance

The Plant shall be designed and constructed to operate without vibration insofar as the nature of the works will permit. Where vibration must be expected this shall be reduced to the minimum which can be achieved by good design, and careful balancing in the case of rotating plant.

Unless otherwise stated or agreed by the Employer each rotating machine has to comply with the requirements stipulated by ISO 7919 and ISO 10816. Maximum vibration of components shall fulfil "Zone A" as per ISO 10816-

1 guideline. If the vibration is higher than stipulated the purchaser has the right to reject the corresponding equipment.

1.9 Trenches for Pipes, Cables and other Services

a. As far as is practicable all piping, drains etc. shall be arranged so that they may be run above ground level
b. Where floor trenching is unavoidable, pipe work shall be supported above the trench bottom.
c. The use of buried pipe work will be subject to Employer/Engineer's approval.
d. It is envisaged that it will only be necessary to take pipes below general site levels to pass under roadways. When taken below ground level for this purpose the pipes shall be positioned in concrete-lined culverts of sufficient dimensions to provide crawling access for maintenance staff. Any culverts shall be provided as part of this contract.
e. The trench width and pipe spacing shall be adequate for insulation, to do pipe replacement, brushing and painting the pipes and supports for maintenance.
f. All trenches shall be sloped and self-draining with no stagnation of water. This applies to pipes in trenches as well as pipe racks.
g. Pipes and cables shall not run in the same trench.

1.10 Packing and Marking

1.10.1 General

All plant and equipment shall be packed in accordance with the requirements of the supplier's recommendations, and the details in this specification.

Nothing in these instructions shall relieve the CONTRACTOR of liability for any loss or damage arising out of deficient or inadequate packing.

Packing and any special freight instructions shall be clearly stated on orders and sub-orders.

If appropriate, arrangements should be made by the CONTRACTOR for special/valuable items to be supervised during transfer and storage at various points along the route and requirements in this respect should be advised at the same time as packing information.

All items containing internal packing /preserving /anti-corrosion materials shall be clearly marked to show this fact, to ensure that the packing/ preservative materials are removed prior to installation/commissioning.

All packing wood, empty cable drums resulting from plant erection shall remain the property of the Client.

1.10.2 Cleaning & protection before shipment

All bright metal parts shall be covered before shipment with an approved protective compound and protected adequately during shipment to site. After erection these parts shall be cleaned with a correct solvent and polished bright where required. The CONTRACTOR shall supply the Engineer with correct information relating to the necessary removal of solvents required for the protective compounds applied in order to protect the Plant items during shipment and storage. These solvents shall be both non-toxic and non-flammable.

Any protective coatings that may be specified elsewhere in this specification shall be applied after tests have been carried out.

Pipes, valves and other similar parts of the Plant which are subject to hydraulic test and are not readily accessible for drying out shall on completion of tests at the manufacturer's works, be drained and washed with an approved dewatering oil prior to the application of the specified protection during transit and prior to site erection.

Valve packings shall be removed after hydraulic test and replaced with dry packing.

All parts, which will ultimately be buried in concrete, shall be cleaned and protected before leaving the factory by a cement wash or other approved method. Before being handed over for building-in they shall be thoroughly descaled and cleaned of all rust and adherent matter by wire brushing.

1.10.3 Packaging design

The packing requirements should be reviewed and confirmed 3 months before dispatch.

Packaging should be in accordance with the relevant Sections of BS 1133 and should be designed with regard to:

a. Type of transport to be used.
b. Intended (and possible alternative) route.
c. Possible weather conditions along route.
d. Labour and handling facilities available along route.

e. Design of item to be packed, so that all necessary cradles, supports, chocks, protective padding and lashings can be included in the packaging design.
f. Protection against fresh or salt water and/or water vapour.

Tube ends and other similar open ends shall be protected from both external damage and ingress of dirt and moisture during transit and while awaiting erection at site. Flanged pipes shall have their open ends protected by adhesive tape or jointing and shall be covered with a wooden blank flange adequately secured.

Precautions shall be taken to protect shafts and journals where they rest on wooden or other supports likely to contain moisture.

At such points wrapping impregnated with anti-rust composition or vapour phase inhibitors shall be used of sufficient strength to resist chafing and indentation due to movement which is likely to occur in transit. The form of the protective wrappings and impregnation shall be suitable for a period of twelve months.

Lids and internal cross battens of all packing cases shall be fixed by screws and not nails.

Hoop metal bindings of cases shall be sealed where ends meet and if not of rust material shall be painted.

Contents of cases shall be bolted securely or fastened in position with struts or cross battens and not with wood chocks wedged in place, unless they be fastened firmly in place. All struts or cross battens shall preferably be supported by cleats fixed to the case above and below to form ledges on which the batten may rest. Cases shall be up-ended after packing to prove that there is no movement of contents.

Where parts are required to be bolted to the sides of the case, large washers shall be used to distribute the pressure and the timber shall be strengthened by means of a pad.

Wood wool shall be avoided as far as possible for packing purposes.

Waterproof paper and felt linings shall overlap at seams at least 13 mm and the seams secured together in an approved manner, but the enclosure shall be provided with screened openings to obtain ventilation.

Where practical, all indoor items such as electric motors, switch and control gear, instruments and panels, matching components etc. shall be "cocooned" or covered in polythene sheeting, sealed at the joints and the enclosures provided internally with approved desiccators.

In the case of ball or roller bearings installed in any item of plant the CONTRACTOR shall include and ship with the plant, one complete set of spare bearings. If replacement of any bearings are required due either to indentation during shipment or other causes during the maintenance period the spare bearings shall be used to replace the faulty bearings and the CONTRACTOR shall replace those used, free of charge, so that at the end of the maintenance period the plant shall be in full running order and a full set of spare bearings shall be available.

The Engineer may require inspecting and approving the packing before the items are dispatched by the CONTRACTOR, who shall be entirely responsible for ensuring that the packing is suitable for transit and such inspection will not exonerate the CONTRACTOR from and loss or damage due to faulty packing.

1.10.4 Marking of packages

All packages shall be marked with the following information on two opposite sides and on the top, using fade proof, waterproof and salt proof black ink:

CLIENT

CONTRACT

CONTRACT NO.

EQUIPMENT NO.

GROSS WEIGHT

NET WEIGHT

MADE IN PACKAGE NO.

NAME OF VESSEL:

Characters shall be at least 50 mm high unless package is too small, in which case the size shall be in proportion.

If marking tags have to be used on bundled structural material, the tags shall be made of metal and clamped flat to each bundle. Paper or cloth tags are not acceptable.

Packages shall be marked on all four sides with arrows pointing to the top.

Fragile or perishable materials shall be marked with the appropriate symbol, i.e. FRAGILE, HANDLE WITH CARE, COOL STORAGE, REFER STORAGE, USE NO HOOKS.

When required due to length or unbalanced weight, containers or pieces shall have centre of balance indicated by painted stripe extending upward on each side with wording "CENTRE OF BALANCE".

Sling marks shall be shown as required.

Fabricated sections of structures and equipment shall have their respective piece marks permanently stamped into the piece to a minimum depth of

1.0 mm and the stamped areas painted with corrosion protective paint of a different colour to the base colour. Characters shall be at least 10 mm high.

On vehicles, unboxed earth moving equipment or materials handling equipment etc. the markings may be shown on a notice suitably fastened to the windshield etc. These shipping marks are separate from and not to be confused with vehicle or equipment colour requirements and equipment identification numbers.

1.10.5 Documentation

A copy of the packing list shall be placed inside each shipping package. copy of the packing list in a waterproof envelope shall be securely fastened to unpackaged pieces or bundles.

Packing lists shall indicate the name of the Client/CONTRACTOR and the

Contract number.

Separate packing lists shall be prepared for each and every shipment made. In the case of several packages included in a single shipment, more than one package may be included on one packing list, providing all required information is shown for each package.

The following information shall be provided for each package:

a. Description of package i.e. box, crate, drum, bundle etc. b. Package number
b. General description of contents corresponding to the invoice.

c. Equipment number where applicable.
d. Gross, tare and net weights in kilograms.
e. Dimensions of package.

Packing lists shall detail complete export marks as indicated in "Packing and

Marking Instructions"

1.11 Erection Marks

All members comprising multipart assemblies e.g. steel framework, piping installations, etc. shall be marked with distinguishing numbers and /or letters corresponding to those on the approved drawings or material lists. These erection marks, if impressed before painting or galvanizing, shall be clearly readable afterwards.

1.11.1Erection & checking at site

All work at the site shall be carried out in such a manner as not to obstruct the operations of other contractors on the site or interfere with the operation of the Employer's existing installations on the site, and the CONTRACTOR shall co-operate with other contractors and the Engineer to attain this end.

The CONTRACTOR shall take all necessary precautions and provide all necessary equipment to protect the existing plant from damage and/or interruption to its commercial operation during the construction period of the Works. Any damage caused to existing plant or installation by the CONTRACTOR's or Subcontractor's plant, machinery, personnel or vehicles shall be made good by the CONTRACTOR at his cost.

The carrying out of all the work included in the Contract shall be supervised by a sufficient number of qualified representatives of the CONTRACTOR, and full facilities and assistance shall be afforded for the Engineer to check the works. The CONTRACTOR shall obtain from the Engineer details of the parts which he proposes to inspect, but such inspection shall in no way exonerate the CONTRACTOR from any of his obligations. The CONTRACTOR, if requested by the Engineer, shall open for inspection before erection any equipment, which has been delivered to the site partly assembled.

The CONTRACTOR shall keep clean the site on which he erects or stores plant, removing all waste material resulting from the works as it accumulates and as reasonably directed. On completion of the works the site shall be left clean and tidy to the satisfaction of the Employer/Engineer. Any damage done to buildings, structures, plant or property belonging to the

Employer shall be made good at the CONTRACTOR's expense.

The CONTRACTOR shall ensure the correctness of electrical and mechanical connections to all equipment supplied under the Contract before such equipment is commissioned.

During erection and commissioning the CONTRACTOR shall provide all temporary scaffolding, ladders, platforms with toe boards and hand-rails essential for proper access of workmen and inspectors, cover or rail off dangerous openings or holes in floors, and afford adequate protection against materials falling from a higher level on to personnel below.

The maximum personal safety must be afforded to personnel either directly engaged on this Contract or who in the normal course of their occupations find it necessary to utilize temporary works erected by the CONTRACTOR or to frequent the working area.

The CONTRACTOR must take particular precaution to ensure adequate protection of all site personnel

during any period when radiographic or X-ray inspection of welding is being carried out. Warning notices must be fully displayed and the inspection areas fenced off so that no personnel will at any time be subject to any radiation dosages in excess of the permissible levels quoted for unclassified non-radiation personnel in published statutory limits.

In each and every case involving a connection between the Plant supplied under this Contract and any other existing plant which may or may not be in service the CONTRACTOR must make suitable arrangements as regards the time and manner in which the connection is made subject only to the approval of Engineer's Employer's Representative who is in charge of the existing plant. Where cases arise involving the operation of the plant or work on plant in operation or whenever required by the Employer's Representative, the CONTRACTOR must obtain a written "Permit to Work" signed by a person duly authorized by the Employer's and countersigned by the Engineer.

1.12 Materials

All materials shall be new and of the best quality for use in the conditions and the variations in temperature and pressure that will be encountered in service without undue distortion or deterioration or the setting up of undue strains in any part that might affect the efficiency and reliability of the plant.

All materials shall correspond either to the approved standards and the respective code number or to exact analysis data, and full information concerning properties and applied heat, chemical and mechanical treatment must be submitted.

Special attention must be paid to eliminating the possibility of corrosion resulting from galvanic effects. Design, selection of materials and all methods of erection shall be such as to keep these effects to a minimum.

1.13. Contract Terminal Points

The CONTRACTOR's responsibility for making terminal connections shall be as follows unless otherwise stated in the specification:

a. Where pipe work supplied under this Contract connects to equipment
b. Already existing or supplied by the Employer, the connections shall be made under this contract. All preparatory work for making terminal point connections such as draining, transferring the fluid shall be undertaken by the CONTRACTOR under directives of the Client. All follow up work such as supply of necessary equipment and tanks, clean up, etc. will be CONTRACTOR's responsibility.
c. All associated switchgear and ancillary electrical apparatus not included in this Contract will be erected and tested under the supervision of the Engineer.
d. This contract includes the terminating and connecting up of all cables which are supplied under this Contract.
e. All associated cabling not included in the Contract will be installed, connected up to the terminal boards and tested under the supervision of the Engineer, but it will be the responsibility of the CONTRACTOR under this Contract to assist the Engineer in re-checking all final connections and to ensure the subsequent satisfactory operation of the equipment.
f. Any terminal points not specified or included in the Tender Documents but required for safe and reliable operation of the plant shall be deemed to be included in the scope of supply and the CONTRACTOR shall make such connections at no extra cost or delay to the

Contract. The Engineer will be responsible for the general co-ordination of the above work and for supervising all combined testing. The CONTRACTOR shall be deemed not to have fulfilled his obligation insofar as the commissioning of the Plant is concerned until complete end-to-end tests have been carried out to the satisfaction of the Employer/Engineer.

2.0 STEEL STRUCTURES, PLATFORMS, STAIRWAYS, LADDERS AND HAND RAILING

All steel structures shall comply with **Section VI Part 5** "General Requirements –

Civil and Structural Works".

Structural Steel

The supporting structure shall be designed considering the internal forces and expansions, as well as forces from wind, earthquake, etc.

Consideration shall be made that the steel structure can also take forces of piping systems that are supported from it, including forces resulting from water filling of the pipes during the hydraulic test.

Special care shall be given to the design of pipe supports for steam pipes, which must be able to support these pipes during water filling (hydraulic test). In order to avoid overstressing of the pipe supports and the associated foundations, the most critical loading condition shall be considered.

Girders for fixing lifting appliances shall be installed above all components having a weight of heavier than 50 kg when dismantling and assembling equipment for maintenance and overhaul, in case this component cannot be reached with a permanent or mobile crane.

Access platforms, galleries and stairways for all equipment that requires frequent operation, checks or maintenance (manholes, valves, instruments, pumps, etc.) shall be provided. All valves and instruments shall be accessible from fixed installed platforms, wherever possible. Mobile facilities will only be accepted as exception.

All steel structure shall be delivered complete with base plates, anchoring bolts, embedded items etc. All parts of steelwork and foundation bolts, which are required to be built into foundations, or are necessary for the support of the plant, shall be the first priority of delivery.

Using monkey ladder anywhere especially the places where maintenance is required regularly are not allowed.

All galleries, platforms, stairways and hand-railing shall be of galvanized and painted steel unless otherwise specified.

The arrangement of galleries, platforms, catwalks and stairways shall be submitted for Employer/Engineer's approval.

Galleries, platforms and stairways shall be designed generally for a load of 7.5 kN/m^2 but where loads in excess of this are likely to be imposed during operation or maintenance, the CONTRACTOR shall make due

allowance for the increased loads in the design. Particular care shall be given to their rigidity. All the necessary supports from the floors, buildings and foundations shall be supplied under this Contract.

Galleries and platforms around plant subject to significant expansion shall be designed to allow for such expansion and to provide adequate access for both hot and cold plant.

Platforms and galleries shall have a minimum width of 1000 mm clear passageway and shall be enclosed by hand-railing on both sides. In cases where there is a space not exceeding 200 mm hand-railing need be supplied for one side only but an edging strip shall be provided on this side. The minimum headroom on platforms and galleries shall be 2300 mm.

Ladders are only to be provided as an extra means of escape.

All aspects of platforms, stairways, ladders and other access ways shall comply with the requirements of ISO 14122-3, unless otherwise stated.

As far as practicable the flooring, stair treads and hand-rails shall conform to a uniform pattern throughout the whole of the Contract Works.

3.0 NUTS, BOLTS AND WASHERS

The threads and other details of fasteners for pressure equipment designed and built under an ASME standard shall be per ASME standards with unified threads (UNC, UN8)

All other fasteners shall comply with ISO Standards issued by Technical

Committees 1 and 2 (ISO/TC1 & ISO/TC2) for metric series fasteners.

Nuts and studs for pressure parts shall be made of materials from the relevant ASTM or ASME standard for the service and the pressure equipment material. The material of all other bolts, studs and nuts shall conform to the requirements of EN standards, BS standards and ISO standards.

Nuts, bolts and studs shall be of materials most suitable for the service operating conditions and designed to ensure the stresses arising in normal operation shall not exceed those necessary to ensure that the specified plant life is achieved.

Fitted bolts shall be a close fit in the reamed holes they occupy, and shall be marked in a conspicuous position to ensure correct assembly.

Stud holes in those parts of the plant which are subjected to heat in use shall be adequately vented.

The threaded portion of any bolt or stud shall not protrude more than 1.5 threads above the surface of its mating nut.

Where practicable the use of slotted head screws shall be avoided in machinery component assemblies, hexagon socketed screws being preferred.

Correct size of bolt and studs shall be used for the particular items. Cutting the threaded position of the excess length stud or bolt shall not be permitted.

4.0 STEEL FORGING

The CONTRACTOR shall draw up material specifications of all important forgings (other than those for code pressure equipment governed by ASME/ASTM standards) and supply copies of these specifications to the Employer/Engineer's for his use. In each case the quality and inspection requirements shall be clearly stated.

Wherever possible steel forgings shall be in accordance with the requirements of EN Standards, BS Standards BS EN 10250, PD 970, the equivalent ISO Standards, or agreed national standards.

Test blocks from which mechanical test pieces will be machined shall be cut from forgings at positions to be agreed by the Employer/Engineer. On large and important forgings several test pieces shall be taken from radial and longitudinal directions.

All forgings shall be manufactured from basic electric steel or fully killed acid open hearth steel. Consideration shall be given to the use of vacuum degassed steel in appropriate cases.

Forgings shall be free from cracks externally or internally, extensive non- metallic inclusions and surface defects. The CONTRACTOR shall carry out non-destructive testing of forgings during machining to verify that no unacceptable defects are present.

Repairs by welding or other means shall not be undertaken on forgings at any stage of the production cycle.

Each forging shall be suitably branded with an identification number which shall be transferred throughout all final machining stages. The identification number shall be marked on all documents and test certificates relative to the forging.

Forgings for code pressure equipment shall comply with all relevant rules from ASME and ASTM standards (material composition, testing, marking, traceability, etc.).

5.0 CASTINGS

5.1 General

Test bars shall be provided from medium and large castings for all necessary material and chemical tests which are to be witnessed by the Employer/Engineer. If required by the Employer/Engineer any castings for rotating or highly stressed parts are to be subjected to non-destructive testing by approved methods including radiographic and ultrasonic means, the cost of which will be borne by the CONTRACTOR.

All castings shall be homogeneous, free of shrinkage, pipes, under sizing, porosity or voids. "Bum-in" repairs are not acceptable and no welding, filling, interlocking or plugging of defective parts shall be done without the Employer/Engineer's approval in writing. All repairs shall be subjected to non-destructive examination (ultrasonic, X-rays, gamma-rays) after heat treatment. Welding repairs to castings that will be in contact with corrosive liquids such as seawater or brine will only be permitted under special circumstances.

5.2 Steel Castings

The CONTRACTOR shall prepare material purchasing specifications for all important castings (other than those for code pressure equipment governed by ASME/ASTM standards). Each document shall indicate fully the quality and inspection requirements for the component casting covered. Copies of the specification shall be issued to the Employer/Engineer for use.

Castings may be repaired by welding providing the approval of the Employer/Engineer is first obtained. The CONTRACTOR shall submit drawings, sketches or photographs showing the location and principle

dimensions of the defect together with the proposed weld repair procedure.

Weld repairs will only be permitted if a casting defect is within the following criteria:

Maximum length of defect	- 20mm
Maximum width of defect	- 10mm
Maximum depth of defect	- no greater than 10% of the wall thickness

Only welders who have passed an appropriate qualification test shall be employed on the repair of castings. All repairs shall be carried out by the metal arc process.

Ultrasonic inspection shall be applied to all important castings to locate the extent of sub-surface defects and to check the wall thickness.

All castings shall be identified by stamped or cast-on reference marks which shall be entered on all relevant documents and test certificates.

The Employer/Engineer may require that certain castings shall be examined using radiographic techniques. The CONTRACTOR shall include for this eventuality and shall comply with the Employer/Engineer's instructions when issued.

Castings for code pressure equipment shall comply with all relevant rules from ASME and ASTM standards (material composition, testing, marking, traceability, etc.).

5.3 Cast Iron Castings

Cast iron shall not be used for any part of equipment which is in tension or which is subjected to impact, or to a working temperature exceeding 100 C unless specifically approved by the Employer/Engineer.

Cast Iron is not permitted on pressure equipment. Use of cast iron should be avoided due to the environment containing H_2S.

Materials for iron casting shall comply with the following specifications according to the following Standards: BS EN 1561, BS EN 1562, BS EN 1563, BS EN 13835 and BS EN 10027 or the equivalent other national standards, e.g. British or European standards.

Weldable grades of Ni-resist austenitic cast iron castings may be repaired by welding provided the approval of the Employer/Engineer is first obtained. The CONTRACTOR shall submit full details of the proposed weld repair procedure and welding procedure qualification test prior to making any weld repairs.

Weld repairs will only be permitted if a casting defect is within the criteria, shown under item 5.2.

Test blocks shall be integrally cast on all medium and large castings.

The Employer/Engineer may require that certain castings shall be checked using radiographic techniques. The CONTRACTOR shall include for this eventuality and shall comply with Employer/Engineer's

instructions when issued.

5.4 Aluminum Bronze Castings

aluminum Bronze is only permitted where not exposed to geothermal fluid or the environment.

The CONTRACTOR shall prepare material purchasing specifications for all important aluminium bronze castings. Each document shall indicate fully the quality and inspection requirements for the component casting covered. Copies of the specification shall be issued to the Employer/Engineer for use. The inspection and quality requirements shall include an analysis of each cast, mechanical testing of test bars from each cast, pressure testing, penetrant flaw detection and radiographic examination of selected critical areas.

Weldable grades of aluminium bronze may be repaired by welding provided the approval of the Employer/Engineer is first obtained. The CONTRACTOR shall submit full details of the proposed weld repair procedure and welding procedure qualification test prior to making any weld repairs. On completion of repairs, welded areas shall be ground smooth and carefully blended into the parent material. The repaired areas shall be examined for defects using penetrant flaw detection and radiography. Crack- like linear defects shall not be permitted.

Weld repairs will only be permitted if a casting defect is within the criteria, shown under item 5.2.

6.0 WELDING GENERAL REQUIREMENTS

6.1General

All welding, inspection and testing of welds and welders shall be carried out in accordance with the applicable American, European, British and German Standard specifications (AWS, BS-EN, BS, DIN, AD-HP) as required by the design conditions of the plant and equipment and agreed by the Employer/Engineer.

For geothermal piping, the design code shall be ASME B31.1 and all welding shall be in accordance with ASME Codes.

Where there is conflict between Codes and/or Standards the Engineer's decision will prevail.

The CONTRACTOR shall supply all necessary plant, labour, equipment, appliances, materials and consumables required to perform all operations in connection with the welding within the limits of this contracts. All equipment, plant and appliances shall be good quality, well maintained and entirely suitable for the intended purpose.

6.2 General Fabrication

The Employer/Engineer shall be notified at least two days prior to commencement of any assembly or fabrication work on site.

The CO_2 and flux-cored welding process will not be acceptable for site welding unless otherwise approved by the Employer/Engineer.

Welders and weldings shall be protected by suitable equipment from wind, airborne sand and moisture. Work shall not be performed when weather conditions do not permit satisfactory workmanship or

adequate inspection.

Weld preparation profiles may be prepared by machining, shearing, flame cutting and grinding and shall be performed carefully and accurately. Flame cutting is prohibited for stainless steel and high alloyed steel (>5% alloy quality). Whenever possible a mechanically guided tool shall be used for flame cutting.

All edges shall be left free of slag, burrs, fins, oxides and foreign matter and the finished profile shall conform to the design tolerances for the weld preparation.

Before execution of the welds, the profile shall be completely clean that means dry, free of any kind of humidity, slag, oxides, paint etc.

Where preheating is required it shall whenever practical be carried out by electric resistance or induction equipment or by specially shaped gas burners. Preheat and interpass temperatures shall be checked by temperature indicating crayons at a distance of not less than 75 mm from the weld groove. The use of hand-held torches for preheating will not be permitted.

Post weld heat treatment in accordance with the applicable European, British and American Standards shall be carried out using equipment specifically designed for the process. Gas burners or hand held torches will not be permitted. For work which is heat treated in a furnace, the CONTRACTOR shall supply copies of the heat treatment charts. Work which is subjected to heat treatments by means of electrically heated elements shall be monitored by suitable thermo-couplers (minimum two thermocouples) connected to a chart recorder.

Copies of heat treatment charts shall be made available to the Employer/Engineer.

While post-weld heat treatment, the pipes shall be extremely supported to ensure that no stress is coming on the weld. All post weld heat treatments shall be carried out under the supervision of qualified personnel.

All transition welds between dis-similar materials shall be made under controlled conditions at the manufacturer's work. Site welding of structural high yield steel will not be permitted without the prior consent of the Employer/Engineer.

All tube butt welds shall have 100% penetration. The surface of the finished weld shall not be concave.

Stainless steel shall be welded under a local inert atmosphere, including gas backing.

All stainless steel welds shall be cleaned and passivated.

6.3 Weld Alignment

Alignment of Welded Joints Unless detailed in the pressure equipment code each joint shall be aligned so that the offset between the internal surfaces does not exceed the following:

< 10mm wall;	± 1.00mm
> 10mm and <13mm wall;	± 1.25mm
> 13mm wall;	± 2.00mm

Wherever possible line-up clamps shall be used for aligning pipe ends. Line- up clamps shall remain in position until completion of the root pass.

On no account shall strips, plate sections or cleats be attached to the pipe for alignment purposes unless approved in writing, by Employer. Where fittings prevent the use of line up clamps, the work shall be set up, properly spaced and supported, and tack welded.

6.4 Welding Procedure Documents

Complete and fully detailed welding procedure documents shall be kept and these shall be made available to the Employer/Engineer on request.

Prior to the commencement of welding the CONTRACTOR shall submit to the Employer/Engineer for approval the welding procedures to be used in the fabrication of the relevant sections of work.

The welding procedure documents shall be fully detailed and each shall indicate clearly which item it is intended to cover. The procedures shall be in accordance with the requirements of ASME IX.

Welding procedure sheets for different materials of piping and valves shall be specified in appropriate sections of Instruction Manuals.

6.5 Welding Procedure Qualification Tests

Welding procedure qualification tests shall be carried out in accordance with the requirements of ASME IX or agreed National Standard for the item of plant under consideration. Providing that the CONTRACTOR confirms that the basic parameters of the procedure have not been changed since approval, the results of welding procedure qualification tests previously carried out under the Supervision of any internationally recognized inspecting authority may be accepted by the Employer/Engineer.

The CONTRACTOR shall inform the Employer/Engineer of any proposed changes to the welding procedures before such changes are implemented. If in the opinion of the Engineer a further qualification test is required as a result of such changes, than the CONTRACTOR shall perform the required test without additional charge.

The results of all tests shall be made available, for examination by the

Employer/Engineer, if required.

6.6 Welders Qualification Tests

All welder's and welding operators shall be qualified for the work and shall hold current welder's qualification certificates in accordance with ASME IX or agreed National Standard for the work.

All welders' tests shall be witnessed and/or approved by the Employer/Engineer before the welder or operator is permitted to work. The decision of the Engineer regarding the acceptability of any test or existing qualification tests shall be accepted solely at the discretion of the Engineer.

A welder or welding operator who fails one or more of the tests shall be retested after further training. Before retest, CONTRACTOR should confirm that the failed welder or welding operator has had further training and practice.

Records showing the date and results of the qualification tests performed by each welder and weld operator together with the identification number assigned to him shall at all times be available for scrutiny by the

Employer/Engineer. The detailed welder's summary list shall be submitted to the Employer/Engineer at agreed intervals of time regularly.

All welding shall be carried out under the supervision of competent welding supervisors.

6.7 Storage of Welding Consumables

Welding consumables shall be stored in a manner that will protect them from all forms of deterioration prior to use and shall be properly identified.

Each batch of electrodes and wires shall be identifiable with the respective manufacturer's test certificate and advice note and shall be used in strict delivery rotation.

Electrodes which have damaged flux coatings are bent, misshapen or have lost their identification shall not be issued on any work.

The CONTRACTOR shall provide drying ovens in sufficient number to permit the correct storage of electrodes for 48 hours before use. Drying ovens shall preferably be heated by electric means and shall have automatic heat controls and visual temperature indication.

The re-baking of low hydrogen electrodes shall be done strictly in accordance with the manufacturer's recommendations.

The procedure for the issue of electrodes shall be carefully controlled. No welder shall be issued with more electrodes than can be used during a ½ day work period.

As far as necessary, all electrodes shall be issued and transported to the work place in thermally insulated containers. The electrodes shall remain in the container until they are required.

Gas cylinders for use with burning or welding equipment shall be marked in accordance with the requirements of ISO 13769. Site storage procedures for gas cylinders will require the approval of the Employer/Engineer.

6.8 Welding Equipment

Any welding equipment which, in the opinion of the Engineer is unsuitable or unsatisfactory for the service for which it is being used, shall be replaced by the CONTRACTOR.

The absence of comment by the Employer/Engineer shall not be taken as approval for any equipment.

6.9 Weld Examination

All non-destructive examinations shall be supervised by a fully qualified and experienced specialist appointed by the CONTRACTOR. Individual operators in each of the respective techniques shall be qualified and trained in the respective subject and shall have reached a standard comparable with CSWIP.

Testing shall be in accordance with the requirements of ASME B31.1 for geothermal piping and to the standards under ISO/TC44/SC5 for other metallic joints or equivalent standards as agreed by Employer/Engineer.

6.9.1 Visual weld inspection

Each weld shall be subjected to a stringent visual inspection and shall be free from undercut, excessive

spatter, craters, cracks, porosity and other surface imperfections. Welds shall be of regular contour, even weld ripple and indicative of good workmanship.

Fillet welds shall be checked for dimensional tolerance and form using a fillet weld gauge. Fillet welds should be slightly concave in form and each leg of the weld shall have equal length.

6.9.2 Radiography

a. General

Radiography shall be carried out in accordance with the requirements and recommendations of ASME V Art. 2 for pressure equipment designed to ASME codes or recognized standards as agreed by the Employer/Engineer for all other items.

b. Manufacturer's works

Radiographic inspection at manufacturer's work shall be accomplished with X-ray equipment throughout.

c. Site

Gamma radiography will be permitted in appropriate cases at the job site. Cobalt 60 sources shall not be used without the express permission of the Employer/Engineer in writing.

d. Techniques

Radiographic techniques shall be in accordance with ASME V Art. 2 for pressure equipment designed to ASME codes or recognized standards as agreed by the Employer/Engineer for all other items.

The CONTRACTOR shall take all possible steps to protect radiographic and all other personnel from the effects of ionizing radiation.

6.9.3 Ultrasonic examination

Ultrasonic examination of welds shall be carried out in accordance with

ASME V Art. 4 for pressure equipment designed to ASME codes or recognized standards as agreed by the Employer/Engineer for all other items.

6.9.4 Magnetic crack detection

Magnetic crack detection shall be carried out in accordance with ASME V

Art. 7 for pressure equipment designed to ASME codes or recognized standards as agreed by the Employer/Engineer for all other items.

6.9.5 Dye penetrant tests

Dye penetrant tests shall be in accordance with ASME V Art. 6 for pressure equipment designed to ASME codes or recognized standards as agreed by the Employer/Engineer for all other items.

6.9.6 Quality requirements for welds

All welds subjected to non-destructive tests shall be entirely free from cracks or crack like defects, lack of root fusion, lack of sidewall fusion, root bum through, or tailed pores. The standard for porosity and slag inclusions will be as indicated in the agreed standards for design and welding.

Personnel who perform non-destructive examination of welds shall have qualified and certified in each examination method in accordance to that standard, which is used for the welding and examination processes.

6.9.7 Mandatory inspections

A minimum of 25% of all butt welds on all classifications of work shall be radio graphically examined, unless otherwise agreed with the

Employer/Engineer.

In addition to the minimum of 25% examination, all transmission welds between dissimilar materials, such as high alloy steels to carbon steel, or austenitic steels or non-ferrous materials to steels, shall be subjected to 100% ultrasonic examination or crack detection wherever practicable. In addition, all butt welds between dissimilar materials shall be subjected to 100% radiographic examination.

Also, all welds in ferritic alloy steels, e.g. having a carbon equivalent value in excess of 0.40% and high yield-strength steels, e.g. having a yield strength greater than 300 MPa, shall be subjected to 100% ultrasonic examination and crack detection wherever possible. In addition, all butt welds in these materials shall be subjected to 100% radiographic examination.

A minimum of 10% of all fillet welds on all classifications of work shall be examined by magnetic crack or dye penetrant tests, unless otherwise agreed with the Employer/Engineer.

The minimum weld examination shall be spread to all welders, that approximately 10% of each person's welds are tested.

For pressure vessels, all pressure retaining welds shall be 100% radiographed. All other welds shall be either magnetic particle or dye penetrant tested.

Radiographic tests shall be done after stress relieving according to the Standards and Codes.

In any case Non-destructive, i.e. radiographic tests, at site shall not be less than the following:

100% / 25%	100% NDT on cross welds and 25% NDT on all other welds for all two phase, steam, brine, and condensate lines.
25%	Minimum for all cold water lines, compressed air and other non-inflammable gas lines having a maximum operating pressure above 7 bar

10%	Minimum for all cold water lines, compressed air and other non-inflammable gas lines having a maximum operating pressure below 5 bar

- For further details on non-destructive testing, see **Section VI part F** "Inspection and Testing".

6.9.8 Weld repairs

The Employer/Engineer's approval shall be obtained prior to commencement of any repair or rectification work.

Weld repairs shall be made to the same procedure as for the original weld. All tests shall be repeated after the repair has been completed and reports on radiographic and ultrasonic tests shall be marked to indicate that the report refers to a repaired weld.

7.0 PUMPS

Pumps should be of the centrifugal type unless technical or strong economic reasons dictate that a positive displacement pump, either rotary or reciprocating, is more appropriate.

All pumps shall be designed for continuous operation unless otherwise specified.

"Monoblock" pump - motor configuration shall not be used anywhere. Pumps shall be installed in

positions convenient for operation and servicing.

Where multiple pump installations are required, each pump and its associated equipment shall be arranged in such a manner as to permit easy access for operation, maintenance and pump removal without interrupting plant operation.

If several pumps are used for the same pumping work, these shall be of the same design i.e. interchangeable. Standard pumps with suitable characteristics shall be used wherever practical. Only proven makes and models shall be supplied. All accessories and the overall design of the pumps sets shall be such that they are suitable for automation as planned for the relevant systems.

Unless otherwise specified all pumps shall be capable of operating at 110% of the rated capacity at the rated delivery head. Maximum size impellers shall not be quoted for. By installation of a new impeller a head increase of

5% minimum shall be possible. The performance of the drive motor is to be determined according to the above mentioned technical requirements and to the requirements as specified in the electrical part.

Base plate for pumps/pump skids which handle sea water/brine or any other corrosive fluid shall be of the same material as the pump or at least stainless steel 316L quality (to be approved by the Employer/Engineer).

7.1 General Requirements of Centrifugal Pumps

Maintenance time should be minimized by the selection of appropriate designs of pump, preferably those

that leave casing to piping joints intact, i.e. horizontal split-casing types for large centrifugal pumps and horizontal, back pull-out types for smaller units. Where a significant saving in floor space or improvement of layout can be shown, a vertical pump may be acceptable.

Generally fabricated components for pump parts such as impeller, shaft, etc. are not acceptable.

Pumps shall be capable of continuous operating with minimum maintenance. The rating of the driver and the pump's NPSH requirements shall be such that the pump is capable of a flow rate 10% in excess of the maximum flow rate required. In addition pumps shall be designed to have a reasonable margin on head (normally 5% on head for clean fluids, 10% for solids- bearing fluids) to compensate for normal wear of pump components. There shall be an adequate margin on NPSH, normally greater than 1 m for values of NPSH (required) between 2 m and 12 m with flow rates up to the stated maximum.

Where any pumps are installed to operate in parallel, they shall be capable of equal load sharing throughout the operating range. This implies a pump head flow characteristic that falls continuously from shutoff to duty point by at least 10%.

The pump unit shall, when operating over its normal range of flow rates, comply with the noise emission requirements stated in clause 1.6.

If a pump can operate at sub-atmospheric suction conditions, the entire pump shall be designed for full vacuum.

All pump shafts shall be of optimum size to transmit the maximum possible output from the prime mover. The pump shaft and coupling are to be so dimensioned that the maximum permissible torque of the shaft is higher than the maximum transmissible torque of the coupling. Directly coupled pumps shall be used preferably.

All pump-motor units shall be installed on substantial base plates, with isolating valves, a discharge non-return valve, air release valves (for both pump casing and seal chamber), drain valves, suction and discharge pressure gauges unless otherwise stated. The supplier should review the minimum flow rates and supply a leak-off system, if necessary, in which case all minimum flow detection devices, diversion valves and pipe work shall be supplied. The extent of supply shall include adequate spare parts for commissioning purposes and a first fill of all lubricants.

All pumps and accessories in contact with the pumped fluid shall be constructed of materials specifically designed for the conditions and nature of the pumped fluid, and be resistant to erosion and corrosion.

Where material specifications are given in the various pump specification, these are to be considered as minimum requirements. They do not relieve the

CONTRACTOR of the responsibility for selecting the correct materials. All mating flanges shall be doweled. Only stainless steel shims shall be used. No corrodible material for embedded supports shall be used.

The pump casing shall preferably be split for ease of maintenance and be designed such that the impeller and shaft are capable of being withdrawn from the casing without disturbing any of the main pipe work and valves carrying the pumped fluid. In general, all horizontal pumps with draw out-rotors are to be fitted with a coupling to facilitate disassembly without removing the motor.

Vertical pumps are to be provided with foundation frames. In case of submersible pumps suitable frames shall be provided in the pump sump. It shall however be possible to remove these pumps without entering the sump.

7.2 Technical Requirements of Centrifugal Pumps

In selecting bearing type, account should be taken of possible vibration damage to the bearing surfaces while the machine is stationary. Where sleeve bearings are used, bearing shells shall be replaceable without removing pump or motor shaft. Bearing housings shall be effectively sealed against loss of lubricant and ingress of fluid or dirt.

All oil lubricated bearings shall have housings fitted with means of drainage, visual oil level indicator and a capped filler or a constant level oiler which is accessible whilst the unit is operating. Grease lubricated bearings shall be connected to readily accessible greasing points either singly or at a battery plate. Lubrication should be by means of a pressure gun.

Bearings housings on horizontal shaft pumps shall be designed to enable the bearings to be replaced without removing the pump or motor from its mounting. All bearing oil wells shall be fitted with visual oil level indicators. Non-pressure-oil lubricated bearings shall be equipped with constant level oilers. Means of draining bearing housings shall be provided.

Where rolling contact bearings are used, they shall be sized to provide a minimum L-10 life of 16,000 hours (as per ISO 281) under conditions of maximum load on the bearings. In the case of a close-coupled pump, this requirement applies to the motor bearings.

For fully closed impellers replaceable case wear rings shall be fitted where diameters exceed 150mm and replaceable impeller neck rings where diameters exceed 250mm. All wear rings shall be a press fit on or in their respective component and positively locked against rotation.

Fully closed impellers are not required for vertically suspended pumps.

Casing design pressure shall be at least 1.1 times the pump shut-valve pressure with the pump operating at maximum possible inlet pressure. The pump casing and base plate shall be capable of withstanding all hydraulic forces, together with externally applied pipe moments and loads and the supplier shall state the pump's pipe load limitations.

The pump unit and all removable components greater than 10kg in weight shall be fitted with suitable lifting lugs and eyes to facilitate all erection and maintenance tasks. Any special lifting tackle shall be supplied.

Suitable means, such as jacking screws, shall be provided to aid the separation of pump components; these shall be arranged so that no damage can be done to mating or sealing faces by their use.

The method of fitting impeller to the shaft shall adequately centre the component but allow its removal without risk of damage to either component. Torque shall be transmitted to the impeller by keying, other than in the case of a multistage vertical pump for which collet drive may be acceptable. The main impeller nut or screw shall not have its thread exposed to the pumped fluid and must either be locked or maintained tight by virtue of the normal direction of rotation.

The pump shafts shall be designed such that the first critical speed of the pump is at least 20% higher than the maximum speed encountered in service.

All rotating components shall be dynamically balanced, to grade G6.3 of ISO 1940-1.

Where two pumps are connected in parallel, the units shall be capable of reverse rotation under full pump head without sustaining any damage.

When the pump (above 200 kW) is operating over its normal flow range, the vibration intensity measured at the bearing housings shall not exceed the level as defined within ISO 10816-7 (3.5mm/s for category I, 4.2mm/s for category II).

For small machines (i.e., less than 200 kW driver rating) vibration intensity shall not exceed 2.5mm/s for category I and 3.2mm/s for category II.

Pumps shall operate smoothly throughout the speed range up to their operating speeds.

Where necessary the pumps are to be fitted with devices to ensure a minimum throughput.

7.3 Shafts, Seals and Couplings

All pumps shall be installed with isolating valves, a non-return valve and suction and discharge pressure gauges unless otherwise stated.

All pumps other than submersible pumps shall have temporary strainers fitted in the suction pipe work during all initial running and commissioning. Permanent strainers shall be provided where specified.

Venting valves shall be fitted to all pumps at suitable points on the pump casing unless the pump is self-venting.

Drainage facilities shall be provided on the pump casing or adjacent pipe work to facilitate the dismantling of pumps. Pipes for leakage water, venting, draining etc. are to be routed to a funnel at the edge of the base plates.

Air release valves shall be fitted at suitable point of pump casing where appropriate for the process fluid.

Packed glands if not otherwise specified shall be used for pumps handling cold water and other non-hazardous liquids. Clean water sealing arrangements shall be provided for gland packing of pumps handling geothermal brine or condensate, if recommended by the pump vendor to ensure longevity of the pump seal.

Mechanical seals shall be preferably of a pressure-balanced type. The design of the unit should allow the mechanical seal to be replaced without disturbing the pump or driver if practicable.

Mechanical seal shall be fitted over a sleeve on shaft. The mechanical seal shall be of the split type to facilitate quick removal/replacement without any disassembly of other parts of the pump.

All pump glands shall be provided with trays and guards to catch leakage. Piping shall be fitted for drainage to an approved location.

Couplings shall be dynamically balanced to ISO 1940-1 G 6.3 where speed exceeds 1800 rpm or shaft diameter exceeds 51 mm. Dynamically balanced couplings shall be match marked. Where a spacer coupling is used, the spacer shall similarly comply.

All coupling and any intermediate shafts shall be fully guarded.

7.4 Pump Materials

Materials of constructions shall be selected with due regard to the corrosive nature of the pumped fluid and risk of corrosion, cavitation, and metal-to- metal galling that can occur within a pump in all its modes of operation. It is the supplier's responsibility to select materials that will provide an adequate service life.

If the pump impeller and impeller shaft are of different material, any portion of the impeller shaft which could be in contact with the water must be encased in a protection sleeve of the same material as the impeller. All materials shall be selected with particular regard for the risk of electrochemical corrosion.

Cast iron is not acceptable for pump cases where the duty involves shock loads or where service stresses exceed 10% of the Ultimate Tensile Strength in tension or 15 % in bending. This restriction does not apply to castings of spheroidal graphite structure with an elongation greater than 10%.

Materials for handling foul water are not specified above and will depend on detailed water chemistry.

8.0 PIPEWORK

8.1 General

Piping and valves shall comply with the latest revision of the applicable codes and standards (latest revisions) such as DIN, EN, ASME or other equivalent international standards. Standard pipe sizes shall preferably be according to ISO 6708 or ASME B36.10M/ B36.19M.

Geothermal piping design, construction and testing shall comply with ASME B31.1.

The pipe and fittings shall be manufactured by an ASTM or API approved facility. This certification shall be current and documentation supporting the approval shall be made available to the Employer on request.

Materials and Mill certification for all pressure pipes and fittings shall be supplied to the Employer. Test certificates shall be provided with the following:

- Heat analyses
- Mill control tensile tests
- Hydrostatic tests
- Quality assurance inspections

The test certificates shall be clearly identifiable with the items supplied. Four copies shall be supplied.

All documents shall be clearly legible and suitable for photocopying.

All units shall be SI units except for nominal pipe diameter which may be in inches Pipe shall be manufactured to the specified codes with the specified wall schedule.

When the pipe is specified Electric Resistance Welded (ERW) type, it may be substituted by Seamless (SMLS) or Electric Fusion Welded (EFW) type, with higher welding efficiency, in accordance with the above standards. EFW type may be substituted by SMLS but not ERW type. SMLS pipes shall not be substituted unless accepted by the Employer

All metallic piping DN 50 and larger shall be butt weld. Smaller piping shall be socket weld except where threaded joints are specifically required in certain instances in the piping material class.

Seal welding of threaded connections is only allowed at hydrostatic test vents, or where specified on drawings.

Spectacle blinds for carbon steel lines shall be made from material to ASTM A516-70N.

All pipe surfaces shall be coated with an Employer accepted corrosion prevention system at the factory prior to shipment. The system shall be able to protect the pipe for at least six months when stored outdoors.

Unless accepted by the Employer, there shall be no joints in the pipe supplied. All goods shall be new and unused.

The following Codes and standards shall be used for geothermal piping:

- ASME B31.1 - Power Piping
- API Specification for Line Pipe 5L
- ASTM A53 - Pipe, Steel, Black, Welded and Seamless
- ASTM A105 - Forgings: Carbon Steel for Piping Components
- ASTM A106 - Seamless Carbon Steel Pipe for High Temperature Service
- ASTM A216 - Steel Castings for Fusion Welding and High Temperature Service
- ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for
- Moderate and Elevated Service
- ASME B16.5 - Steel Pipe Flanges and Flanged Fittings
- ASME B16.9 - Steel Butt Welding Fittings
- ASME B16.11 – Forged Fittings, Socket-Welding and Threaded
- ASME B16.25 - Butt Welding Ends
- ASME B16.28 - Steel Butt Welding Short Radius Elbows and Returns
- ASME B36.10 - Welded and Seamless Wrought Steel Pipe
- MSS SP44 - Standard for Steel Pipe Line Flanges
- MSS SP48 - Standard for Steel Butt Welding Fittings

8.1.1 Weldolets, sockolets and threadolets

Sockolets and Threadolets Class rating shall be as calculated from ASME B16.11 and Weldolets shall be to the pipe schedule for the run pipe. They shall be manufactured from forged carbon steel to ASTM A105 or accepted equivalent.

8.1.2 Flanges

Flanges shall be ASME standard forged steel complete with material certificates on all geothermal lines.

Raised face flanges shall have concentric serrated raised face. They shall be drilled and spot faced. Bores are to match connecting piping.

Pressure-temperature ratings and dimensions for all flanges on geothermal lines shall comply with ASME B16.5. Dimensions of flanges over DN 600 shall comply with ASME B16.47 Series A.

Unless otherwise specified, Class 300 and below flanges shall be of raised- face type.

Unless otherwise specified, Class 600 and above flanges shall be of ring- type-joint type.

ASME flange material shall be to ASTM A105. Flange faces shall have stock finish.

Flange face shall be coated with an Employer accepted corrosion prevention coating system at the factory to protect it from corrosion during shipping and storage in the outdoor environment.

Nuts and studs for ASME flanges shall conform to UN thread form. Studs shall comply with ASTM A193 GR.B7. Nuts shall comply with ASTM A194 GR.2H. Stud bolts shall be threaded in accordance with ASME B1.1 Class 2A fit.

Flanges shall be installed with the bolt holes straddling the vertical centerline of the pipe, unless specified otherwise.

Slip-on or socket weld flanges shall not be attached directly to fittings such as tees, elbows or reducers. There shall be a minimum of 50mm straight run between slip-on or socket weld flanges and pipe fittings.

When flanges are to be welded into a line the second flange of the pair shall be tacked in position. The alignment and rotation shall then be checked before final welding begins. Where flanges connect to valves or other fittings, a similar procedure shall be adopted.

The fitting shall be installed and the flanges bolted up before the final joint is tacked and welded. Where such fittings are not available at the time of pipeline construction the Contractor shall fabricate a spacer piece with the equivalent face to face dimension as the fitting and bolt this into the line in place of the fitting. The Contractor shall verify the bolt hole alignment of all flanges already installed before welding mating flanges.

All flanged surfaces and grooves shall be clean, dry and unmarked prior to make-up. Gaskets shall be new, clean and free from defects. Stud bolts shall have a full, continuous thread and be long enough to extend a minimum two (2) full threads beyond the back nut when tight.

Anti-seize compound shall be used on the threads of all flange bolts and all exposed threads shall be liberally coated with high temperature grease before installation.

8.1.3 Gaskets

Gaskets for steam, condensate and brine piping systems shall be high temperature spiral-wound gaskets, 316SS with non-asbestos filler

Gaskets for steam, condensate and brine piping systems shall be ring type joint, R-octagonal for Class 600 flanges and above, unless otherwise specified.

Gaskets shall be manufactured to suit flanges to ASME B16.5. The inside diameter of the inner ring shall match the STD Wt. bore for Class 150 and Class 300 gaskets.

Spiral-wound gaskets shall be stacked no higher than half diameter of the gasket. Each stack shall be sandwiched by two pieces of plywood (or equivalent) of appropriate thickness to keep them flat and strapped together for shipment.

Ring joint gaskets shall comply with ASME B16.20, shall have a maximum Rockwell 'B' hardness of 56 and shall be zinc coated.

Alternative gasket materials shall not be used without Employer's acceptance.

8.2 Piping Design Information

The CONTRACTOR shall supply to the Employer/Engineer schedules of the pipework provided under this Contract. These schedules shall state, for each pipework system or parts of a pipework system, the design and operating pressures and temperatures, the fluid transmitted, the piping and valve materials, the types of valves, any corrosion allowances, the pipework design code, insulation proposals, pipe supports and any other data relevant to the mechanical design of the pipework system or part of a pipework system.

The following standard pipe sizes shall be used for the different systems: Diameter in millimeters.

- DN: 25, 50, 80, 100, 150, 200, 250, 300, 350, and 400 etc.

Piping systems operating in the areas of materials creep rupture strength shall be designed for a system live time of 250,000 hours.

Unless otherwise specified or approved or unsuitable due to corrosion or other considerations, all pipe DN300 and below as well as all wellhead branch piping (production and reinjection wells) up to the first isolation valve shall be of seamless drawn steels.

The steels shall be suitable to withstand the temperature and pressure conditions involved in the operation of the plant under all circumstances.

The use of cast iron pipes will be not allowed.

In any one system or pipe service all pipework and fittings shall be of the same material or similar analysis unless specified or agreed to by the Employer/Engineer.

The corrosion allowance on all geothermal carbon steel piping shall be a minimum of 3 mm.

All materials (piping, valves, fittings etc.) in contact with fluid containing

H_2S shall be compliant to NACE MR0175.

After calculations, the wall thickness selected shall be to the next higher available wall thickness schedule.

8.3 Piping Arrangement and Installation

Intersection Points (IPs) shall be shown on the detail drawings and pegged out by a qualified surveyor to within a circle of 50 mm radius prior to installation.

All pipe support locations shall be measured along a straight line between IPs. These measurements shall be cumulative and the tolerance on plan position of any support shall be ± 100 mm with the exception of those close to bends, valves, compensators and other in line equipment which shall be ± 10 mm. The maximum lateral misalignment of any support shall be ± 3 mm between IPs.

Pipe levels on supports shall be similarly determined from straight lines between IPs, but to an accuracy of ± 3 mm maximum.

All pipe saddle locations and sizes, and offsets and offset directions shall be shown on the appropriate drawings.

At all times the Contractor shall handle and support the pipe in such a manner as not to overstress or cause damage to it.

Pipes shall be strung only on rights-of-way which have been cleared, and, where necessary, graded. The Contractor shall ensure that they are strung for the proper placement of pipe, size, weight and grade.

Pipe shall not be strung directly on the ground but placed on sand bags or padded skids.

Valves, flanged fittings or other equipment with finished surfaces shall be placed on skids to prevent such surfaces from coming into contact with the ground

The piping shall be kept clean internally and all tools and construction materials are removed before the piping is welded.

The Contractor shall at all times handle and support the pipe in such a manner as not to overstress or cause damage to the pipe or its connection points.

The longitudinal seam of the pipe shall be at the top of the pipe but offset minimum 50 mm arc length from the vertical centre line so that there is at least 100 mm between the longitudinal seams of adjacent pipes at a circumferential weld joint.

Hot or cold field bending of pipe to achieve alignment shall not be permitted.

Flanged piping connections to pumps, vessels and other rotating equipment shall be aligned to ensure flanges do not spring apart on removal of their bolts.

Welding wires and electrodes and other materials for welding shall be according to relevant standards or codes of the appertaining piping system or the recommendation of the pipe material and weld material supplier. Adequate information documents shall be submitted to the Employer/Engineer before starting the welding work at site.

All welding ends on piping, bends and fittings prepared both in shop and field shall be machined. Welding joint design shall avoid all sharp corners. The preferred weld type shall be butt-welded joints and welding neck flanges. Socket welding is only permitted up to DN50.

When connecting to equipment flanges, the matching pipeline flange shall match the equipment flange irrespective of the individual pipe line classification. Therefore all equipment having flanges like pumps, valves, etc. shall be shipped with its counter flanges, gaskets, as well as bolts, nuts. The requirements for bolts and nuts as stated under paragraph 3 apply.

Other piping systems may comprise welded connections or bolting of pipes to the valves or equipment. The use of short pieces of pipe in making up long runs is not permitted.

All welding of saddles and reinforcing pads to pipe shall be by welders qualified to the requirements of ASME B31.1.

The number of joints shall be kept to a minimum necessary for efficient maintenance of the plant. Tees and bends shall be to standard dimensions. Bends shall be of the pulled type or forged. Hot bending with packing may be used for larger sizes according to facilities available, but hot bends in alloy or stainless steels may only be made after permission has been given by the Employer/Engineer. No crimping or visible flattening at the bend will be accepted. For fabricated low pressure pipework gusset or mitre bends may be employed

but designed in accordance with the piping code.

Provision shall be made for the drainage of systems by means of suitable falls and allowing for the full expansion that can take place under all conditions of operation. Drainage falls are to be arranged, as far as possible, in the same direction as the operational flow.

The minimum drainage fall in steam pipework is to be 1 in 500, unless otherwise approved by the Employer, with a continuous fall to the discharge point. The design of steam pipework shall ensure that drainage falls are maintained with pipe expansions and other conditions which can arise during transient and steady-state operation. The installation is to be designed to prevent the collection of pockets of water during operation and start up periods.

As far as it is possible all process pipes shall be above ground on pipe supports. Wherever the pipes have to cross roads or other facility, this shall be achieved by proper trenches.

The layout of the piping shall be subject to approval by the Employer/Engineer. These drawings shall indicate the position of all supports, drainage points, fittings and all closing pipes. However, all piping systems shall be arranged to allow for adequate slopes in the direction of flow. At the point of drainage, drain pockets of sufficient size and approved construction shall be fitted. Drain piping shall be separately run to the blowdown tank or drain tank as may be appropriate.

Pipe material, flanges, bolts, nuts, washers and the like for compressed air respectively instrumentation and control air systems shall be hot dip galvanized.

The pipe system for compressed air respectively instrumentation and control air systems shall be of threaded type i.e. welding at site is not permitted.

Any plastic piping required to be used in outdoor applications shall be fully suitable to withstand the effects of sunlight over the life of the plant and shall be subject to Employer/Engineer's approval. Plastic pipes above 150 mm nominal diameter shall not be site run and design arrangements shall be submitted to the Employer/Engineer for approval. Where plastic pipework is used it shall be arranged to minimize the risk of accidental damage during plant operation or maintenance.

Miscellaneous, generally small bore, piping is run on-site to suit the site configuration. Unless otherwise indicated on the drawing, the Contractor shall identify a suitable route for this piping. Acceptance from the Employer is required before installation can proceed.

8.4 Buried Piping

All buried pipes outside the well pad areas shall be at least 1 m below the finished ground surface

The Contractor shall provide a protective coating for all metallic pipes to be buried.

All buried steel pipes shall be adequately protected against corrosion by an approved Denso tape, Polyken tape or equivalent system. The Contractor shall submit their proposed system and procedures for site application for the Employer's review and approval.

The protective coating shall be applied preferably in the factory prior to stringing the pipes along the pipe route except that site joints shall be wrapped in situ. There shall be at least 25 mm overlap when wrapping around pipes.

All protective coatings shall be applied and inspected in accordance with the Manufacturer's specification.

The bed on which buried pipe is to be installed shall be covered with a layer of sand or stone-free soil, and

backfill shall be similarly free of stones and/or sharp objects.

8.5 Pipe Bends

Standard long radius pipe elbows shall be used to make bends in the pipeline. Where the bend angle is too shallow, generally when the adjacent girth welds in large diameter pipes are less than 100 mm apart at the closest point, a mitre joint shall be used in accordance with the requirement of the code.

Unless agreed with the Employer, all elbows shall be long radius bends (1.5D radius). Dimensions shall be to ASME B16.9 and butt-weld ends to ASME B16.25.

Welded fitting material shall comply with ASTM A105, ASTM A106 Grade B or ASTM A234 Grade WPB

All trimmed elbows shall have one factory machined beveled end, i.e. each standard pipe elbow cannot be used to make more than two bends in the pipeline.

No other fabricated bends shall be used without written approval from the Employer. Piping along common routes shall run parallel to one another.

Where necessary to fabricate bends and offsets in piping less than DN 100, they shall be hot bent. The temperature shall be sufficiently high throughout the operation to prevent cold stressing of the metal and the pipes shall be sand-filled to help prevent distortion. All aspects of the hot bending process shall comply with the requirements of ASME B31.1.

Higher values may be approved by the Employer in special applications or in intermittent or emergency conditions. Approval shall be in writing.

Notwithstanding the maximum velocities permitted above, the noise levels in the pipework systems shall comply with the appropriate clauses of the specification.

The CONTRACTOR shall take all necessary measures to limit noise in accordance with the latest developments in technology.

If this requirement cannot be met by adequate construction of the pipework and valves concerned, sound absorbing housing or insulation have to be provided

Process design shall avoid erosive and damage to pipe due to wet steam erosion.

8.6 Traps, Drains and vents

The CONTRACTOR shall provide all traps, drains and vents which are called for in this specification or which are necessary for plant operation, line or plant filling or warming through.

Drains and vents from different systems, or parts of systems operating at widely differing pressures, shall not be interconnected.

All horizontal pipework shall be graded generally in the direction of flow for draining and venting as appropriate.

Drains shall be provided on low points for all lines. All low point drains shall be provided with a valve. All drains shall be sized to provide adequate drainage under all start-up and operating conditions. The minimum drain size is DN 50 for the main process geothermal lines.

Vents shall be provided on high points for all lines. All high point vents shall be provided with a valve. The minimum vent size is 40 mm for the main process geothermal lines. Manual vents and drains shall be provided for gas venting and warm through purposes.

Drains are to be installed at all obstructions, flow orifices shall have an internal drain and vent.

High point vents and low point drains provided solely for hydro testing shall be plugged with a threaded plug on completion of testing.

All vents, drains or dump points with more than 25 bar operating pressure are to be lead to flash tanks and into funnels at visible points with covers.

Drains and vents shall be fitted with two valves, one suitable for regulation at full pressure. Venting/draining facility shall be provided between two valves or an equipment and valve in steam system to enable depressurization before maintenance.

All vent and drains valves on steam service shall be provided with a dual valve combination with a master valve to allow replacement of the normally operating valve on line.

Clearance shall be provided in the direction that drain valves point on geothermal lines to enable rod-out (Hot-tap) of a plugged valve on pressurized lines and atmospheric drain lines.

All sample port connections on steam and geothermal water lines that are used for process control or for protection purposes shall have a roddable full-port isolation valve.

Drawings or documents shall provide details on materials for instrument connections, drains and vents on the piping detail drawings.

Instrument, sample, drain and vent valves shall be in accordance with the line class and instrument type of the piping.

Instrument, sample, drain and vent valve details shall be included in the manual valve list.

8.6.1 Drain pots and steam traps

Drain pots and steam traps shall be installed on all steam lines in appropriate locations to drain all condensate during start-up and normal operation. Each condensate drain pot shall have a manually operated low point DN 50 drain and a steam trap for condensate removal.

Drains shall be from condensate collection pockets attached to the steam lines, of adequate size and form to intercept condensate in the main steam flow and to allow solids washed into the drip leg to settle.

The use of orifices in place of steam traps may be permitted for special applications which are ill-suited to steam traps, such as where the condensate is heavily contaminated with gases or salts.

For steam plant, where it is appropriate, steam traps shall be provided. The type of trap for each duty shall be carefully selected for the particular service conditions, including the pressures and temperatures, maximum condensate flow and range of condensate flows to be encountered, likely frequency of operation, and quantities of gases likely in the steam or condensate, and the implications of failure of the particular trap. Steam trap provision shall not be limited to one trap supplier, if a single supplier is unable to provide all the different types of traps necessary to match the various plant duties.

The application of steam drain and trap arrangements shall include appropriate provisions for any

necessary venting of gases, and to minimize the risk of corrosion in the drained pipes or vessels.

Each steam trap shall be fitted with a bypass and all necessary isolating valves so that the trap may be taken out of service without blocking the drain point.

All steam traps are to be lead to flash tanks and shall be bypassed by means of a free drain led to a funnel.

Drain pots shall be baffled and have provision for cleaning out.

All steam traps shall be provided with a double isolation system from the steam line. The second isolator shall allow maintenance on the trap, while the first one is for isolation of the trap bank. All steam traps sets shall be provided with a strainer directly upstream of each steam trap (or integral to the trap) and a valve bypass.

Steam traps shall have unitized steam trap banks. The system shall be designed so that steam trap maintenance can be safely performed without having to take the bank out of service.

There shall be ASME flanges after the first isolator and at a convenient downstream point so the entire trap bank, with bypass, can be changed as a unit if necessary.

The isolation valve to each individual steam trap shall be an ASME flanged connection or a break flange shall be provided to allow the steam trap to be removed without unscrewing.

8.7 Pipe Supports and Anchors

Pipework shall be supported and anchored in an appropriate manner in accordance with the provisions of ASME B31.1 or the Standard to which the pipework is designed.

Steel sections for standard pipe supports shall be installed by the Contractor. Unless shown on the drawings, the design of the pipe support shall be submitted to the Employer for review.

Supports shall not be dependent for flexibility on the flexure of supporting rods or straps. Supports shall be positioned before the pipe has been erected and near to valves wherever possible. Supporting straps around flanges or welded joints will not be accepted.

The CONTRACTOR shall ensure that the piping systems meet the requirement of ASME B31.1, latest edition, with respect to thermal expansion & flexibility.

Where it is required that the comprehensive stress analysis be taken, these systems should be analyzed for the following conditions:

Pipe (and equipment) cold with full account being taken of cold spring incorporated in the line and due allowance being made for the dead weight of the piping. Tabulate maximum cold terminal reactions, Pipe on racks and in the trenches should not rest directly on structures. They shall have independent supports. Teflon or similar sheet should be used between two stub plane.

All supports shall be provided with means of adjusting the tension of springs, the height of supports and the length of rods or straps. All such adjusting devices shall be capable of being securely locked.

Parts of supporting elements which are subjected principally to bending or tension loads or working temperatures for which carbon steel is not recommended, shall be made of suitable alloy steel or shall be protected so that the temperature of the supporting member will be maintained within the appropriate

temperature limits of the material.

The supporting arrangements of all pipework systems shall be designed with due regard to any additional loads imposed during hydraulic or hydrostatic leak testing, and cleaning and steam blowing operations.

Particular attention shall be paid to sliding surfaces in guides and sliding supports and to the springs employed in variable and constant load supports.

Pipe supports shall be galvanized.

Where necessary, constant load supports shall be provided. The CONTRACTOR shall take all necessary precautions to ensure that the piping shall be free from vibration.

Outdoor piping support systems shall be designed to withstand the environmental conditions described elsewhere in this specification. Spring supports shall not be used.

The CONTRACTOR shall prepare, and include in the plant operating and maintenance manuals, pipework layout or other similar drawings marked to show the position of every pipe support on all high pressure pipework, and any pipe DN 80. Each of the supports marked on these drawings shall be assigned a unique plant reference number by the CONTRACTOR. The CONTRACTOR shall prepare, for submission to the Employer/Engineer before erection, and for inclusion in the operating and maintenance manuals, a schedule of all these supports. The support schedule shall, as a minimum, state the support reference number, the type of support, the directions of freedom of movement, and the magnitude and direction of pipe movement from the cold installed to the hot operating conditions. A spring support schedule shall also be provided to the Employer/Engineer and included in the operating manuals, which as a minimum, states the support reference numbers, the spring rates, the hot operating load, and the magnitude and direction of travel from the cold installed to the hot operating conditions.

8.8 Floor Collars Wall Boxes and Weather Hoods

At all points where pipes pass through concrete or other similar floors and walls, suitable floor collars or wall boxes shall be provided under this Contract.

The floor collars shall have raised kerbs of suitable height, which shall not be less than 75 mm. The wall boxes shall be flush fitting and of neat design and approved finish.

The CONTRACTOR shall provide all necessary fittings for the passage of pipes through external walls and roofs, together with the supply of all necessary components for weather proofing or vermin proofing. Wherever possible, service pipes running adjacent to each other shall pass through a common box. Where pipes of varying bore pass through a common box, a neat "fill-in" cover plate shall be provided between the pipes and the box.

In the case of flanged pipework, boxes shall be large enough to permit the passage of the flange.

Weather hoods shall be provided at the open ends of all upward facing, atmospheric exhaust or vent pipings.

8.9 Pipe Terminations and Connections

The CONTRACTOR shall co-operate fully with other contractors and the Employer/Engineer to establish agreement on the jointing technique at terminal points.

All pipe terminations and connections shall be proofed by the CONTRACTOR. It is the CONTRACTORs obligation to attention (inform) the Employer/Engineer to all relevant system shortcomings.

All pipe connections shall be fusion welded except where flange connections are required or specified to facilitate erection or maintenance or where pipe materials used preclude welding.

Screwed pipework will only be permitted for pipes of less than DN 50 in non-critical air or water services.

Screwed joints on instrument air lines shall be made using Teflon tape seals. Below DN 25 connections may be compression type couplings in positions where leakage will not introduce any hazard and the type of coupling and particular application has been approved by the Employer/Engineer.

Pipework flanges shall comply with the requirements of the code to which the pipework is designed. Flanges having ratings less than 10 bar g will not be permitted except where agreed with the Employer/Engineer.

All plastic pipe flanges shall be in accordance with standards issued by ISO/TC 138. Jointing material, bolts, nuts and washers shall be provided where necessary for flanged pipes, valves and fittings supplied under this Contract. Bolts, studs, nuts and washers are to be galvanized unless otherwise approved by the Employer/Engineer.

Jointing of thermoplastic piping shall be carried out in strict accordance with the manufacturer's recommendation.

Flexible joints flange adapter coupling type suitable for the piping material shall be used within the valve pit to facilitate valve removal during maintenance.

Fibre glass pipes shall be used for both drinking and service water throughout the station, i.e. under ground, above ground. Inside the building reference is made to **Section VI part D** "Civil Works". Demineralized water piping shall be stainless steel 316L.

8.9.1Piping at vessels

Valves at vessels should be installed at the vessel nozzle provided that access via a platform or ladder is available. Otherwise the valves should be located at the first available platform or ladder.

Relief valves shall be located so as to be accessible from a platform. Relief valves shall be installed in the vertical upright position and arranged for convenient removal and handling.

Piping shall be arranged and supported in such a way that no stress due to the piping itself be transmitted to the nozzle of the machine as well as valves can be easily removed at vessel for maintenance.

All vessel manholes shall be hinged type. The minimum size of manholes shall be diameter 600. Above manholes, hand grip frames shall be provided inside and outside.

All manholes shall be fixed in easily accessible places and free from any disturbances along the manhole cover and provided with all arrangement to facilitate easy removal.

8.9.2 Piping at heat exchangers

By proper arrangement of the piping system and its supports it shall be ensured that joints to be disconnected for maintenance are a minimum when removing the shell or the tube bundles. Clearance for using a mobile

or portable type handling equipment shall be provided, if required by the weight of the equipment.

Piping shall be arranged, or check valves shall be provided in such a way that in case of a power failure the waterside of the heat exchanger will not be drained.

Each heat exchanger shall have its own drain and vent valves on both sides of the exchanger.

The piping connected to the nozzle shall be designed taking into account the necessity of being able to insert blind flanges for hydrostatic testing.

Cooling water shall flow upwards and piping shall be set so that in case of water flow shutdown the equipment remains full of water.

8.10.3 Piping at pumps & compressors

Piping shall be so designed that forces and moments transmitted to the

equipment through connecting piping do not exceed the permissible limits specified by the equipment manufacturer and shall be so arranged that the equipment can be dismantled or removed without adding temporary supports or dismantling the shut off valves. Piping shall be so designed and arranged that free headroom and clearances are provided for the removal of the equipment by use of mobile equipment. Clearances around equipment shall facilitate maintenance or local repairs.

Chain wheels or extension stems are not permitted for valves adjacent to pumps. The piping system shall principally be designed to permit easy hand operation from grade or platforms. Valves 50 mm and smaller shall not be chain-operated.

Pump suction lines shall be designed so that there are no vapour pockets. In case of horizontal reduction at the pump inlet an eccentric reducer shall be used and positioned in such a way that the upper inside wall remains on a horizontal plane to avoid cavitation. Principally all pumps shall be equipped with permanent suction strainers. However, duplex strainers are to be provided wherever and whenever required as specified. Strainers shall be located as close as possible to the pumps suction between suction nozzle and the shut off valve.

The piping shall permit removal of strainers by removal of the spool piece. Enough clearances shall permit installing blind flanges against the block valves for lines handling hazardous fluids.

Piping at centrifugal and/or screw compressors shall permit opening of compressor casing for inspection and for removal of compressor rotor, and shall be so arranged that the compressor can be temporarily piped up to blow out the suction line with service air.

Particular attention should be paid to the piping arrangement for reciprocating compressors. Piping manifolds shall be designed to distribute gas equally to the cylinders and to minimize vibration.

8.9.4 Piping for instrument connections

All connections and root valves on piping systems for instruments, thermocouple wells, test wells, alarms, gauges, and flow elements shall be easily accessible from a permanent platform except as noted below.

Where the area below flow elements, thermocouples/thermo wells, test wells, gauges and transmitter

is clear of obstructions and permits the use of a 3.8 m step-ladder and neither the transmitter nor the centre line of the flow element exceeds 4.8 m above finished grade, permanent platforms will not be needed.

The minimum size of root valves (primary isolating valves) shall not be less than DN 25. For gas services (not steam) ball valve type shall be used.

8.10 Internal Cleaning of Pipes

The Contractor shall ensure that all pipelines shall be thoroughly cleaned of all scale, corrosion and consumables remaining from construction operations.

This cleaning is required to be completed prior to any tie-in procedures, to ensure that a minimum of debris is required to be removed from the pipes during the commissioning procedure.

Cleaning may be undertaken by power cleaning or water blasting or, air or steam blowing. The level of cleanliness and the cleaning procedure shall be provided to the Employer for review.

The cleanliness of the piping will be checked during the Tests on Completion Tests.

Steam lines shall be cleaned to a level appropriate for the supply of steam to a geothermal steam turbine. The Employer will provide this standard to the Contractor. The Contractor shall propose a cleaning methodology involving steam blowing/purging complete with target bar testing to demonstrate compliance with the steam cleanliness standard provided by the steam turbine manufacturer.

The procedure adopted is to include the following and may be more specifically described elsewhere in the specification.

a. Compliance with clauses 1.11 and **Part 6** of this specification relating to packing and marking, galvanizing and painting.
b. Thorough cleaning of all internal surfaces prior to erection to remove accumulations of dirt, rust, scale, and welding slag due to site welding before erection.
c. Prior to, and during erection, all parts shall be inspected to make sure that they are clean, and adequate steps shall be taken to prevent entry of foreign matter both during and after erection. Each section erected shall be cleaned out before being connected into the previous section. All headers shall be cleaned before closing up.
d. Thorough cleaning of all pipework after erection by blowing through to atmosphere with steam or flushing with water. In the case of high temperature pipework, a cycle of heating, cooling and blowing or flushing is to be repeated several times to ensure that any remaining Slag or scale which would otherwise become loosened during service, is removed before commissioning.

The CONTRACTOR is to provide all necessary facilities in the pipe system for carrying out the requirements of item (d) including any temporary pipework, valves and supports.

8.11 Underground Pipework

All underground pipework shall be designed in order to withstand the loading from covering soil as well as from traffic. DIN 1072 SLW 60 shall be applied.

Underground piping systems shall be self-anchoring, i.e. no thrust blocks for loadings resulting from test and operation pressure are permitted except in specific areas where partially encased thrust blocks may be provided as reviewed case by case.

The outside insulation of such pipework has to be selected in order to withstand the prevailing highly corrosive conditions. The water conditions are described in the general project requirements.

All steel underground pipe work shall be protected by wrapping or similar to prevent external corrosion. All underground pipe routes shall be indicated by above ground markers to the satisfaction of Employer/Engineer.

The Employer/Engineer reserves the right to ask for a cathodic protection system wherever deemed necessary in addition to the insulation proposed by the CONTRACTOR.

Where guiding tubes or sleeves for penetrations such as through building walls, walls or dikes of tank farm, etc., of steel are practicable, such material has to be supplied and proper sealing and outside protection carried out by the CONTRACTOR.

Underground piping should be avoided to allow easy operation/ maintenance. Water, steam and condensate pipes, which are laid underground, shall be run in trenches with enough space for easy maintenance.

Underground pressure piping systems should be grouped and routed together whenever possible and a minimum distance of 250 mm should be allowed between pipe walls and from trench bottom. Lines of various diameters grouped together shall be laid so that the bottom of the pipes is at the same elevation.

When lines connect to mains, use the 45ϟ top take-offs wherever possible. Where infringement of the frost line could occur by connecting to top of mains, connect to the bottom instead and route line back up to the elevation described above.

All risers from underground lines coming above grade shall terminate with a flange 300 mm above high point of finished surface to facilitate testing. Flanges shall be according to Aboveground Material Technical Specifications. Consideration should be given to terminating the underground line at the block valve of nearby heat exchangers, coolers, condensers, etc., in which case the 300 mm terminal elevation may be waived.

Consideration should be given to route the underground pressure piping systems along with general routing of sewers. Keep in mind clearances required should repairs to the sewer systems be necessary.

Necessary clearances between underground piping systems and electrical instrument cable runs, especially when the two cross over each other shall be provided.

Underground lines requiring metering, shall be designed so that the line can either be brought up out of the ground and the flow element installed above grade in an area where the flow element is accessible, or else a concrete box for access to the flow element. The form and reinforcement drawings including bar bending diagrams and rebar lists shall be prepared by the CONTRACTOR for execution by the Civil CONTRACTOR.

Valves in underground piping systems shall be located where practical above ground. When valves are located underground, the valve shall be preferably installed in a concrete box or suitably constructed enclosure, which will permit packing around the valve with suitable materials to prevent freezing. An extension hand wheel shall be provided to extend a minimum of 300 mm above high point of finished

paving or ground. In areas where the underground valve is located within vehicle driving areas, the access to the valves shall be provided with a suitable cover plate and an extension hand wheel (removable type) located in the vicinity at pipe way column, structure side of building, etc. Valve pits shall be of adequate size and readily accessible for inspection, testing, maintenance and removal of equipment. Suitable flexible joints shall also be provided for easy removal of the valves.

Sufficient funnels and leads at equipment to permit drainage shall be provided.

Main runs of underground lines shall be DN50 minimum. Sizes smaller than DN50 are only allowed for stub-up for instrument connections, vents, drains, etc.

The underground pipe route shall be indicated by above ground markers. Underground piping systems shall be fully self-anchoring, i.e. no thrust blocks for loading resulting from test and operation pressure are permitted.

8.12 Glass Reinforced Polyester/Epoxy Pipes (GRP/GRE)

8.12.1 General

This specification covers the minimum requirements for fiberglass filament wound piping.

The piping systems materials covered in this specification are:

Material Type	Maximum Service Temperature [°C]	Service Pressure [Bar]
Glass Reinforced Polyester	60	10 bar to full vacuum
Glass Reinforced Epoxy	110	32 bar to full vacuum

Fabrication Methods

Pipe shall be manufactured by the glass filament winding process using the specified thermosetting resin to impregnate of closely spaced continuous glass filaments around a straight mandrel at a predetermined pattern and under controlled tension as described by ASTM D 2996 (Standard Specification for Filament Wound Reinforced Thermosetting Resin Pipe).

Unless otherwise agreed the following fabrication methods shall be applied for the different products.

Manufacturers Pre-qualification

GRE, GRP pipe and fittings shall be manufactured by an established pipe Manufacturer in a purpose-built facility for the production of such materials. The Manufacturer shall have at least 10 years' experience at the facility in the production of the full range of pipe diameters (25 - 3700 mm) pipe, fittings and related products. Evidence of previous experience shall be presented to the main Project CONTRACTOR during the bidding stage. The Manufacturer shall have an approved Quality Management System complying with ISO 9001 and 9002.

8.12.2 Codes and standards

The following internationally accepted standards are the minimum requirements for the manufacture of GRE and GRP Pipe Systems and should be referenced throughout the Project Specification where appropriate.

AWWA C950 Glass Fibre Reinforced Thermosetting Resin Pressure

(Latest Edition).

ASTM D2310 Standard Classification for Machine-Made "Fiberglass" (Glass-Fibre-Reinforced Thermosetting- Resin) Pipe

ASTM D2996 Standard Specification for Fiberglass Filament Wound

Pipes

BS 14364 Plastics piping systems for drainage and sewerage with or without pressure. Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP). Specifications for pipes, fittings and joints

BS 1796 Plastics piping systems for water supply with or without pressure. Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP)

ASTM D3517 Specification for Glass Fibre Reinforced thermosetting resin pressure pipe.

AWWA M45 AWWA Fiberglass Pipe Design

8.12.3 Basic technical requirements

8.13.3.1 Wall structure

GRE/GRP pipe shall be machine-made filament wound pipes consisting of a corrosion resistant liner, a structural wall and a resin rich exterior layer.

Resin-rich inner liner (corrosion barrier)

The interior wall of the filament wound pipe (sometimes called the liner or internal corrosion barrier having an approximately thickness of 1.5 to 2.0 mm) shall be constructed so as to have a smooth, resin-rich surface. This surface shall not contain dyes or fillers which can hider visual inspection. The innermost 0.5 to 0.8 mm surface shall be reinforced with one or two highly corrosion resistant veil of "C" glass. This first surfacing layer of Inner Liner shall contain approximately 90% of resin material.

The remainder of the liner 1.0 to 1.2 mm shall consist of 75% of resin and may incorporate two layers of 450 g/m2 powder bound "E" glass chopped strand mat having a glass content between 25 and 35% by weight on the equivalent of chopped strand "E" glass depending on the method of manufacture.

Structural Wall

The structural wall shall be as specified in AWWA C950 for Grades 1 to 4. Aggregates may be used within the stiffening layer, for the purpose of achieving the design stiffness.

The filament wound structural wall shall be free of fillers and shall contain no silica sand, glass microspheres, longitudinal glass tape or dispersed chopped material.

Structural filament reinforced shall be provided with minimum 65% by weight of continuous glass filament wound pipes and not less than 60% for continuous filament wound pipes.

External Layer

Pipe shall have a 0.01" (0.25mm) thick resin rich exterior surface layer.

A resin-rich post coat, identically constructed as the inner liner, must be applied to the external surfaces of all of the RTR-piping system components, all external surfaces shall be able to resist the anticipated corrosion imposed by the service and ambient conditions.

Reinforcing Ribs

Where stiffener ribs are used to structurally reinforce the pipe wall, they must be protected in the same manner as specified for the external surface above. In addition, effects of strain in the outermost surfaces of the ribs must be determined in accordance with **Section VI Part A** (General Project Requirements) of this specification.

8.12.3.2 Materials

All materials and the manner and degree to which they are used during the construction of all components required for the RTR-piping system described by this specification shall be selected so that:

They will resist the corrosive effects of both the contained and surrounding environments as described in **Section VI part A** (Site Conditions) of this specification.

All structural materials shall be new and free from all deleterious defects and imperfections and only be used for production after having been controlled and approved by the Manufacturer's Quality Department.

Testing and controlling shall be done according to the relevant methods, as described in **Section VI part A** (Inspection and Testing) of this specification.

Design for the above ground pipes shall consider coatings for UV protection and internal Algae growth prevention.

Thermosetting Resins

The resins to be used are as follows (dependent upon system type and operating conditions):

Polyester: Isophthalic Resin meeting BS 3532 type B.

Vinylester: Epoxy based Vinylester Resin

Epoxy: Aromatic or Cyclo-aliphatic amine cured Epoxy Resin

The final selection of resin manufacturer and grade of resin shall be made on the basis of their proven resistance to the transported medium at similar service conditions and environments.

A written statement from the resin manufacturer shall be submitted for approval by the Employer/Engineer stating that the resins and catalysts being furnished will perform satisfactorily for the duration and service conditions specified for the pipeline; providing the resin is mixed and applied in accordance with the written instruction furnished to the CONTRACTOR.

Curing Agent

The curing agent shall be an aromatic or cyclo-aliphatic type. The choice of the curing agent type depends on the application of the RTRP-system and the fabrication method.

Fillers

Resin fillers, as defined in BS 14364 and BS 1796, are not allowed.

The resin shall not contain fillers except as required for viscosity control or fire retardation. The limit of filler addition shall be 5% by weight of thixotropic agent which will not interfere with visual inspection.

The structural wall may include silica sand for pipe having a pressure up to

1 bar.

Where aggregates are used, they shall be 98 % pure, round edge silica sand, complying with the requirements of BS 14364 and BS 1796.

Glass

Glass Reinforcements shall be compatible with the impregnating resin used. Resins used shall be a commercial high grade thermosetting Isophthalic, Epoxy based vinylester or Epoxy type as specified under clause above.

No dark pigments shall be used in the GRE / GRP pipe or joints. No resin additives shall be used except when required for viscosity control.

AS reinforcement of thermosetting resin two types of glass shall be used with a low alkali content. The glass reinforcement materials shall be dry stored and protected against dust or other negative influences.

C-glass shall be used as reinforcing material for the chemical resistant inner liner. This type of glass shall appear in the form of a fleece with a surface weight of 25-50 g/m^2 and shall be provided with a special finish to assure a good adhesion with the resin.

E-glass shall be used as reinforced material for the mechanical resistant layers. This type of glass appears in the form of roving as woven cloth. Roving shall be used in the filament winding process for the production of pipes and elbows.

Woven cloth shall be used for the production of fittings and as local reinforcement of all products. The glass shall be provided with a special finish to assure a good adhesion with the resin.

Roving used in the structural wall shall not exceed 4800 Tex.

The reinforcing glass fibers used to construct the components shall meet the requirements of:

BS 14020 "Reinforcements. Specification for textile glass rovings"

BS 14118 "Reinforcement. Specifications for textile glass mats (Chopped strand and continuous filament mats)"

BS 3396 "Woven glass fibre fabrics for plastic reinforcement"

BS 3749 "Woven glass fibre rovings fabrics for the reinforcement of Polyester resin system"

8.12.3.3 Dimensions & Technical Data

All GRP/GRE-pipe described will be identified by its diameter as measured between the inside wall surfaces of the pipe (ID). This normal inside diameter identification will be sued for the pipe sizes beginning at 100 mm and up to 3,000 mm or grater. Unless otherwise specified, the length of any single section of pipe shall not exceed 18 m overall.

Wall Thickness

Pipe systems with DN < 2500 shall be of the solid wall type (unribbed). The wall thickness required for each size / pressure class shall be established by the Manufacturer to meet the design requirements but in no case shall the wall thickness be less than (0.010 x ND); where ND is the nominal pipe inside diameter, in millimetres.

Length

GRE (Standard L = 3 for DN =< 80, 10 Meters for DN >= 100) and GRP pipe (Standard = 6, 11.85 or 12 Meters) shall be manufactured in standard laying lengths not greater than 12 meters. Random short lengths, if supplied, shall not exceed 5% of the quantity supplied. The tolerance on the Manufacturer's declared laying length shall not exceed ± 25 mm.

Diameters

Pipes shall be manufactured either in standard metric outer diameter sizes, or based on the nominal diameters.

The actual inside diameter shall not vary from the manufacturers declared inside diameter by more than 0.5 % or 3 mm whichever is greater.

Stiffness

The pipe stiffness shall be determined by the Manufacturer to meet the design requirement with particular regard to installation method, burial depths, deflection limits, buckling and vacuum requirements. The pipe stiffness shall be in no case be less than 2500 N/m², when tested in accordance with AWWA C 950 or BS 14364 and BS 1796.

The maximum burial depth per stiffness class shall be as follows:

Burial Depth m	Stiffness N/m^2	Type of Backfill
up to 6.0 m	2500	Sand / Gravel
up to 8.0 m	5000	Sand / Gravel
up to 10.0 m	10000	Sand / Gravel

Axial Strength

The piping system components connected by a thrust resistant joint shall have a suitable axial tensile strength to resist the piping full axial thrust load generated at direction changes and dead ends.

Hoop Tensile Strength

GRE / GRP pipe systems shall meet the minimum hoop tensile strength requirements specified in AWWA C950 for the appropriate operating pressure class. However, the structural wall hoop tensile stress for pressure pipe shall not be less than 120,000 KN/M2 when tested in accordance with AWWA C950 or BS 14364 and BS 1796.

8.12.3.4 Design data

The CONTRACTOR shall be responsible for implementing / installing the correct design for each pipe system. Pipe design calculations shall be submitted to the Employer/Engineer for review and approval.

Buried GRE / GRP pipe design shall be established in accordance with AWWA C 950 and AWWA M 45 manual "Fiberglass Pipe Design". Above ground (self-restrained, tensile resistant) GRE and GRP pipe design shall be established in general accordance with ASME Code Case N-155-2. Support requirements for complex above ground piping systems shall be based on computer flexibility analysis (static and dynamic) of the piping systems.

Pipe shall meet the following **minimum** design requirements:

Design Pressure: full vacuum to 10 bar (g) for pressure application

Gravity for gravity application

Surge Pressure: 40% of design pressure unless otherwise specified.

Design Temperature:

As specified on DWG's, but not more than:

- 60°C for Isophthalic / Isophthalic resin
- 110°C for Epoxy / Epoxy resin

Safety Factors:	Pressure rating	>=	1.8
	Ring bending strain (stress)	>=	1.5
	Combined strain (stress)	>=	1.5
	Buckling	>=	2.5

Maximum allowable fluid velocity: 3.00 m/s

Modulus of Elasticity at 23 °C

Hoop Direction (ASTM D790): 24,131.7 N/mm2 (3,500,000 psi) Axial Direction (ASTM D638): 12,410.6 N/mm2 (1,800,000 psi)

Hardness – Barcol (ASTM D2583)

The laminated surface shall have Barcol hardness of at least 90% of resin

Manufacturer's minimum specified hardness for the cured resin.

Contact-moulded fittings, specials and weld overlay

Minimum physical properties for hand lay-up laminates shall conform to accordance with the following ASTM test method:

- Ultimate Tensile Strength: ASTM D638
- Flexural Strength: ASTM D790
- Flexural Modules of Elasticity: ASTM D790

Filament wound laminates

Determination of maximum allowable strain

HDBS Test Method: refer to ASME B31.3, A302.3.2

A service design factor of 0.33 shall be applied to the Hydrostatic Design

Basis (HDBS) stress obtained per ASTM D2992 Procedure B to determine the hydrostatic design stress and maximum allowable stress for the design of RTRP components.

- Coupon Testing Method

Accelerated flexural strain using coupons taken from similar constructed pipe samples of at least 75% of the required maximum size for the project. The indicated safety factors shall be applied to the strain to procedure first crack by ASTM D790 testing using strain gauges.

Max. Allowable strains at 23°C

By test methods (1) or (2), the maximum allowed combined strain shall not exceed:

Pipeline Specs.	Normal Design	Transient Design
Geothermal Condensate	0.0018 mm/mm	0.003 mm/mm

Note: For elevated temperature services, the allowable design stresses must be reduced based on the physical properties of the specific resin/glass laminate at that temperature.

Deflection capability

The pipe with or without ribs shall be capable of diametrical deflections per method ASTM D2412 of 15% min. without structural wall interlaminar separation or cracking or liner cracking or crazing.

Contact-moulded laminates

Allowable stresses for the design of the contact-moulded RTRP components and joint overlays shall incorporate the same safety factor as the adjacent pipe but, as a minimum, shall be equal in strength to the adjacent pipe.

The allowable stresses for the elevated temperatures shall be qualified for the specific temperatures.

The pipe with or without ribs shall be capable of diametrical deflections per method ASTM D2412 of 15% min. without structural wall interlaminar separation or cracking or liner cracking or crazing.

Additional requirements for buried pipes:

Minimum earth cover for buried pipe.	1.0 m
Initial Installed deflection for buried pipe	1.5 %
Long term installed deflection for buried	3 % Maximum for ribbed pipe
pipe	5 % Maximum for solid wall pipe

8.12.3.5 Requirements for GRP pipes for special systems

8.12.3.5.1 Sewage system

For sewer systems, corrosion resistant glass of the type "ECR" shall be used throughout the wall laminate, along with vinylester resin in the liner and isophthalic resin in the structural wall, either with or without aggregates.

8.12.3.5.2 Firefighting system

For firefighting systems, the resin used shall be epoxy, and the piping components manufacturer shall be Factory Mutual approved and listed. The approval certificates shall be submitted for Employer/Engineer's review.

8.12.3.5.3 Potable water system

All GRP / GRE pipes and fittings conveying potable water shall be certified and listed for potable water use by the Water Research Centre "WRc" – United Kingdom, in accordance with BS 6920, or by the National Sanitation

Foundation (NSF) – USA, in accordance with NSF standard 14.

8.12.4 Joints & fittings

8.13.4.1 Joints

The requirements applicable for the various types of joints are as follows:

a. Rigid Joints

These joints are self-restrained (tensile resistant) and shall not require thrust blocks at direction changes.

b. Adhesive Joints

Adhesive bonded joints with epoxy adhesives shall be used for GRE pipes with sizes up to and including 600 mm in diameter. The epoxy adhesive shall be supplied by the pipe Manufacturer in accordance with the operating requirements. In areas where flexibility is required rubber seal lock joints may be used.

c. Reinforced Overlay Joints (butt & wrap)

Butt & Wrap joint where used shall consist of layers of Glass fibre reinforcement impregnated with isophthalic, epoxy based vinylester or epoxy resin. The wall thickness, tensile and axial strength of the reinforced overlay shall meet or exceed the design strength of the adjoining pipe sections. Butt & Wrap joints on site shall be performed only by or under the supervision of the pipe Manufacturer. The joints shall be tensile resistant and suitable for use above or underground with no thrust blocks.

d. Flanges

GRE / GRP flanges where used shall be machine filament wound. Contact moulded flanges may be used for sizes 2000 mm and larger. Flanges shall be manufactured with Isophthalic, Epoxy or Epoxy based vinylester Resin. Flanges shall be flat faced with full and / or 'O' Ring type gaskets. Gasket material and design shall be as per the Manufacturer's recommendations. The pipe Manufacturer shall provide the torqueing sequence and maximum tightening torque as appropriate for each flange size and design and should at least be present in a supervisory role during the torqueing of all flange connections. Washers shall be used under all nuts and bolts heads with special spacers to be used at flange to valve connections as required. Flange drilling and rating shall be as specified on the drawings. Flanged joints shall be tensile resistant for above ground service.

e. Flexible Joints

- Standard buried GRP pipe unrestrained joints shall be filament wound coupling, with confined rubber ring gaskets. Rubber rings shall be of natural rubber conforming to BS EN 681 or ASTM F477 for sea water service, and synthetic rubber for other services. Neoprene rubber shall be used for oil contaminated services. Joints shall allow for at least 0.75 degree deviation while remaining water tight at 1.5 times the pipe operating pressure. The rubber rings shall be the sole element depended upon for water tightness. This system will require non encased thrust blocks at changes in direction to accommodate thrust loads.
- Rubber Seal Locked Joints may also be used for pipes up to 600 mm in diameter. This system is fully restrained and requires no thrust blocks at changes in direction.
- All of the joint types given above shall be designed to remain watertight when tested after installation to 1.5 times the pipe line pressure for a minimum of one (1) hour.
- For design qualification of tensile joints, the joint when assembled in accordance with Manufacturers written instruction shall withstand a hydraulic test pressure of 3 times the working pressure with no seepage or leak for 60 seconds. End closures shall apply the full end load due to pressure on the pipe (or fitting) specimen being tested.
- Field adjustment joint to be of the double bell coupling or reinforced overlay type.

8.12.4.2 Fittings

Fittings subject of this specification are 11° 15°, 22° 30', 45° and 90° elbows, concentric reducers, 45° laterals, tees, flanges, adaptors and couplers.

All specials and fitting required for bends, branches, closures and connections shall be at least equal in performance to the pipe of the same classification.

Fittings in the diameter range up to 300 mm are filament wound, using preimpregnated roving tape (woven cloth), which will be applied onto the outside of a mandrel in a predetermined pattern under controlled tension. Elbows in the diameter range from 100 mm up to 300 mm can also be manufactured by filament winding of continuous fibrous glass stand roving. In the diameter range up to 300 mm the following fitting shall be standard available: 45° and 90° elbows, concentric reducers, 45° laterals, tees, flanges, adapters and couplers.

For the fitting up to 300 mm the inside diameter (ID) is fixed by the mandrel outside diameter.

The outside diameter (OD) of the fitting is determined by the amount of material that is wound on the mandrel. Fitting in the diameters ranging from 350 mm up to 3000 mm are manufactured from pipe parts which are fitted together first and then wrapped round with pre-impregnated woven cloth.

RTRP-"Sweep" form fitting 610 mm diameter and smaller such as elbows and special configurations that require compound curves shall be fabricated by filament winding or by the open moulding method.

Elbows, tees, laterals, crosses, etc. shall be fabricated by the joining of mitered sections of filament wound pipe of the necessary diameter by means of resin/fiberglass overlays and shall be structurally sound for thrust momentum and deflection forces and discontinuity stresses.

The use of steel for part of these fittings will not be permitted. The tolerance from the stated value on the angle of change of direction of a bend, tee or junction shall be 2 degrees. The tolerance on the effective length of fitting quoted by the CONTRACTOR shall be 50 mm.

8.12.5 Marking

Each pipe and fitting shall be indelibly marked with the following information.

- Manufacturers Name or trademark
- Manufacturing date
- Manufacturing number
- Nominal diameter in mm
- Operating pressure in Bar
- Nominal laying length in meters (for pipe only)
- Manufacturers Inspection mark

8.12.6 Document submittals

The following information shall be submitted with the Manufacturers

Proposal.

- GRE / GRP Pipe Data Sheet (s)
- Detailed Resin Data
- Detailed Glass Reinforcement Data (curing agents, flexibilisers, other additives, etc.)
- Detailed Joint & Gasket Data.
- GRE / GRP Pipe Manufacturer's Pre-Qualification
- Manufacturer's ISO 9001 Certification

In addition to the above, the following shall be submitted during the detail engineering period:

- Detailed manufacturing process for pipe, joints and fittings.
- Detailed drawings for pipe ends, joints and fittings.
- Complete pipe design calculations for each Diameter/ Pressure.
- Friction loss factors pipe and fittings.
- Details of pipe and fittings, weights and standard pipe supports
- Manufacturers Quality Assurance Manual.
- Inspection and Testing Program (ITP).
- GRE / GRP pipe Manufacturers written handling, storage and installation instructions.
- Proposed hydrotest method statement.
- Proposed pipe transport procedures
- Flexibility analysis report for the above ground piping

8.12.7 Transport, storage & installation

The CONTRACTOR shall submit the pipe Manufacturer's Installation Manual and associated Data for Clients review upon Contract Award. A site meeting to including the client, the CONTRACTOR and

Manufacturer is to occur within two weeks from Contract Award to clarify any outstanding issues / questions on the given installation procedures.

GRE / GRP pipe shall be handled, stored, transported and installed in strict accordance to the Manufacturer written instructions.

The pipe installation procedures and practices chosen shall meet the design requirements specified.

No stacking of pipe larger than 1.8 m in diameter shall be allowed on site or during transport.

The CONTRACTOR shall employ on a full-time basis the services of field representatives from the pipe Manufacturer throughout the pipe off-loading, storage, installation and testing period.

8.13 Valves

8.13.1 General

All valves shall be suitable for the service conditions under which they are required to operate, including continuous geothermal service. The design, construction and choice of materials shall take into account all operational deviations including pressure surge and thermal shock.

All valves shall have platform or movable platform for operation and maintenance. Necessary handling facility shall be available for each valve.

It shall be the responsibility of the CONTRACTOR to ensure that all aspects of design, fabrication, inspection and testing conform to the applicable and specified codes, standards and specifications.

Valve trim materials for steam service generally should be of the same material as the pipelines with stellite sealing rings and seats; all other materials should be dimensionally stable over the operating temperature range. Where the valves include the use of stellite or other hard facing material to the valve seats, there shall be a differential hardness of not less than 50 and not more than 100 Brinell between fixed and moving seats, with the harder material on the fixed seats. Valves having a back-seating facility are preferred, particularly in critical positions.

All valves shall be flanged. Valves less than DN 50 may be screw or socket weld fitting subject to acceptance by the Employer.

All valves shall be provided with materials certificates and pressure test certificates. Where ISO 15156:2002 requirements apply a certificate of compliance is also required.

Unless otherwise specified, the bodies of valves shall be forged or cast steel. Gun metal or cast iron valves shall not be used.

Isolating valves for steam services should normally be flexible wedge gate type.

Valves operating under sub-atmospheric conditions shall be with glands and seating rings water sealed. All necessary sealing water header tanks and piping shall be provided under this Contract. Where temperatures permit, use may be made of diaphragm or "pinch-type" valves which do not close due to atmospheric pressure.

Diaphragm valves shall be used for services carrying chemicals or aggressive fluids, and also for salt water services.

Any valve which is designed for uni-directional flow shall have an arrow embossed or cast on the valve body clearly indicating the required flow direction.

All valves, unless otherwise approved or specified, shall be of the external rising spindle type. Where desirable to protect the spindle against ingress of dirt, or where the position of the valve may create a hazard to operators when the spindle is extended, suitable spindle covers shall be provided. The spindles and operating gear of all valves for use outdoors shall have weather and dust proof protection.

Any gear or bevel wheels used to transmit motion shall be of cast steel or approved quality cast iron with machine cut teeth. No thrust from the valve shall be transmitted to the extension spindles and valve pedestals shall not be mounted directly on floor plating. Any floor steel work trimmers for supporting pedestals shall be provided by the CONTRACTOR.

Special attention shall be given to the operating mechanism and correct lubrication of all valves to ensure a minimum of maintenance and ease of operation.

All valves shall be positioned so as to be readily accessible for operation and maintenance from permanent floors, galleries or access platforms.

Any valve at the end of a service shall be suitable for isolation, or shall be provided with an upstream isolation valve.

All valves shall be able to be rendered inoperable by locking for the permit system.

As far as practicable any maintenance or replacement of wearing parts shall be possible with the valves in situation, but for valves with connecting branches of less than 50 mm nominal bore full access to moving components only will be accepted. The seats of all steam valves shall be accessible for machining for purposes of reclamation or repair.

Eyebolts or similar facilities shall be provided, where necessary, to facilitate the handling of heavy valves or components.

No valve shall be installed with its operating spindle gland below the horizontal centre line so as to avoid dirt entering the gland and to ensure complete drainage.

When valves are required to be locked in position for operation they shall be provided with an approved locking system on the spindle (no chain) and with a master key system.

The internal diameter of all valves at the ends adjacent to the pipes shall be the same as the internal diameter of the pipe to which they are joined. Valve internal diameter shall follow the ASME B16.34 and/or valve maker standard. Subject to Employer/Engineer's approval during detail engineering phase.

All valves shall be provided with labels or nameplates. These labels shall include in the inscription a valve "name", or abbreviated description of the valve duty, and a unique plant reference number for the valve. Within 12 weeks of award of Contract, a valve numbering scheme to cover the complete Contract Works shall be agreed. After approval of the numbering scheme, the CONTRACTOR shall draw up a valve schedule to cover the Contract Works. The scheduled details of each valve shall include the valve number, its title as it appears on the valve label, the nominal size of the valve, its design pressure and temperature, the Manufacturer's name and model number and a brief description of the valve materials. The valve schedule shall be subject to Employer/Engineer's approval. The finalized valve schedule shall be included in the operating and maintenance manuals, provided under this Contract.

Where a modulating valve in high-pressure service has a full-flow emergency by-pass, the latter shall also be capable of modulating duty.

The valve bonnet size shall be such that all surfaces of the valve shall be accessible for repair, lifting, weld surfacing and seat replacement.

All tools needed to lap and seat replacement and repair shall be provided. Valves, which need gears due to

high differential pressure, are to be fitted with spur or bevel gears.

All valve stems shall be adequately protected with grease at all times to avoid corrosion

Valves in piping are located and shown on the drawings so as to be operable from normal working areas and platforms. Hand wheels shall be oriented accordingly. Unless specified otherwise on the drawing, butterfly valves shall be installed with the valve shaft in the horizontal position.

Valves installed in "site-run" piping shall be located so as to be easily accessible from ground level or from walkways and platforms. Butt and socket welded valves shall be in the closed position when welded into pipelines and shall remain closed until the valve has returned to ambient temperature.

8.13.2 Hand operation requirements

Where required, valve spindles shall be lengthened so that the hand wheel shall be at a height approximately one meter above the level of the floor or platform from which the valve is to be operated and where necessary they shall be provided with headstocks and pedestals of rigid construction. All thrusts when opening or closing the valve shall be taken directly on the valve body. Pedestal hand wheels or valve tables shall be provided at a convenient operating floor or intermediate floor level. Such pedestals and valve tables shall be mounted direct on floors or steel members and not on floor grills or plating.

All valve hand operating mechanisms shall be easily operable by one man. The mechanisms shall be such that the total force at the rim of the handwheel or other point of application of manual action shall not need to exceed 400N (normally 200N pull plus 200N push) to exercise any valve of handwheel diameters up to 400 mm and 800N for those above 400 mm.

For limiting hand wheel forces, for control and operation purposes it may be necessary to install gears and drives.

Special attention shall be given to the operating mechanism for large size valves with a view to ensuring that a minimum of maintenance is required and to obtaining quick and easy operation.

All gate, globe and screw down non-return valves shall be of the non-rising hand wheel pattern unless specifically approved by the Employer/Engineer.

All valves shall be closed by rotating the hand wheels in a clockwise direction when looking at the face of the hand wheel. In cases where the hand wheel is not directly attached to the valve spindle suitable gearing shall be introduced to ensure clockwise closing. The face of each hand wheel shall be clearly marked "open" and "shut" or "closed" with arrows indicating the direction of rotation to which they refer.

On all hand-operated valves, where the hand wheels are liable to be dangerously or uncomfortably hot to operate with the naked hand, suitable heat insulation shall be provided on the rims and spokes. Plastic valve hand wheels will not be accepted. All valve spindles shall be fitted with indicators so that the valve opening can be readily determined. In the case of valves fitted with extended spindles, indicators shall be fitted both to the extended spindles and to the valve spindles.

8.13.3 Control valves

Control valve manifolds shall be accessible from either ground or permanent platforms.

Control valve manifolds shall be as per approved arrangement including clearance for removal of actuator case, plug and stem.

Control valve manifolds shall be adequately supported to avoid pipe loads or moments being transmitted to the control valve.

Control valve manifolds located in pipe lines on pipe ways and which cannot be brought down to ground due to process reasons, may be located above and to the side of the pipe way and provided with a walkway or platform.

Control valve manifolds are preferred at ground wherever possible and shall be located along building walls, or adjacent to equipment. They shall be kept clear of operating aisles and working spaces. Where practical, they shall be grouped along pipe way supports with sufficient clearance for maintenance.

Control valve manifolds located in buildings shall be arranged along the walls or beside pumps in a manner, which will not impede operation or maintenance of pumps or other equipment.

Control valves operated by liquid level controller shall be preferably located so that the gauge or level indicator can be read from the control valve location. If this is impractical, a level indicator shall be provided at the control valve.

Control valves shall be so arranged that the control valve can be removed without damaging the flanges. Piping around control valves shall provide enough clearance to permit removal of the control valve flange bolts. Control valves (C/V) installed on piping DN 400 and below shall be provided with manual isolation valves upstream and downstream and a bypass valve of the same characteristics to allow C/V maintenance with the system in operation.

Control valves up to DN 200 shall be designed of the same nominal diameter – or maximum one nominal diameter less than – the associated pipe. Control valves above DN 200 shall be designed of the same nominal diameter – or maximum 40% of nominal diameter less than – the associated pipe. Subject to Employer/Engineer's approval during detail engineering phase.

When the pipeline fluid is viscous or contains sediment, slurry, fines, etc., the by-pass valve shall be installed in a horizontal position above the control valve, so that deposits cannot build up in trapped lines.

Local pressure gauges shall be provided at the upstream and downstream of each control valve. Further specific requirements for control valves are contained in **Section VI Part C Chapter 7.**

8.13.4 Gate valves

Gate valves shall be full-bore configuration. Bolted bonnets are required with outside stem and yoke. Glands with replaceable packings are to be used. Packings shall be non-lubricated PTFE. Body trim seat and wedge gate to be stellite hardface, body seat rings, stem and small internal parts in contact with geothermal fluid to be 13Cr. Gate valves are to be fitted with generous hand wheels and to use a non-rotating rising stem so that the status of the valve is obvious from the stem position.

Gate valves should be such that the bore of the fully open valve is obstructed by any part of the gate.

Gate valves sized DN 400 or larger are to be fitted with a geared hand wheels and where pressure equalizing valves are required, they are to be supplied and fitted with a DN 50 pressure equalizing valve

8.13.5 Check valves

Check (non-return) valves are to be full-bore swing check valves. Springs and pins are to be 316 stainless-steel where in contact with geothermal fluids. The direction of non -restricted flow is to be indicated by an arrow on the outside of the valve

8.13.6 Pressure relief valves

Geothermal site standard is to use rupture discs rather than safety valves for geothermal fluid applications. If a Pressure Safety Valve is used in contact with Geothermal Fluid it shall have a rupture disc installed under it with a rated pressure the same as the valve set pressure. An excess flow valve and pressure gauge shall be installed on the rupture disc top holder.

Pressure safety relief valves shall be of the balanced bellow type and ASME certified.

They shall conform to API 526, API 527, ASME B16.5, B16.10 and B16.34 as required, unless accepted otherwise. The disc in the valve shall be positively guided and self-aligning.

The bonnet spring chamber shall be isolated from the process fluid and where open easing lever is specified, it shall have gland packing to seal the spring chamber from the outside.

The Contractor shall ensure that the relevant vendor's painting system for the valve shall be to the vendor's standard and shall be suitable for the outdoor corrosive geothermal environment. The painting system shall be submitted to the Employer for review. The set pressure of each valve shall be set and sealed in the factory.

8.13.7 Rupture discs

Rupture discs shall be used as emergency relief devices for geothermal steam/gas/brine.

Rupture discs shall be installed without a safety valve. A manual isolation valve shall be provided to enable rupture disc replacement on-line.

The disc holder assemblies may be suitable for sandwich mounting. The discharge aperture shall be the same nominal diameter as the flanges.

Rupture discs and holders shall be suitable for exposure to geothermal fluids and the discs manufactured of Inconel 625. The Contractor shall supply 3 spare, uninstalled, rupture discs for each holder installation.

The holder assembly shall be manufactured from 316 stainless steel on both, inlet and outlet, sides. The rupture discs shall have the rupture pressure at the specified temperature marked on the discs.

Rupture discs shall be of the reverse buckling type with a scored surface to give a bursting tolerance of 5% and shall be capable of withstanding a pulsating service of 15,000 cycles up to 85% of disc rated pressure. Discs shall also withstand full vacuum conditions. Bursting disc arrangements shall be designed for workshop assembly and be selected such that incorrect assembly and mounting cannot occur.

The Contractor shall supply bursting discs with zero manufacturing tolerance, notwithstanding the above bursting disc bursting tolerance (of ±5%).

Manufacture, testing, certification and marking of discs and holders shall conform to ASME VIII, Division I.

8.13.8 Pressure reducing valves

Reducing valves shall be of approved type and shall be perfectly stable, quiet and vibration less in operation when pressure-reducing at any throughput up to the maximum flow and shall be suitable for continuous use at the operating conditions.

Where electrical or hydraulic valve operation is included the operating mechanism shall be remote controlled. On failure of the operating mechanism the valve shall neither lose nor open automatically but shall be readily adjustable by hand.

A pressure relief valve shall be provided on the outlet side of each reducing valve, capable of exhausting to atmosphere the maximum discharge of the reducing valve without undue build-up of pressure on the LP side. The discharge from the relief valve shall be led to safe approved target. Pressure gauges and thermometers shall be provided upstream and downstream of the reducing valve.

8.14.9 Butterfly valves

Butterfly valves shall have flanged bodies. Where the disc of a butterfly valve requires significant thickening to provide adequate stiffness a through- flow (low loss) design is required.

The actuator/manual gearbox shall be mounted direct to the valve body, other than where both actuator and body are fitted with feet for pedestal mounting; no actuator loads shall be transmitted via the pipe work. The valve should be mounted with spindle set horizontal. If the valve is designed for unidirectional flow, an arrow shall be cast or embossed in a prominent position on the valve body to indicate that direction.

The valve must be capable of positive shut-off in both directions against full system pressure. Unless an alternative type is proposed by the CONTRACTOR and approved by the Employer/Engineer as being fully suitable for the particular duty, the seating of the disc shall be positive (that is, the disc must not be capable of passing through the shut position); a stop fitted on the actuator/operating lever is not adequate for this purpose.

Unless the CONTRACTOR can demonstrate that some alternative design is capable of adequate long-term sealing, the design shall be such that the shaft is offset from the seal ring (that is there shall be an unbroken peripheral seal when the valve is shut).

If the valve body is rubber (or elastomer) lined, the lining should be made by a self-containing and replaceable inlet, unless otherwise approved by the Employer/Engineer.

Internal shaft bearings must be capable of operating dry, that is, not dependent on the presence of the pumped fluid.

8.13.10 Non return valves

The design of non-return valves shall preclude the possibility of the valve jamming in the open position; the effect of solid particles settling-out in dead spaces within the valve should be recognized in this respect.

Unless stated to the contrary, non-return valves should be rapid- closing. Power-assisted closing is acceptable where necessary for rapid shut-off. For large non-return valves on air and water services, consideration shall be given to the consequences of valve slam and the possible requirements for a hydraulic snubber to minimize slam effects.

8.13.11 Power operated valves (general requirements)

Valves, dampers and similar devices requiring abnormal physical effort to operate or high speed operation, shall be provided with powered actuation. Hand operating equipment shall also be fitted for closing and opening, which is effectively decoupled during power operation.

Electric actuators shall be used for all actuated isolation valves.

Electric actuators for on/off duties shall be fitted with travel limiting devices capable of accurate and positive adjustment. Torque limiting or other devices shall be provided to prevent damage to the mechanism in the event of jamming of the driven device.

All powered valve or damper mechanisms shall be provided with accurate indication of the position of the driven device. External limit switches shall be proximity limit type.

Electrically operated devices may be provided with integral or separate switch/ control equipment in accordance with the requirements of the control and instrumentation specification. Provision shall be made for the inclusion of interposing relays and volt free contacts to suit modern control systems, including digital control systems. Fieldbus shall not be used for electrically operated actuators.

Power supply shall be in conjunction to the particular requirements of the control and instrumentation specification.

Direct solenoid operation of valves shall comply with the control and instrumentation section of the specification.

Reversing contactors and limit switches, used to control electric power driven mechanisms, shall be robust and of proven reliability by both type test and commercial operation. Solid state switching may be accepted when temperature conditions permit.

8.13.12 Control valves

Control valves shall be sized to operate between no more than 70% open at the normal flow, or 80% open at the maximum flow, whichever is greater, and no less than 40% open at the normal flow.

Where necessary shaft bearings shall have lubricating nipples installed to allow on-line bearing lubrication using standard pressure lubricating equipment. The Contractor shall ensure that the relevant vendor provides acoustic trims and other accepted means to reduce vibrations and noise during valve operation to the levels indicated in the data sheets.

The Contractor shall ensure that the relevant vendor states any requirements on pipe and piping layout for optimum operation of the type of control valves offered.

The valves offered for liquid service shall have a smooth flow path in order to minimise the risk of deposition of solid materials that may be carried with the fluid.

All valves shall have a cast carbon steel body (ASTM A216-WCB) and

Stellite seats and trim.

All electronics, accessories and attachments shall be suitable for vibrations generated by fluid flowing through the valves.

Lubrication nipples shall be installed on the top and bottom shaft bearings of all rotary valves. Control valve

seats shall be replaceable.

8.14 Requirements for Piping Components & Valves (Pipe Classes)

Piping classes shall be provided by the CONTRACTOR.

Pipe and valve class grouping, KKS code, design temperature, design pressure, rating and pipe wall thickness shall be selected in accordance with the plant data.

For each system under this Contract the CONTRACTOR shall submit detailed comprehensive pipe and valve specifications for approval as per requirements described in technical specification. In case of contradictions the stronger requirement will prevail.

9.0 THERMAL INSULATION

9.1 General

Thermal insulation of pipe work and equipment shall comply with the relevant recommendations of BS 5970 and BS 5422. All insulation material offered shall be in accordance with BS 3958 or equal Standard as applicable with regard to definition, physical characteristics and tests.

All portions of the plant which have an exposed surface and, during normal operation, run at temperatures of 59 degrees C and above, shall be insulated.

The thickness of lagging applied shall be such as to reduce the heat losses to economic levels. Unless otherwise stated the required thickness shall be

such that, with a still air temperature of 20 degrees C to 35 degrees C, and if appropriate screened from solar gain, the surface temperature of the lagging insulation material proper before the application of finishing material or paint shall not exceed the temperature of 59degrees C, but subject to Employer/Engineer's approval during detail engineering phase.

In addition to insulation provided to reduce heat loss to economic levels, insulation, or other measures (such as guards) which the CONTRACTOR may propose and the Employer/Engineer approve, shall be provided for purposes of personnel protection. The following surface temperatures measured with an air temperature not exceeding 30degrees C and where appropriate with a sun- screen to limit solar gain, shall not be exceeded:

a. Non-metallic surfaces within reach from a permanent working level without the use of portable access equipment, 59degreesC maximum.
b. Metallic surfaces within reach from a permanent working floor level without the use of portable access equipment, 55degreesC maximum, but subject to Employer/Engineer's approval during detail engineering phase.
c. Metallic and non-metallic surfaces at higher levels but within reach from ladders or any portable access equipment, and where access is possible, 50 degrees C maximum, but subject to Employer/Engineer's approval during detail engineering phase.

These requirements for personnel protection are based on the guidelines contained in BS 5970.

Thermal insulation shall be applied to equipment, plant, and piping operating at temperatures below the maximum dew-point where condensation could form to the detriment of plant structures or equipment or

cause discomfort to operating personnel. Low temperature thermal insulation shall be completely sealed to

prevent moisture water-logging.

All insulation materials shall be vermin proof, non-hygroscopic, free of sulphur, chemically inert when both wet and dry, and fire resistant. Under no circumstances shall asbestos or asbestos-containing materials be used. Insulation materials shall be calcium silicate for all pipework, with thermal wraps or blankets for valves and areas where calcium silicate is inappropriate.

The insulation shall provide mechanical strength against denting and buckling suitable for use in an operating steamfield with large animals present. Calcium Silicate is proposed for this reason.

Insulation materials required for insulation of stainless steel pipes and equipment shall have chloride content less than 0.15%.

The minimum thickness of the thermal insulation is 25 mm, but subject to

Employer/Engineer's approval during detail engineering phase.

The insulation mats must be regular in shape, chemically inert, free of sulphur and alkali, rot proof respectively.

For applications where insulation dust could be introduced into food for humans or animals, magnesia insulation, free of man-made mineral fibres, shall be used.

All insulation joints are to be staggered and any cavities between joints are to be filled with a suitable material of similar composition to the main insulation.

All insulation external to buildings shall be weather and waterproof. All insulated horizontal flat surfaces shall be cambered to prevent the formation of puddles and to shed water.

Within 2 months of award of Contract, the CONTRACTOR shall submit to the Employer/Engineer a schedule of thermal insulation for all pipework, vessels and other mechanical plant, and the cladding or sheathing of the insulation, and which shall summarize the CONTRACTOR's proposals. This insulation schedule shall include, as a minimum all the requirements of this clause of the specification and describe the CONTRACTOR's proposals for meeting the specification requirements, detailing the materials to be used, the proposed methods of application and finishing.

9.2 Methods of Application

During the application of heat insulation the CONTRACTOR shall protect adjacent plant, buildings and floors from damage. The plant shall be covered with dust sheets or other protective coverings. The CONTRACTOR shall make good any damage at his own expense.

The insulation shall generally be installed in accordance with the recommendations of BS 5970 unless specified otherwise within this specification.

Piping and equipment shall be clean, dry and free from grease, dirt, loose rust or scale before application of insulation materials.

Longitudinal seams shall not be located at the top of the pipework cladding. Longitudinal seams shall be overlapped to prevent the ingress of water. Drain holes shall be installed in each cladding section. Circumferential swage shall be used to prevent tracking of water inside cladding.

On vertical or near vertical piping all insulation shall be supported in position by means of metal rings, part rings, studs, or cleats at intervals of

950mm and above each expansion break in the insulation. The insulation supports should not penetrate the insulation more than is absolutely necessary for reliable support purposes.

On flat or large curved surfaces, the insulation material shall be supported by cleats or similar attachments welded or screwed to the surface being insulated. The average spacing of the cleats shall be:-

For vertical surfaces $450mm^2$

For upward facing surfaces $600mm^2$

For overhanging and downward facing surfaces (maximum) square spacing $300mm^2$

Preformed materials shall be used for the insulation of pipework but where the pipe size is too large for this to be practicable, suitable mats shall be used.

The insulation mats shall be stuck to galvanized wire mesh using galvanized steel wire. The mesh size shall be approximately 19mm.

The insulation blankets shall be stitched in position longitudinal and circumferential by wire of 1mm diameter. The wire material shall be galvanized.

Where flanges and flanged valves are to be insulated the pipework insulation shall be terminated short of the flanges to enable easy withdrawal of the flange bolts without damage to the insulation.

A hole of approximately 7.5mm diameter shall be formed in the insulation adjacent to flanges extending from the joint to the outside so that any leakage which may occur will be quickly apparent.

Thermocouple pocket bosses, pressure tapings shall be fitted with removable boxes or sections.

A vapour barrier in accordance with the recommendations of BS 5970 shall be provided for all surfaces on equipment operating below ambient temperatures.

9.3 Finishes and Appearance Cladding

Metal cladding shall be provided to give a neat, smooth external finish and to protect the insulation of all pipe work, ducting, vessels and casings.

Where insulation is in an outdoor application special attention shall be paid to the provision of weather resistant finishes, and finishes shall, as a minimum, comply with the recommendations of Section 28 of BS 5970.

The cladding material shall be finished in a green coloured camouflaged pattern similar to that on the recent steamfield projects at Olkaria.

The fixing of the cladding shall be such that it shall not be blown away with the strong gusts of wind. The cladding material, the support and the fixing materials shall be corrosion proof. If different materials are used galvanic corrosion must be avoided.

Metal cladding shall be of aluminium or galvanized steel unless otherwise agreed by the Employer/Engineer. Galvanized steel shall be employed at any point where frequent or severe mechanical loading or damage is likely to render aluminium unsuitable. Metal cladding shall be of thicknesses not less

than those required by Table 7 of BS 5970, but also not be less than the following:

Outer Insulation Diameter	Cladding Thickness
Up to 350 mm	0.75 mm
Above 350 mm	1.0 mm

Apparatus, ductwork, tanks shall be covered with 1.2mm thick metal cladding. Areas where workmen occasionally walk over shall be provided with insulation strong enough to support a man's weight. The insulation layer in this region shall consist of a material to withstand walking on such as for example a calcium silicate or similar material. The CONTRACTOR shall identify such areas and include this in his insulation schedule.

The cladding shall be arranged in conveniently-sized sections and shall be shaped to suitably stiffen the sheets, allow for thermal expansion and to give a good appearance. Suitable framing shall be provided to which the sheeting shall be secured where necessary for its satisfactory support.

The arrangement of metal cladding shall be such as to minimize electrolytic corrosion, in the light of the corrosion risks on the site and in the positions of the particular parts of the metal cladding. Unless otherwise agreed by the Employer/Engineer, galvanized mild-steel cladding shall be secured with galvanized mild-steel, or austenitic stainless-steel attachments, and aluminium sheets with aluminium or austenitic stainless-steel attachments.

The material employed for metal cladding shall be fully compatible with the insulation. Unless completely inert due to the choice of cladding material, or the cladding having a factory-applied coating, the inner surfaces of all metal cladding shall be protected with a suitable bitumastic or other paint.

Insulation finishing shall where appropriate, include arrangements to allow the escape of moisture trapped within cladding or other finishing. The cladding shall be watertight, self-draining and arranged at all inspection ports, doorways, etc. so that small sections can be easily detached for maintenance purposes. Plant items requiring maintenance access shall be provided with insulation cladding arranged in easily removable sections.

Valve and pipe flange insulation shall be enclosed by aluminium or galvanized steel boxes. These boxes shall be in minimum of two halves to facilitate removal for inspection or maintenance without disturbing the insulation or sheathing on adjacent piping.

All finish material shall incorporate provision for differential thermal expansion between the finish and the insulated surface. Where slots are cut to permit expansion, the ingress of dust or dirt is to be prevented by the use of straps or masking pieces to cover the slots.

10.0 ALIGNMENT OF BEDPLATE MOUNTED PLANT AND EQUIPMENT

All rotating equipment shall after installation and before running have its alignment and where necessary any important internal clearances checked and corrected as required.

Where rotating plant is mounted on bedplates approved packers of a total thickness of 6 mm shall be provided between the driver feet and the bedplate to allow accurate alignment of the driven and driving parts.

In order to facilitate the lining up of large and heavy units equipped with unit bedplates, jacking screws or other suitable facilities arranged to provide axial and transverse movement of the driving unit shall be incorporated.

The CONTRACTOR shall carry out the levelling and adjustment of the plant on the civil foundations, before the plant is secured in position by suitable non-shrink grouting.

The CONTRACTOR shall make records of the alignment, levelling or positioning measurements and shall maintain such records until his activities at site are concluded. Where large and complex plant is installed on extensive foundations a datum shall be established to check for any future movement or settlement of foundations.

11.0 LOCAL CONTROLS

The Contractor shall provide sufficient local controls to allow for the safe operation of the plant. Where local presence is required for the operation, starting, stopping, testing, or isolation for regular maintenance, local controls shall be provided.

12.0 PRESSURE VESSELS

All vessels shall be designed, constructed and otherwise comply with ASME VIII Div. I, or an appropriate international or national pressure vessel design code approved in writing by the Employer.

Should any difficulty arise in the decision as to whether a particular vessel shall comply with a pressure vessel code, the vessel shall be "coded" unless specifically excluded in clause U- 1 of the US ASME Boiler and Pressure Code, Section VIII, Division 1, dealing with the scope of that code. All pressure vessels shall be certified by an independent Approval Authority like e.g. ASME, TUV, LLOYDS, etc., for the design and manufacture.

The welding factor for all pressure vessels shall be $V_N = 1.0$

Connections shall be provided for all pipe work, together with connection and tapping points for instrumentation.

Manholes, drains, relief valves and any access stairways and handrails necessary for safe operation and easy maintenance shall be provided.

The pressure vessel shall be designed for full vacuum even if vacuum breakers shall be installed on the vessel.

Atmospheric vessels are containers that have a constantly open connection to the atmosphere (no valve must be installed in this connection) and which remain under atmospheric pressure in all operational situations.

The atmospheric vessels shall be designed and manufactured as pressure vessels according to the design condition of the connected pipe systems.

For atmospheric vessels, unless otherwise stated the minimum wall thickness shall not be less than 10 mm. The connecting pipe to atmosphere shall be dimensioned so that even under unfavourable operating

conditions, no internal pressure or vacuum can be build up.

In addition to the nozzles necessary for the process technology additional items as quoted below shall be provided in minimum:

- One (1) or two (2) manholes depending on the standard requirements and vessel size,
- Two (2) spare nozzles of nominal bore to be specified by the Engineer,
- One (1) drain nozzle,
- One (1) temperature nozzle,
- One (1) level indicator local.

All nozzles shall be provided with flanges and shall be so arranged that a sensible pipe arrangement is possible. The stub length for all stub pipes shall be at least 200mm, measured from the tank wall to the flange sealing surface. In the case of insulated vessels, the length shall be chosen so that there will be a clear space of at least 100mm between the cover of the insulation and the underside of the flange.

Where atmospheric vents are provided, they shall be dust and vermin proof. Manhole covers of nominal diameter 500mm and larger shall be provided with swinging arms.

Bearer plates shall be made of the same material as that from which the tank is manufactured. Horizontal vessels/tank shall be supported by welded on steel saddles. Longitudinal expansion of the vessel because of the effect of heat shall be taken into account. Therefore, one saddle shall be fixed and the other designed as a sliding support. The matching counter plates of the sliding supports, which shall be connected solidly to the structure of the building, shall be supplied and installed by the CONTRACTOR.

The saddle plates to be welded to the vessel/tank shall be of the same material as the vessel/tank. Care shall be taken to ensure that the plate is welded on with a continuous seam.

All measuring and control equipment shall be provided as per the appropriate table of instruments for each vessel. A minimum requirement is that each vessel/ tank shall be equipped with a local level indicator that can be shut off. In addition, all the measuring points and alarms necessary for safe operation shall be provided by the CONTRACTOR.

All pressure vessels/tanks shall be provided with a manufacturer's name plate which is easily visible. This plate shall provide the following information at least:

a. Manufacturer's name or manufacturer's symbol
b. Serial number
c. Year of construction
d. Capacity in cubic meters
e. Maximum allowable operating pressure
f. Test pressure
g. Identification number in accordance with the plant classification system
h. Description of the vessel itself.
i. Design temperature
j. Weight

SECTION VI PART C: TECHNICAL REQUIREMENTS

ELECTRICAL EQUIPMENT

1. GENERAL

1.1 General Design Requirements

The plant/equipment shall be designed to ensure continuity of operation under all working conditions at the site as the first consideration and to facilitate inspection, maintenance and repairs. All reasonable precautions shall be taken in the design of equipment and of the works, to ensure the safety of personnel concerned with the operation and maintenance of the works.

The rated frequency of the system is 50 Hz.

The requirements of the **Kenyan Grid Code** shall apply.

Wherever the requirements in this specification are in conflict with any of the requirements in other sections of the contract the specification having the most stringent requirement shall be governing.

Materials and equipment for use should work efficiently and with high level of reliability with special consideration to:

a) Ambient weather conditions
b) Dust storms
c) Fire risk and flooding as a result of fire protection
d) Direct/indirect solar radiation
e) H_2S content in the atmosphere

Outdoor equipment shall be designed so that water cannot collect at any point. The undersides of all tanks shall be ventilated in an approved manner to prevent corrosion.

All kiosks and cubicles shall be fitted with controlled door operated internal illumination lamps and shall be adequately ventilated to prevent condensation.

All kiosks and cubicles shall be fitted with controlled anti-condensation heaters. Anti-condensation heaters shall be designed to operate at 240 V AC. A thermostat shall be provided to monitor the internal temperature of the switchgear or cubicle.

Cast iron shall not be used for the chambers of oil filled apparatus or for any parts subject to mechanical stress.

Mechanisms shall be constructed to prevent sticking due to rust and corrosion, and the bearings of exposed operating shafts shall be designed so as to prevent moisture seeping along shafts into the interior of equipment.

No welding, plugging or filling of defective parts shall be carried out without the prior sanction in writing of the Engineer.

Corresponding parts of similar equipment, and equipment liable to renewal, shall be fully interchangeable and the Contractor will be required to demonstrate this feature to the Engineer's satisfaction.

All equipment shall operate without undue vibration and with the least practical amount of noise.

All equipment shall be designed to minimize corona or other electrical discharges.

All electrical equipment shall be type and routine tested in the factories. Type tests will not be repeated if type test certificates of identical or similar ("similar" according the definition of IEC) equipment and for the same frequency (50 Hz) are available. The type test certificates shall in English language and shall certify that the type test is according to IEC Standards.

All electrical components shall be adequately rated for their most onerous duty and the specified ambient temperature. When equipment is mounted in panels, cubicles etc. due account shall be taken of any heat generated by the equipment therein and the components shall be appropriately selected, rated or de-rated as necessary to suit the most onerous operating temperatures within the enclosure.

Where electrical equipment is located within a designated hazardous area, it should have a minimum degree of protection against explosion suitable for that area classified as per IEC 60079.

The following kind of labels shall be used:

a) Name and rating for main equipment (motors, transformers, etc.) All labels and markers shall be of stainless-steel plates with engraved black letter and with inscription in English.
b) Name and rating for process and auxiliary equipment. These labels shall be of stainless-steel plates with engraved black letter and with inscription in English for rating and name plates.
c) Inscriptions for indoor cubicles, cabinets, boards and panels. These labels shall be of white hard plastic plates with engraved black letter and with inscription in English.
d) Inscriptions for outdoor cabinets, boards and panels. These labels shall be of stainless-steel plates with engraved black letter and with inscription in English.

1.2 Environmental Considerations

H_2S may be present around the site at concentrations up to 5 ppm. Concentrations above 0.3 ppm are unacceptable for exposed copper conductors, and concentrations down to 0.1 ppm have adverse effect on silver-plated connectors and conductors. Rapid tarnishing of these and other materials occurs in this atmosphere. Consequently:

- Switchgear and electronic equipment shall be located only within air- conditioned rooms or enclosures supplied with air under positive pressure from which the H_2S has been removed.
- The only exceptions to this are the individual items of equipment with only a single function having an IP rating of IP 67 (to IEC 60529) or better, and TEFC electrical motors.

- No equipment including bus-bars, links, terminals, fittings, circuit breakers, contactors, relays, contacts and the like, is to be made in whole or in part of silver, nickel-silver, copper, phosphor bronze, brass or other copper or silver alloy, unless hermetically sealed or tin plated to a minimum thickness of 0.002 mm, or otherwise suitably plated. Cadmium plating shall not be used for any purposes including screws and fastenings.
- All circuit boards shall be effectively conformal coated, e.g. epoxy encapsulated or be tinned and lacquered, except over gold-plated areas used as connectors. The lacquer shall be applied to both sides to protection protect against hydrogen sulfide, humidity and dampness. The lacquer used shall be inert to attack from fungi, bacteria, atmospheric

conditions, and sunlight (including UV component), and shall have proven suitable and stable properties for at least 15 years maintenance- free service under the conditions specified.

- Where copper conductors are used they shall be epoxy heat shrink encapsulated or tinned on exposed sections.
- Except for earth conductors which shall be copper, aluminum cabling is to be used in preference to copper, with bi-metallic cable lugs.
- HV insulators shall be suitable for Very Heavy pollution level according to IEC 60815.

Although some equipment may be located in air-conditioned areas, it shall be suitable for operation for sustained periods without the benefit of the air conditioning. Maximum design temperature shall be based on the maximum ambient temperature plus all temperature rises that can occur as a result of heat gains, flows and dissipations that may affect the installation area.

All enclosures shall comply with the requirements as given in this section.

2.0 STANDARDS

The design and manufacturer of all electrical equipment shall comply with the latest editions of the IEC Recommendations. Compliance with ANSI/IEEE/NEMA standards will only be accepted in case no applicable IEC standards are available.

In case an IEC Regulation or ANSI/IEEE/NEMA standards does not exist or cover the Scope of Works, National Standards, at least equivalent to German VDE Standards or British (BS) shall be applied. In such a case, the Contractor shall provide the Engineer with two sets (official, complete, unabridged and in the English language) of all relevant standard specifications according to which the equipment is manufactured for approval.

The requirements of the **Kenya Grid Code** shall apply.

For interfaces with Kenya Grid the related standards/requirements shall apply.

In case of conflicting requirements amongst any of the specified standards, the standard having the most stringent requirement shall be governing.

3.0 VOLTAGE REQUIREMENTS

The requirements stated in the latest edition of the Kenya Electricity Grid

Code shall apply.

The following voltage levels are pre-assigned and shall be used in the project:

Voltage	Item	Star point/Neutral treatment
220 kV, 50 Hz	connection voltage to the public grid	Solidly, grounded

11 to 15.5 kV, 50 Hz	generator voltage, depending on manufacturers standard	According to manufacturer's standards
6.6 kV, 50 Hz	voltage for motors equal to/bigger than 200 kW and for power distribution within the new plant	Medium resistance to be decided on S/C and ground fault study during detail design engineering
3.3 kV, 50 Hz	Interconnection voltage to existing unit 4 and 5 and the Steamfield distribution grid.	Medium resistance to be decided on S/C and ground fault study during detail design engineering
240/415 V + 10%, 50 Hz	standard voltage for power supplies to • small electric power consumers and motors below 200 kW • lighting and domestic power	Solidly grounded
110 V DC, + 10%, - 15 %	Voltage for instrumentation and emergency users of electricity, like turbine emergency oil pumps, circuit breaker control, inverters switchgear and HV substation control	Ungrounded
240 V, ± 10%, 50 Hz	Uninterrupted voltage supplies to consumers, which require uninterrupted infeed like DCS components, control actuators etc. below 15 kVA	Solidly grounded
24 V DC (20 V to 30 V)	for power supplies to the DCS system	To be defined by Contractor

4.0 PROTECTION FOR SAFETY

4.1 General

In view of the potential dangers of electrical power, the following measures are required for the protection of life, equipment and materials. Basically, all 'live' parts, i.e. all parts of electrical, operational equipment at an electrical potential above or below earth potential when in operation, and with a rated voltage over 24 V, must be insulated or covered so that they cannot be touched accidentally.

In addition, measures must be taken by the CONTRACTOR to prevent the occurrence or persistence of

excessively high contact potentials on conductive parts of electrical operational equipment (frames etc.) brought about by faults in insulation.

For installations up to 1000 V, voltages over 50 V are considered to be excessive contact voltages. Within enclosed electrical installations, with voltages over 1000 V, the contact potential shall be according to the values given in VDE 0101: Annex C (Touch voltage and body current) and IEC 61936-1.

The following rules and regulations are to be observed in carrying out protective measures and in earthing procedure:

- IEC 60079 and 6036,

- VDE 0101and IEC 61936-1 for installations above 1000 V.

In areas exposed to the hazard of explosion, the protective measures outlined in IEC 60079 and IEC 61241 are to be adhered to in the erection and installation of electrical plant and equipment.

Electrical, chemical, thermal and mechanical influences must on no account impair, in any way, the protection afforded against explosion. In particular the high ambient temperatures and the influence of nearby heat sources at the installation point must be taken fully into account.

4.2 Protective Measures for Installations up to 1000 V

Protection against direct contact

All 'live' parts of electrical operational equipment that can be reached by hand must be protected against direct contact either by means of insulation or through constructional design, position or arrangement, or by means of special devices. If, in the case of enclosed switchgear or control cabinets, access is required in the course of normal operation (e.g. for replacing fuses), protection against direct contact must still be ensured when the switchgear or control cabinet has been opened up.

Protective insulation

Protective insulation is to be provided by means of additional insulation over and above the insulation provided for operational purposes. This measure must prevent the occurrence of a dangerous contact potential.

Connection to neutral

The LV network shall be of the TN type, i.e. the LV neutrals of the auxiliary transformers are earthed directly.

Neutralization (protective multiple earthing) is intended to prevent the persistence of an excessively high contact potential on conductive parts of the installation which do not form part of the actual operating circuit.

Protective multiple earthing as a protective measure requires the neutral to be earthed close to the transformer.

The LV system for symmetrically as well as unsymmetrical connected power consumers shall generally be of the TN-S type, i.e. a five wire system. The separation of N and PE shall be carried out. Because of the clear demarcation between the neutral conductor N, carrying operational current, and the protective earthing conductor PE, which - under non-fault conditions - carries no current, **NO** connection between either N and PEN or N and PE is permissible beyond the point of separation of the

PEN conductor into PE and N.

The neutral conductor is to be insulated in the same manner as the phase conductors. The use of constructional parts of the switchgear as a neutral conductor is not permitted.

All earthing conductors have to be rated depending on the value of earth- fault current. Separate installed earth conductors must be at least 16 mm² for copper and 100 mm² for galvanized flat-iron.

The earth electrode resistance of a low-voltage system earth must not be higher than 2 Ohms. If the required earth electrode resistance cannot be achieved, other measures have to be taken to ensure that potential contact will not be higher than 50 V.

4.3 Protective Measures for Installations over 1000 V

Protection against contact

At least the following measures are to be taken for all parts that are 'live' when in operation:

- Protection outside of closed electrical operating areas:
- Complete protection from all sides against contact, the degree of protection shall be at least IP 54 according IEC 60529
- Protective devices may only be removed by means of tools.
- Protection inside closed electrical operating areas:
- Protection against contact with 'live' parts within reach of personnel,
- Protection against accidental contact outside the reach of personnel.

The above-mentioned measures for protection against contact are also to be applied to 'dead' parts of the plant where, in the case of a fault, a dangerous contact potential might arise, however, where the parts must not be connected to the protective earthing system for operational reasons.

Protection against contact voltages

Protective earthing is to be used as a safeguard against excessively high contact potentials for conductive parts of the installation which do not form part of the operational circuit. Here, all normally 'dead' parts equipment and apparatus shall be earthed if it is possible for them to come into contact with 'live' parts as a result of faults due to the occurrence of surface leakage paths, arcs or direct connections to a 'live' part of the equipment.

In considering the dimensioning of the protective earthing system, the thermal loading and voltages on the earthing equipment are decisive factors and these should be based on the maximum possible earthing current, which can arise.

5.0 ELECTRICAL EQUIPMENT INSTALLATION CONDITIONS

ENCLOSURE CLASSIFICATION

The electrical equipment shall be designed taking into consideration the following ambient conditions:

- Maximum design temperature (outdoor in the shade) +45°C
- Maximum daily average ambient shade temperature +35°C
- Maximum monthly average shade temperature +28°C
- Maximum annual average shade temperature +18°C
- Maximum design temperature of the electrical equipment installed indoors in air conditioned rooms +30°C
- Maximum design temperature of the electrical equipment installed in non-air conditioned rooms +45°C
- Minimum design temperature 0°C
- Maximum Design Ground Temperature +40°C

All equipment and materials provided for outdoor installation shall be resistant against the prevailing climatic conditions, sand storm, strong sun radiation and high H_2S content in the air.

Equipment enclosures for electrical equipment shall comply with IEC 60034, IEC 60079, IEC61439, IEC 60529, IEC 60947, and IEC 62271 as applicable.

Unless otherwise specified equipment enclosure classes shall be as follows:

Equipment	Internal location		External location	Below ground
	Dry	Damp		
MV switchgears	IP 41[1)]	---	---	---
LV switchboards, distribution boards, local control panels	IP 41[1)] IP 52[2)]	IP 54	IP 65W	---
MV motors and generators	---	IP 55	IP 55W	---
MV motor/generator terminal box	---	IP 56	IP 56W	---
LV motors and generators	IP 54	IP 55	IP 55W	IP 58
LV motor/generator terminal box	IP 54	IP 56	IP 54W	IP 55
Motor operated valve actuators	---	IP 57	IP 57W	IP 57
Lighting - offices	IP 32	---	---	---
Lighting - toilets	---	IP 54	---	---
Lighting – plant	IP 54	IP 55	IP 65W	IP 56
Lighting – Switchgear rooms	IP 32	IP 42	IP 54W	IP 65

Lighting – pump house	~~~	IP 54	IP 55W	~~~
Lighting, Street	~~~	~~~	IP 54W	~~~
Equipment terminal boxes	IP 55	IP 55	IP 65W	IP 66
Junction boxes; Local Control Panels	IP 55	IP 55	IP 65W	IP 67

[1)] In air conditioned rooms

[2)] In all other dry rooms

The additional measures (e.g. "W") shall consist of sunshades, protection covers against splashing water, rain water and sand, additional sealing, special acid resistive coating etc., depending upon the particular site conditions.

In instances where enclosures are exposed to the atmosphere they must be protected against ingress of dust and windblown, sand and direct solar radiation.

All enclosures shall be protected against ingress of vermin. Louvered openings shall be backed with fine mechanical wire screens.

There shall be no openings for ventilation or other purposes in barriers between compartments of the switchgear cubicles.

Electrical operational equipment which must be installed in areas exposed to danger from explosions must have the required explosion-proof design appropriate to the flash-point group classification of the explosive mixture as laid down in IEC 60079 and IEC 61241. Attention must be paid to IEC 60079 and IEC 61241 or equivalent with respect to the use of electrical operational equipment in workshops and storage premises exposed to the risk of explosions. In all rooms and areas where the local and operational conditions and surroundings can lead to the accumulation of gases, vapors, mists or dusts which, in combination with air, form explosive mixtures, the operational equipment and installations to be used in these circumstances must be of explosion-proof design. All operational equipment must be designed to comply with the class of protection dictated by the ignitable mixture (e.g. compression-proof casing, external ventilation, inherent safety, etc.) and the incorporation of supplementary safeguards where applicable.

Electrical, chemical, thermal and mechanical influences must on no account impair, in any way, the protection afforded against explosion. In particular the high ambient temperatures and the influence of nearby heat sources at the installation point must be taken fully into account.

The doors of the different cabinets, panels and switchboards shall be equipped with a uniform key lock system, consisting of:

- Door handle with locking bolts, to keep the door in the closed position
- Key system to lock the door

The MV equipment shall have different keys than the LV equipment. The proposed key-lock system must be approved by the COMPANY/Engineer. The uniformity of the key-lock system with the various equipment manufacturers will have to be coordinated by the Contractor. The keys shall be sorted in each electrical/equipment room in suitable key boxes, lockable by pad-lock.

6.0 EARTHING AND LIGHTNING PROTECTION

6.1Earthing and Potential Equalizing System

The earthing system and potential equalization shall comply with the following standards:

- IEC 60364-4-41: Electrical Installation of Buildings – Protection for Safety: Chapter 41: Protection against Electric Shock
- IEC 60364-5-54: Electrical Installation of Buildings – Part 5-54: Selection and Erection of Electrical Equipment - Earthing Arrangements, Protective Conductors and Protective Bonding Conductors
- IEC 61936-1: Power installations exceeding 1 kV a.c. - Part 1: Common Rules
- DIN EN 50522 Earthing of power installations exceeding 1 kV a.c.
- IEC 61643: Low-voltage Surge Protective Devices

For earthing, protective earthing, functional earthing, potential equalization and lightning protection-potential equalization, a common system shall be established.

Within all buildings, internal earthing rings/bars of copper shall be installed. Earth bars shall be of adequate size and suitably supported and braced to carry the rated short-circuit current for the associated electrical circuits, for the rated short-circuit current duration, without damage or excessive heating likely to damage joints, associated or adjacent components.

No framework parts or other structural components shall be used as earth bar.

All system and plant components which are to be earthed as well as electrical components, like protection and control cubicles, sub-distribution boards, control systems, motors and transformers, shall be connected to the earthing rings/bars.

All steel structures within a welded section shall be connected to the main earthing system.

At pipelines for flammable liquids or gases, earthing tags shall be provided at each flange. All bolted flanges shall be bridged using a flexible braided copper conductor. Each pipe shall be connected at least once to the main earthing system.

An earthing cable shall be included in all main cable runs.

Protective earthing and potential equalization of electronics cubicles, frameworks, racks etc. shall be executed as follows:

- Earthing rings shall be installed in the I&C rooms as buses, to be connected at several locations – at least two – to the earthing network.
- For each row of cubicles, at least two connections shall be made to the earthing ring. Cubicles in a row shall all be connected by conductors to each other.
- If cubicles are attached to raised platform flooring of steel structural parts, it shall be ensured that these are electrically connected to each other throughout the area.

The raised floor shall be connected to the earthing ring at several locations, and as a minimum at two corners of the room.

Foundation earthing

All buildings, including those with a steel skeleton, shall be equipped with foundation earthing. The foundation earthing shall be installed in addition to reinforcement that is likewise connected together with braided conductors.

The foundation earthing shall be used in connection with the other earthing systems like protective, operational, functional and lightning protection earthing.

In the case of pile foundations, earthing rods of the same length as the piles shall be installed along with the foundation piles at pile intervals of around

10 m and connected at around every 2 m to the pile reinforcement using braided conductors. The earthing rods shall project beyond the top of the piles and then be connected to the earthing system of the ring foundation.

In addition to the closed ring of the foundation earthing system, a net of mesh size around 10 x 20 m shall be embedded in the bottommost concrete layer. The foundation earthing shall be connected to the reinforcement by a braided conductor at intervals of about 2 m.

At intervals not exceeding 20 m, and with at least two in every room, connection tags from the foundation earthing shall be foreseen for connecting the internal earthing ring. Connection tags shall likewise be foreseen for connection to the external earthing system and to the lightning rods. Optionally, lighting rods can be connected to the external ring earthing, with connections then made from this ring earthing to the foundation earthing by way of the internal earthing ring at intervals not exceeding 20 m.

Screening

The measures described in the following serve for screening and potential control within (see VDE 0101 Annexes D, and E) and for lessening over-voltages.

- For reinforced concrete buildings, at each corner of the building including the bottom slab, an additional mesh of approximate mesh size
- 10 x 10 m, shall be provided at the topmost reinforcement. The meshes shall be produced by welding.
- Within the reinforced concrete walls and ceilings of electrical and I&C- rooms mesh size 5 x 5 m shall be provided.
- At intervals corresponding to the mesh width, earthing wires from the reinforcement shall be incorporated into the building pillars, rising from the foundations to the roof, and so welded that they are continuous. These earthing wires shall terminate at the roof parapet.
- For steel skeleton buildings, equivalent measures shall be taken.

- Framework sections shall be welded to make up a defined, electrically conducting connection or shall be bolted together so that they are electrically conducting.
- Metal façades and coverings shall be preferred over non-conducting materials and at their topmost and bottommost points shall be connected at an adequate frequency to the lightning protection system.
- Reinforcement of cable ducts of reinforced concrete shall be connected to parallel running earthing cables. These earthing cables shall be connected to the screen of the building earthing system or to the foundation earthing system.

6.2 Lightning Protection

All buildings and structures shall be equipped with a lightning protection system (LPS). Lightning protection level I (LPL) according to IEC 62305 shall be considered.

The **building lighting protection system** is to be executed to:

- IEC 62305-1:2010
- IEC 62305-3:2010 and
- IEC 62305-4:2010

and alongside protection of human life, shall prevent damage not only to buildings, but also to electrical and electronic installations.

All buildings and structures are to be protected against lightning strikes by means of lightning collectors and conductors. The collectors are to be arranged in such a way that, as far as possible they collect all lightning strokes without these directly striking the parts to be protected. This condition is considered to have been fulfilled if no point on the roof surface is more than 5 m away from a collector. Collector lines suffice as collectors, e.g. along the ridge and at gables and eaves

Ridge conductors must be taken right to the end of the ridge. Moreover roof conductors should run as natural continuations of all main conductors. Conductors at the gable extremities or eaves must be laid in the closest possible proximity thereto. In the case of steel-framed structures the ridge conductors must be connected to the roof supporting structure at least every 20 m. Lower level annexes are also to be provided with collectors.

Roof lines and other conductors are to be laid and fixed in such a way that they can withstand the stresses expected from storms, lightning strokes, roof work, etc.

One main conductor between the lightning collectors mounted on the top of the building and the potential grading ring laid in the ground is to be provided every 20 m of the before-mentioned lightning collector. The max. Spacing between conductor fixings may not exceed 1 m for horizontal runs and 1.2 m for vertical runs.

7.0 EMC MEASURES

All EMC measures shall ensure that during subsequent operation, no impermissible malfunctions or damage to equipment occurs due to violating electromagnetic compatibility.

The description of the measures is not limited to this chapter, but also forms a part of other chapters, in

particular “Protective measures", "grounding and lightning protection” and “Cabling”.

The EMC requirements are set out in the following paragraphs.

Under consideration of the conditions and constraints, the equipment used shall emit the lowest interference signals and exhibit the highest immunity to interference.

All equipment items shall operate properly when connected to networks with a power supply corresponding to the maximum permissible tolerances as laid down in DIN EN 50160 (as regards, harmonics, voltage fluctuations etc.).

Priority is given to reducing sources of interference.

Additionally, by means of high-quality screening, generation of over- voltages due to inductive or capacitive coupling shall be reduced. Influencing by electrical and magnetic fields shall be lessened.

Earthing and potential equalization systems designed for low-impedance shall reduce generation of over-voltages due to ohmic coupling.

If EMC resulting from the measures named above is still not adequate, further measures shall be taken within buildings, for example by isolation and suppressor circuits.

Thanks to the lightning protection and screening measures taken at the buildings, within them an EMC protection zone is formed.

All installations penetrating this protection zone, that is where they pass through the external walls of buildings, shall be incorporated into a lightning protection-potential equalization system as close as possible to the points of entry and exit of the building. This applies also for conductors carrying a potential. At entry or exit, these shall be included in the lightning protection-potential equalization system by way of suppressor circuits.

Cable runs to outdoor plant components and between buildings may also be screened by appropriate measures, and so form a part of the protection zone. If this is done, the suppressor circuit can be dispensed with.

A suppressor circuit shall be provided at all low-voltage main distribution boards.

Overvoltage protection shall be foreseen within the power supply for both central and distributed power supplies to electronic cubicles.

All conductive parts of the structures and installation within the scope of the contract must be connected to the main earthing system.

8.0 CABLE AND CABLE TRAYS

8.1 Cable Laying and Routing Requirements

The Contractor is responsible for cable routing and laying has to observe a strict unit/common service separation. The cables must be routed in different cable channels or, as the minimum requirement, on different cable trays, so that in case of a fire or any accident in a cable channel or tray the unit and the common service will not be affected together.

The following salient resources shall be used in cable routes changing a fire protection zone for achieving

the desired objective of minimizing fire risks:

- Fire barriers
- Fire resistance doors
- Emergency exits
- Cable penetration sealant
- Fire detection system
- Water spray system
- Water drainage system
- Smoke extractor fans.

Following standards, besides other, shall be observed for above requirements:

Fire tests of Building Construction & Materials; (BS Specification BS476: Part 20, 21, 22 and 23, (which basically addresses test methods & performance criteria for materials used in building construction) for power station cable; NFPA No. 80-2010 i.e. Standard for the Installation of Fire Doors & Windows may also be referred in this regard.

The instrument transformer, measuring and control cables as well as the cables of the Communication Systems must be laid sufficiently apart from the power cables so that no interference will occur and the transmission of fault signals is excluded. For this purpose the following raceway service levels shall be adopted:

Level	*Service*
A1	AC Power cables above 1000 V
A2	Unit Auxiliary transformer cables and Incoming cables to switchgear- above 1000 V
B1	DC Power cables and AC power cables below 1000 V
B2	Auxiliary transformer cables and Incoming cables to switchgear- below 1000 V
B3	Control circuits - 110 V d.c.
C1	Measuring & control cables for 60 V & above

C2 Instrumentation & control cables below 60 V

Note:

a. Cables in category B1 to B3 can occupy the same raceway provided they satisfy the requirements of Code NFPA 70-2008 Art. 300-3-C (1).
b. Cables in category C1 to C2 can occupy the same raceway provided they satisfy the requirements of IEC/IEE/ BS 7671: 2008, Article 528-01-01.

Following minimum separations shall be observed between above defined levels for assurance against electromagnetic interference:

Levels	Separation
(A1, A2) and (B1, B2, B3)	300 mm
(B1, B2, B3) and (C1, C2)	300 mm
(A1, A2) and (C1, C2)	600 mm

On vertical cable risers, walls and ceilings the cables must be secured with

corrosion-resistant cable clips (e.g. cable clamps with cable protecting cable sleeves).

Cable risers near gangways or in electrical rooms that are exposed to possible mechanical damage are to be protected up to 1 meter from ground by suitable metal cover.

All holes in ceilings, floors and wall made for cable routing must be sealed fire-resistant, when the cables have been laid. This also applies to switchgear panels and cubicles, passages between cable ducts, at vertical risers etc. As there is an increased danger of fire during the construction period the holes shall be fire-resistant sealed at that stage already. This applies especially to vertical runs.

When the cables are no longer supported on cable trays or risers etc. the power, DC and instrument transformer cables must generally be run singly in high-strength plastic conduit, at ambient temperatures above 60° C in galvanized steel conduit. With lighting cables, measuring and control cables and telephone cables, several similar cables can be run in one conduit. Surface-mounted conduits must be secured every 1.5 m.

In general the bending radius during installation shall be within acceptable limits as specified by cable manufacturer.

The laying of cables outside of buildings should be preferably on cable bridges were the cables are to be naturally ventilated.

The cables must be laid at a depth of 0.8 m at least, if it runs inside of the plant area and at a depth of 2 m at least, if it runs outside of the plant area.

The cables shall be buried in a suitable thermally stable bedding material as required for the cable heat dissipation and include a cable warning tape with the inscription “CAUTION BURIED HIGH VOLTAGE CABLE”. The remaining trench may be backfilled and compacted with the available excavations.

A ground temperature of 40° C has to be considered. Where cables have to pass under streets cable duct blocks with a suitable bore(s) should be provided. The marking of cable routes by concrete cable markers with a maximum distance between the cable markers of 100 m. The location of each cable marker with the coordinates shall be surveyed and registered in a cable routing map.

When laying the cables on cable trays, cable risers, cable channels, etc. and when choosing the size of the cables care must be taken that sufficient ventilation is available and that there is no possibility of thermal overheating, or strain on the cables.

Cables which must move with connected apparatus owing to thermal expansion or mechanical vibration must be provided in a flexible form or they must have sufficient slack at the location.

All the ends of the cables must be prepared according to the particular requirements of the manufacturers and connected to existing terminal strips, terminal screws, apparatus terminals, etc.

The necessary cable sealing ends and the stripped and fanned-out cable ends, where no sealing ends are provided, must be fixed to the appropriate supporting structures.

Cables supplying redundant motors or consumers shall be laid on redundant cable ways/trays.

8.2 General Cable Construction Requirements

The medium and low voltage cables shall be plastic-insulated copper cables.

For cables that are exposed to ambient temperatures above 60°C Teflon or silicone cables are to be provided.

The cables must be suitable for laying indoors, in the open (direct or indirect sunlight), in ducts, on trays, in the ground and in water. The cables must be resistant to direct solar radiation, the effect of oil, bacterial action, vermin, insects and rodents. Outer sheaths are to be manufactured from non-combustible or flame retardant material.

All cables must be provided at both ends with identification in the form of numbered labels corresponding to the plant coding system which are clearly visible, captive and unrottable. The individual cores will be numbered or identified by color-coding.

The cables must be laid to ensure that they can be replaced or renewed in a simple manner.

Fire-resistant cables

Fire-resistant cables shall be provided for the feeders:

a) for auxiliaries required for safe shut down of unit including motors for lubricating oil pump, turning gear, jacking oil pump, air pre-heater, fuel line control valve and any other critical equipment for safe shut down not mentioned herewith.

b) For control of unit circuit breaker and turbine lockout

c) Between emergency diesel generator and associated switchgear

d) fire-detecting and fire-fighting systems.

The cables for (a) to (c) above shall have fire resistance capability of BS-6387 Categories B or IEC 60331. The cables for (d) above shall be Mineral Insulated Copper Cased (MICC) and overall sheathed with low smoke and preferably zero halogen material or any other type of cable with equivalent or better capabilities than MICC . The feeders as indicated above shall be routed in specially laid out trenches so as to be reasonably away from fire hazards like fuel lines (oil and gas), lubricating oil lines, oil filled transformers etc. The Contractor shall obtain approval from Engineer for the type of cables and their routing etc.

The cables for (d) above shall be conventional type for the run buried underground.

All accessories necessary for junction and jointing shall be of special screw type design. For installation tools only especially provided for that purpose shall be used.

8.3 Medium Voltage (MV) Power Cables

The design of the MV cables shall be screened, single-core or three-core

cables preferably with XLPE insulation. The cable shall be sealed with a red, non-fading PVC outer sheath. Three-core cables shall be designed with individually screened cores.

The cable conductor shall be tinned copper wires, for cables inside the plant boundary or tinned aluminum wires for cable laid outside of the plant boundary.

The MV power cables must be designed for the thermal and short-circuit characteristics of the electrical systems, taking into consideration the fault clearing time of the associated protection relay and a safety margin of 0.25 sec.

Where the cable core screens are inadequate to meet the earth fault current calculated by the Contractor, a metallic layer of adequate cross-sectional area shall be included in the design applied over the screen. The metallic layer shall be constructed of annealed high-conductivity tinned wires.

The cables must be terminated and connected to the indoor metal-clad switchgear or the sealing ends are installed in cable connection hoods mounted on the power transformers.

In the event of outage of the air-conditioning plants of the switchgear buildings the internal and external conditions will become the same. There- fore sealing ends are to be used, which are suitable for the maximum conditions at site.

8.4 Low Voltage (LV) Power Cables

The low voltage power cables shall be standard single and multi-core cables with tinned copper conductor and XLPE insulation.

To ensure the elimination of excessive contact potentials on any object, effective earthing must be carried out as a safety measure and suitable 3- core, 4-core and 5-core low voltage power cables must be provided. The minimum conductor cross-section of the low voltage power cables is 2.5 mm^2. If 3 1/2-core cables are used, the reduced conductor for protective neutral must have a cross-section of at least 16 mm^2. In lighting systems (especially discharge lighting circuits) the use of a reduced conductor for the protective neutral is to be avoided.

Depending on the site conditions the DC cables must be single-core, 2-core or 4-core. Between batteries or rectifiers and the DC switchgear single-core power cables should in general be used.

The LV power cables must be designed for the dynamic and thermal characteristics of the electrical system and for continuous operation.

Over sheath

The PVC over sheath shall be oil-resistant and treated in order to prevent the cables from spreading fire and shall be black colored for all LV power cables. The sheath shall contain the manufacturer's name, the voltage levels Uo/U in kV and the cable type.

8.5 Current Carrying Capacity and Voltage Drop of Power Cables

The ratings for continuous loading of the cables shall be calculated according to the relevant IEC regulations. The Contractor must submit corresponding tabulations for all cables to be used.

The Contractor shall submit detailed LV & MV cable sizing & ampacity calculations which include but not limited to: cable voltage drop, cable short circuit capability, cable damage curve, etc taking into consideration grouping factor , insulation power factor , load factor , % fill (cable in trays) , motor service factor, temperature rise derating factors , etc. In some locations, the heat generated from the equipment, elevates the ambient temperature, such elevated temperature has to be accounted for.

The voltage drop on various feeders shall not exceed the following specified percentage limits as referred to nominal voltages:

- Main feeder cables to switchboards at rated current 1 %
- At consumer terminals at rated current. 5 %
- At motor terminals during DOL starting for HV-motors 10%
- At motor terminals during DOL starting for LV-motors 15 %
- Supply cables for lighting and fail-safe equipment 2 %

8.6 Measuring and Control Cables above 60 V/ Instrument

Transformer Cables

For voltages above 60 V the cables must have PVC insulation and a mini-mum conductor cross-section of 1.5 mm^2 and shall be tinned

If they lead to outlying buildings, cables with a common core screen and protection against induction must generally be used.

For instrument transformer cables the minimum conductor cross-section must be 2.5 mm^2.

The maximum voltage drop shall not exceed 2%.

8.7 Measuring and Control Cables below 60 V

For voltages up to 60 V, measuring and control cables shall have stranded or

solid tinned copper conductors of minimum 0.8 mm diameter. Multi-pair control cables with paired lay-up of the leads and lay-up of the pairs themselves shall be used.

Wherever necessary, e.g. for all cables leading outside the relay rooms and/or control rooms, the control cables shall have a common screen (Al- foil or Cu-foil).

Cables must generally have appropriate electrical protection against inductive/resistive influences and lightning.

The required compensating wires for temperature measurements must be at least 1.5

mm^2 tinned copper conductors.

The maximum voltage drop shall not exceed 2%.

The individual cores of the multi-pair control cables shall be identified by numbers or a color coding system.

8.8 Underground Fiber Optic Cables

The optical fiber cable shall be suitable for direct buried applications and each cable shall be seized with 400% over capacity in the number of single mode fibers available on completion of commissioning and shall be in compliance to ITU-T G.652.

The tubes shall be filled with filling compound and stranded, together with fibers, around a resin glass plastic strength member to form a compact and circular core. The cable structure shall be completed by application of a synthetic core wrapping an APL (Aluminum Polyethylene Laminate) inner sheath, an ant rodent, double sheath with corrugated steel tape armor and an outer sheath in polyethylene or HDPE (High Density Polyethylene) with zero halogen or better proven industry application material.

Each single mode optical fiber shall be designed to provide good performance at 1310nm and/ or 1550 nm and the geometric and transmission characteristics shall fully comply with ITU-T recommendations.

The fiber material shall be manufactured with pure silica cladding and doped silica core in order to guarantee optical transmission performances.

The centre of the cable core shall contain a resin glass with a typical diameter of 2.4 mm or better and the diameter shall be defined in accordance with the maximum pulling force.

The secondary coating tubes of the fibers shall be colored for counting of the fibers and counting direction identification in accordance to Manufacturer Standard.

The cable maximum pulling tension and minimum bending radius shall be in accordance with the cable manufacturer's specifications.

The tension of the cable shall be monitored and controlled/limited during pulling. In case of mechanical pulling, the tension limit mechanism/recorder shall be calibrated and proven to the satisfaction of the employer.

The Fiber Optic Cable shall be treated with care. The cable shall not be trampled upon, run over by vehicles, pulled along the ground, over fences, rock or asphalt. The cable shall be carefully inspected and observed prior to, and during pulling work.

On completion of pulling each cable section and before the cable is cut, a check must be made to ensure that there is sufficient cable for racking, testing and splicing. This test/splice allowance shall not include any portion of the cable covered by a cable grip.

All cable at splicing locations and communications offices shall be identified with approved permanent tags.

All fiber optic cables shall be terminated directly to the connector which will be housed on an employer approved fiber distribution panel (Patch Panel).

Appropriate cable splice closures for the type of cables to be spliced shall be provided. The closures shall be approved by the employer; re-enterable, waterproof and externally non-metallic buried splice closures.

Splicing of fiber optic cables shall be done by arc fusion method using a latest model, fusion splicer as approved by the employer, in compliance with clients engineering and construction standards. Where clients standards are unavailable, GTE splicing specifications shall be used as directed by client's representative.

The fusion splicing equipment shall be of the highest mechanical and optical quality to assure uniform, low-loss splices. The splicing equipment shall employ automatic, high-resolution fiber alignment technology; based on pre-splice least-loss criteria established by the machine itself. The splice machine(s) shall have a visual monitor by microscope or miniature CRT/LCD viewing screen, and shall provide a read-out estimate of the splice loss.

The fiber cleaver(s) shall be of the highest quality to assure uniform, clean, 90 degree cleaved fiber ends.

8.9 Cable Supporting Structures

Construction requirements

Basically, pre-fabricated cable trays, cable risers, hanger rods, screws, clamps and all fixing material of corrosion-resistant finish, hot-dip galvanized, shall be used. If in certain sections the use of trays and risers is not possible, cable racks are to be provided in such places. These shall be made of corrosion-resistant, steel angle sections, hot dip galvanized. The steel angles must be cut to size on site and exposed cut surfaces must be suitably treated on the spot to prevent corrosion before being fitted. The minimum requirement for this treatment is the application of an anti- corrosion layer of zinc coating.

All cable tray T-junctions, cross-overs, vertical and other shelving, bends, etc. must consist of pre-fabricated tray elements so that crushing of the cables at these transition points is avoided.

The cables laid on the trays must be carefully arranged and ordered. All cable tray routings consisting of several individual cable trays that are located outside buildings and exposed to the sunlight shall be provided with sun-shades made of the material as described for the cable tray equipment.

The trays and risers must be installed in such a way that in accessible manways an escape route at least 800 mm wide by 1950 mm high is available for the personnel.

For safety reasons the lower parts of the hanger rods and all other exposed parts in manways and escape routes must be fitted with plastic covers.

In indoor installations hot dip galvanized material with an average coating thickness according to ASTM A123M is to be used.

In all external areas, in not complete closed buildings and in areas with corrosive gas or steam the hot dip galvanized material used shall be provided with an additional coating according to DIN EN ISO 12944ff.

The cable trays must be designed to ensure that there is 15 % spare space on all trays when commissioning and handing-over is complete. If number of cable trays in any area will be 6 or more then instead of providing 15 % spare space in individual trays, an additional tray shall be provided.

The fixing materials for the cable trays and risers must be corrosion- resistant or at least be hot-dip galvanized. The rods, brackets and risers must be fitted with appropriate support brackets to be fixed to anchor rails or fixed by dowels and screws in walls and ceilings.

Welding to steel structures and the welding together of hot-dip galvanized cable-laying accessories is not permitted.

After completion of the cable-laying work the maximum deflection of the cable trays shall not exceed 2.5 mm per 1.5 m (specified distance between two hanger rods).

In exceptional cases, when the prescribed support spacing cannot be complied with, wide-span cable trays are to be used. In this case the following maximum deflection shall not be exceeded on completion of the cable laying work:

Fixing distance mm	max. permissible deflection m
3	3
4	5
5	8
6	11

8.10 Identification of Wires

The wiring and cores of internal wiring in switchgear, control panels and desks, relay panels, marshalling kiosks and the like shall be identified in accordance with the associated connection/wiring diagrams either by means of identified by wire numbers except when an automatic system of wiring is used.

Both ends of every wire shall be fitted with interlocking ring-type ferrules of white insulating material, and engraved in black. The identification numbering system used for the ferrules shall be to the approval of the Engineer.

Where a wire of a multicore cable passes from one piece of equipment to another, e.g. from a circuit breaker to a remote control panel, the Contractor shall ensure that the identity of the wire is apparent at both ends by the use of functional local dependent ferruling.

Each core of multi-pair wiring shall be identified by color and terminal block identification together with an identification tracer per bundle.

Permanent identification of all terminals, wires and terminal blocks shall be provided.

All wirings shall conform to a color code, in accordance with the following code:

DC Circuits	Grey (trip circuits shall be provided with red ferrules at the terminal blocks´)
PT Circuits	Red
CT circuits	Yellow
Alarm circuits	Blue
AC power circuits	Black
Connection to earth	Green/Yellow

A consistent system of wiring numbering/identification shall be used throughout the plant. The system shall be approved by the Engineer.

9.0 REQUIREMENTS FOR LOCAL CUBICLES AND LOCAL HOUSINGS FOR E.G. SWITCHGEAR, CONTROL, MEASUREMENT AND

SIGNALING EQUIPMENT

Steel-clad cubicles and enclosures with fixed, integral switchgear and apparatus at least of the PTTA type must be provided.

The switchgear cubicles must be partitioned off and incorporate a busbar system, the necessary instruments, control switches, switch panels of the individual switch and apparatus chambers. The main busbars are to be installed on the rear face, top side of the switchgear cubicle in a lockable shuttered compartment.

Connections to switching devices, MCB's fuses etc. are to be made from these busbars. The lower part of the cubicle will house the terminal strips and connecting blocks, the clamps for the cable terminals and, if required parallel connection copper straps for the connection of more than 2 cables in parallel. An adequate number of ball studs must be provided within the switchgear cubicle suitable for earthing the main and distribution busbars as well as the switchgear itself by means of portable earthing and short circuiting equipment (to be provided once per switchgear panel row).

The space in the interior of the cubicles must be divided into a section with 'live' parts, 'live' switching elements etc. and a section with control and measuring equipment. The sections are to be separated by reinforced sheet- steel.

Care must be taken that in the event of arcing hot gases will not escape to the front of the cubicles (the operational side).

Ammeters are to be provided on the cubicle front panel for the cubicle feeders and the supply outlets for motors higher than 55 kW or motors of lower rating, but particularly important for the process. A single voltmeter with 4-position voltmeter changeover switch must be provided for measurements of busbar voltage between each phase and neutral. Measuring instruments should, in general, be square in shape.

Special precautions shall be taken in the design of electronic devices for protection and control systems housed in the cubicle in order to allow for the specified ambient conditions.

Heating elements are to be provided generally in each local cubicle or cabinet and shall be humidity controlled.

It must be possible to disconnect power supplies to the cabinets by means of manually operated power circuit-breakers (MCB's).

For easy monitoring and a rapid grasp of the operational state, colored mimic diagrams with the required switch position indicators, apparatus symbols and pilot lamps must be provided in every case on main process cubicles and switchgear cubicles. Lamp test facilities for all indicating lamps connected shall be provided. All indicating lamps shall be of LED type.

All cubicles shall be provided with the required earthing screws.

Plastic-insulated, stranded conductors must be used for wiring within the switchgear cabinets, which must be numbered at each end with special tabs so that change by mistake is impossible.

Preferably plug-in type auxiliary relays are to be used. Apparatus being sensitive to impact must be protected against shock and vibration.

On completion of hand-over the cubicles must contain at least 15 % of fully fitted spare terminal capacity and 15 % of spare space for the future installation of extra equipment. It shall be possible to replace indicating lamps on the front panels of cubicle feeders and motor-supply outlets without isolating the equipment concerned. Further-more the control system must be designed in such a way that lamps operate at less than their rated voltage in order to avoid their being overheated.

Incoming and outgoing cables have to be fixed by suitable metallic cable glands.

All local control/switchgear panels and “black boxes” shall be provided with duplicate Power supplies for control and alarm signaling purposes. Such duplicate supplies shall be derived from separate power sources as far as practical. Suitable arrangements for the changeover of supplies shall be provided. The changeover arrangements shall be such that failure of one supply shall not cause a loss or reduction in output. Where failure of one supply could cause a loss or reduction in output than the changeover arrangement shall be automatic (diode decoupling, changeover contactors, etc.) and alarm shall be provided to indicate when loss of supply/changeover has taken place. Where failure of one supply does not result in loss or reduction in output, changeover may be by means of changeover switches or links. Alarms shall be provided to indicate loss of supplies.

All cubicles, desks and panels shall be painted externally and internally with high gloss paint to an agreed color.

The internals of all cubicles, desks and panels shall be painted matte white.

For the cubicle from hot deed galvanized material without paint will be accepted if manufacturer standard construction.

In all outdoor areas, in semi closed buildings (e.g. cooling tower) and in areas with corrosive gas or steam the hot-dip galvanized material (cubicles, panels, desks, supports, frames, etc.) used shall be provided with an additional powder coating.

All panels shall be mounted on an approved form of anti-vibration mounting whenever necessary and where they are mounted on computer type flooring suitable support frames from sub-floor level shall be provided.

10. LOCAL CONTROL POINTS AND LEVEL CONTROL CABINETS

10.1 General

Any electrical consumer unit, which is not controlled automatically from the remote control room, is to be fitted with a suitable local control cabinet.

The local control cabinets are to be installed in the immediate vicinity of the motor drive to be controlled.

Pump motors, which are level controlled locally, will be given an automatic and manual control. The respective level control cabinets are to be fitted in the immediate vicinity of the pump motors, gauge glasses or level monitoring instruments.

10.2 Construction Requirements

In general local control cabinets and level control cabinets with plastic casings resistant to impact, sand and direct solar radiation, mounted on walls or hot-dip galvanized supporting constructions, are to be provided. Hot-dip galvanized casings will be acceptable.

Protection class shall be as indicated in **Section 5**. The necessary earthing terminals must be provided for earthing purposes.

The cabinets must be equipped with the necessary mini circuit breakers, fuses, auxiliary relays, power contactors, terminal blocks and cable attachment components.

For motors with pre-selection control (operation/stand-by) operation hours counters are to be provided.

The stipulation of clause "Reg. for local cubicles and local housing for e.g. switchgear, control, measuring and signaling equipment" shall be applied too.

In hazardous areas, the necessary explosion proof control cabinets and level control equipment must be provided in accordance with IEC 60079.

10.3 Local Control Points

The local control points are to be equipped as the minimum requirement

with:

- ON button

- OFF button
- Running lamp
- FAULT LAMP
- TRIP HEALTHY indication
- Lamp test

When two motors are installed, serving as operation and stand-by unit, then in addition to a double set of the above items, the following equipment has to be installed as the minimum requirement:

- MOTOR 1 - MOTOR 2 (running motor/stand-by motor) pre-selection switch,
- Automatic transfer to the stand-by motor in case of failure of the running motor.

10.4 Level Controls

In the case of pump motors controlled by levels, in addition to the level control in each case the MANUAL - AUTOMATIC selector switch and the necessary local points are to be fitted. Control of individual pump motors must be effected as follows as the minimum requirement:

- MANUAL- AUTOMATIC selector switch
- Level control with maximum and minimum contacts
- low level contact on motor - OFF
- bottom maximum contact on motor - ON
- Top maximum contact as warning to the central control room
- Low-low level contact as pump dry-running protection and alarm signal to the remote control room
- Local control point with ON and OFF button, running and fault lamp.

When two pump motors are installed for the same purpose the control is to be effected as follows, as a minimum requirement:

- MANUAL - AUTOMATIC selector switch
- PUMP 1 - PUMP 2 (running pump/stand-by pump) pre-selection switch
- Level control with three high level contacts:

- First (1): high level contact for pre-selected ON
- Second (2): high level contact for alarm signal to the central control room
- Low level contacts for pumps OFF

11.0 TERMINAL BOXES AND TERMINAL CABINETS

In order to minimize the amount of cables and distribution of signals and to centralize connections in the plant, terminal boxes or, wherever necessary, by larger amounts of terminals, terminal cabinets shall be fitted on all the necessary

- Cable crossover terminal points
- Central collecting points for individual analog and binary signals and local transmitters
- Signal collecting and distribution points for fire alarm, telephone, loudspeaker and clock system
- Central distribution points for local signals.

Terminal boxes and cabinets must at least have class of protection IP 54 and must be equipped with the necessary terminal strips, cable glands and fittings components for the connection of the cables.

The necessary earthing terminals are to be provided for the earthing of the boxes and cabinets.

In any area subject to the danger of explosion, the necessary explosion- protected terminal boxes and cabinets are to be provided in accordance with

IEC 60079ff.

12. DIAGRAMMATIC SYMBOLS

Diagrammatic symbols complying with IEC 60027, IEC 60034 and

IEC 60617 are to be used for setting out the circuit and terminal layout.

13. COLOR CODE SYSTEM FOR SWITCHGEAR, LOCAL SWITCHING, MEASUREMENT, CONTROL, SIGNALING CABINETS AND MIMIC

DIAGRAMS

RAL 7032, pebble-grey shall be applied for all electrical and instrumentation equipment housings.

Color code for indications, push buttons on control cubicles, panels, desks, etc.

The following will be applied:

a) Indication lamps

- Valve open position green

- Valve closed position white
- Motor running green
- Motor not running white
- On control module for green "controller ON" "controllers" white “controller OFF"
- Alarm signal, trip signal, faults red
- Step indication white (with numbers)

b) Push buttons

Green shall be applied for all push buttons installed in the control desk, which are operable only together with the release push buttons. All other push buttons on local panels or cubicles will be black or dark grey.

Where the On/Off function of a push button cannot easily be identified by the location, this will be indicated by a sign "ON"/"OFF" or "0"/"I" or by color code as described above.

For mimic diagrams which are to be included in the particular cubicles or cabinet front panels etc. the potential Contractor has to elaborate a color scheme to be approved by the Engineer. The required setting indicators, apparatus symbols have to be incorporated in the mimic diagrams. The individual voltage levels on the mimic diagram must in any case be represented by different colors.

14. TECHNICAL CONDITIONS FOR HIGH VOLTAGE MOTORS

All motors with rated power (referred to 40° C ambient temp.) of 200 Kw and above must be designed as HV motors.

The rating of each motor shall be adequate to meet the requirements of its associated load, without infringing upon the service factor. The service factor is defined as the ratio of the installed motor output to the required power at the shaft of the driven machine at its expected maximum power demand including specified 10% excess capacity pump. Service factor employed shall be 1.1.

14.1 Constructive Features

The following constructive features shall apply:

- Climatic protection provisions for mounting in the open in a humid and hot climate. Insulation class F. During operation at rated power of the driven machine, the motor insulation must only be stressed in accordance with the requirements of class B insulation.
- Motor parts made of iron internally and externally sandblasted and surface-protected.

- Paint finish resistant to chemicals and H_2S content.
- Bolts bichromated.
- All joint faces and gaps sealed.
- Anti-condensation heating to be switched into operation when the motor feed circuit is in the 'off' position. Heater supply power 'on' indicating lamp is to be provided.
- Special treatment of windings with resin impregnation plus immersion in varnish.
- Varnish-insulated laminations.
- Pressboard material protected by varnishing.
- Totally enclosed fan cooled type. For motor ratings the cooling air available at the specific location has to be considered.
- Condensation outlets to be provided at the lowest point in the housing.
- Design and construction of the motors shall comply with IEC 60034-1 and60034-5. 60034-5.

14.2 Electric Features

The following electric features shall apply:

a) Motor rating to be at least 110% of the maximum required electric power consumption of the driven machine.
b) Continuous delivery of rated power at voltages of 90 - 110% of the rated voltage at rated frequency within the limits of thermal class F.
c) Rated power output at ambient temperatures existing at the particular site of installation and under continuous running conditions.
d) All motors shall be designed as 3-phase squirrel-cage motors suitable for direct on line starting. It must be possible, with 100% residual voltage, to switch them on to a large and stable power supply network without incurring damage or deformation. The motors must still be capable of faultless running up to speed with a voltage drop to 80% of rated voltage and with rated loading.
e) Motor starting current must not exceed 5.5 times rated current (referred to motor rating at 40° C ambient temp.). The voltage drop at direct-on- line (DOL) starting must not exceed 12 % at the motor terminals.
f) From the cold state three consecutive starts up to full speed must be possible. The second start must be possible immediately after the first start, the third 20 minutes after the second.
g) After one hour running under nominal conditions (rated voltage/load) additional two consecutive starts shall be possible. Restarting shall be possible immediately after motor has run down to standstill.
h) A minimum frequency of starting cycles of 1000 per year must be guaranteed.

14.3 Protective Features

The following protective features shall apply:

a) High voltage motors must be fitted with measuring points for the determination of slot and bearing temperatures.

b) Six Pt 100 resistance thermometers (2 per phase) are to be provided for slot temperature measurement, and a double thermocouple or resistance thermometer per bearing must be provided for bearing temperature measurement.
c) Each Pt 100 shall be connected, potential free, to a terminal strip. The connections to the thermometer as well as the associated over- voltage cutouts shall be brought into separate terminal boxes.
d) Where motors have closed-cycle cooling, temperature-measuring points must be fitted in the cold air stream.
e) The winding temperature has to be detected with RTD's at high temperature and alarm to be produced, at extra high temperature the motor to be tripped.
f) For motors ≥ 1000 MW winding and bearing temperature readings shall be provided in the DCS.
g) All motor gaps and joints between it and other units must be sealed. g) Earthing clamps at both sides of the stator have to be provided.
h) All motors shall be provided with an emergency trip push button installed closed to the motor and connected directly to the trip circuit in the MV voltage switchgear panel.

14.4 Other Features

Terminal Boxes

The main terminal boxes on the high voltage side shall be provided with a pressure relief joint for the purpose of reducing the danger of an accident as a result of short-circuits, and shall be fitted with a terminal block suitable for any desired type of connection.

Cable connecting boxes must be longitudinally divided to facilitate fitting of cable sleeves and end caps.

Inside the terminal box an earthing clamp for connection of the cable shield must be foreseen.

The opened terminal boxes must have provision for local earthing to be carried out.

Bearings

Motors with ratings below 1000 kW shall be provided with roller bearings and with a lubricator and lubricant supply regulator fitted with solid brass cages that can be refilled while the machine is running.

The bearings of the motors must be free from stray bearing currents.

Connections, star-point terminal boxes etc.

All motors must have the star-point connection brought out separately to terminals.

For all motors with a rating of 1000 kW or above a differential relay for winding protection shall be provided and installed in the associated switch- gear. In that case the star-point connection shall be brought out separately to terminals.

The differential current transformers are to be designed to class 5 P10 or class PX with a rating matched to the protection system. The CTs shall be accommodated in the star-point terminal box.

Coupling

The motor shaft halves of the couplings, finish-bored, balanced, and complete with key ways are to be drawn on to the motor shaft and balanced out together with the rotor.

Cooling

Air cooling for the motors is the preferred method; where water-cooling is applied, conditioned, treated water is to be used.

Motor air exchanger circuits should be suitable for the prevailing atmospheric conditions, i.e. ambient temperature, content of humidity and salt in the air, etc. are to be considered.

Running quality

The running quality must be within the classification of "Class C, Zone A" according to the ISO 10816-1 or equivalent, i.e. the vibration velocity must be not greater than 1.8 mm/s (rms).

Reverse speed

If reverse running can occur in the case of equipment driven by a motor (e.g. cooling water pump) the motor must be designed for maximum possible reverse speed.

A reverse rotation alarm and starting-circuit interlock are to be provided to ensure that the equipment cannot be started while running in reverse.

15. TECHNICAL CONDITIONS FOR LOW VOLTAGE MOTORS

If not specified otherwise all motors must be designed to meet IP 54 enclosure.

All motors with rated power (referred to 40 °C ambient temp.) less than

200 kW must be designed as LV motors.

The rating of each motor shall be adequate to meet the requirements of its associated load, without infringing upon the service factor. The service factor is defined as the ratio of the installed motor output to the required power at the shaft of the driven machine at its expected maximum power demand including specified 10% excess capacity pump. Service factor employed shall be as follows:

Power rating	Service factor
• up to 1 kW	1.25
• more than 1 kW up to 10 kW	1.2
• more than 10 kW up to 50 kW	1.15

- more than 50 kW 1.1

15.1 Constructive Features

The same features as for high voltage motors shall apply.

Anti-condensing heating shall be provided for motors of 40 kW and above for indoor motors and 5 kW and above for all outdoor motors and in damp areas.

15.2 Electric Features

All motors shall be designed as 3-phase squirrel-cage motors suitable for direct on line starting.

The motors must be capable of being switched on to a large and stable network and with phases in opposition.

The electric features a), b) and c) of high voltage motors according to

Section 14.2 Electric Features also apply here.

Motors starting current must not exceed 7.0 times rated current (referred to the motor rating and 40 °C ambient temp.).

15.3 Protective Features

An earthing clamp inside the terminal box has to be provided.

Motors with a capacity exceeding 100 kW shall be provided with an emergency trip push button installed closed to the motor and connected directly to the trip circuit in the LV voltage switchgear panel.

15.4 Other Features

Connection boxes

The cable connecting boxes are to be installed easily accessible on the motor. The connecting boxes must be capable of being turned by 90° or

180° and of being opened up longitudinally. The connection boxes are to be fitted with a terminal block.

Bearings

Maintenance-free bearings are to be provided for motors up to 37 kW rating at least. All motors utilizing maintenance-free bearings must be clearly and permanently indicated as full. All other bearings must be provided with a lubricator that can be used while the machine is running. Over-lubrication must be avoided by means of a lubricant controlling device.

Motors installed in inaccessible locations must have lubrication connections piped to accessible locations.

The motors are to be provided with roller bearings (i.e. groove ball or cylindrical roller type). The motors must be free from stray bearing currents.

Shafts

Where not otherwise specified, motors must be fitted with a free shaft end.

Protection against explosion hazards

Low-voltage motors, which are to be installed in areas exposed to the risk of explosion, must comply with the rules laid down in IEC 60079 and IEC

61241 for explosion-proof design in relation to the flash-point group classification for the particular explosive mixture.

15.5 DC Motors

The use of DC motors is to be avoided and must be agreed by the Engineer.

The max. Starting current must not exceed 3.5 of the rated motor current (referred to the motor rating at 40°C ambient temperature). In case of a voltage reduction of 15% the DC motors shall remain operative respectively achieve their nominal load.

16.0 ACTUATOR DRIVES

As far as applicable the above "Technical conditions for low voltage motors" shall apply.

In addition all actuators for valves, dampers etc. are to be fitted with socket and plug of well-established make to IEC 60309 or equivalent for the power cable connection. For the control cable connection separate socket and plug shall be provided.

Self-cooling at respective ambient temperature conditions is mandatory. Fan cooling is not accepted.

17.0 FREQUENCY CONVERTERS

General

On the basis of the requirements of the driven equipment, the Contractor shall design, supply, install and commission a complete, fully operative, variable-speed converter drive (frequency converter and motor, for motors up to 400 kW, for motors 400 kW and above in addition to the converter a converter transformer shall be provided).

Converters made by reputable manufacturers are to be used.

Technical requirements

The design of the converter (maximum continuous rating) is to be based on the maximum shaft output required by the equipment assembly.

Maintenance work and cable connections must always be possible from the front of the converter cubicles.

The frequency converters shall be specified and configured to have the ability to ride through momentary power losses, such as feeder transfers, and to have the capability to be programmed to automatically reset and restart after a shutdown due to loss of power. These features should be considered in the design of a comprehensive plant motor restart program. Frequency converters control schemes involving unsupervised restart shall be reviewed by Process Automation for consistency with process and equipment control philosophy. If frequency converters are used to feed equipment that "will

contribute to a multi-unit or total plant shutdown", the frequency converters must have 1 to 3 second ride through capability.

The harmonic distortion caused by the frequency converters drives shall be well below the values indicated in IEC 61000-2-4 (class 2) and below the values indicated in IEEE 519. The terminals on the input and output sides are to be rated such that parallel cables can be connected. The converter allows the speed of three-phase asynchronous motors to be adjusted steplessly. It must be fully equipped for remote control and monitoring in the control room.

An on-load disconnector and a power contactor are to be provided at the power input of the converter.

For motors with a rating up to 400 kW the frequency converter shall be designed in at least a six-pulse circuit on both the line and motor sides.

Frequency converters using IGBT's should preferably be provided on both the line and the motor sides.

For motors with a rating above 400 kW the converter should be designed in a 12 pulse circuit (as a minimum) supplied via converter transformer.

The converter is to be disconnected if the voltage drops to less than 80% of the rated voltage or if one or more phases of the line voltages are missed. When the line voltage is restored, the converter is to be connected again automatically, providing the break in the power supply did not last longer than 5 seconds. The plant check back signals (floating change-over contacts) must continue to be received during this period, while alarms are to be suppressed. It must be possible for the converter to be connected at any coasting-down drive speed and with in-phase voltages. The specified frequency set point is to be resumed automatically.

If the voltage reduction or the power failure lasts for a long time, the drive must remain switched off; in this case, it must subsequently only be possible to switch it on again either manually or by means of the higher order control.

The converters are to be designed for 10% more than the maximum power output required by the system. The purpose of regulating the converter is to ensure that the indirect current and voltage remain within the permissible limits during all control processes. This should apply both when the motor is started up and when the speed is adjusted during operation.

Forced ventilated converters are to be equipped with redundant fans (two double fans).

Flow monitors (not air vanes) are to be used to monitor the fans. Positive control is to be provided for fan drives with a master drive.

Converter transformers

The converter transformers for supplying the frequency converters are to be designed and the auxiliary equipment to be provided in accordance with IEC 60076-11.

The transformers are to take the form of cast-resin transformers and are to be installed in protective casings made of sheet steel, cooling method AN, type of protection at least IP 21 and shall be installed indoors in air conditioned rooms.

The transformer output shall correspond to the power requirement of the frequency converters plus 20%.

It should be possible to vary the high-voltage side within a range of

2 x ± 2.5 %, by means of reversible clamp connectors.

The connections on the high-voltage side have to be carried out using cables.

Busbar connections with short-circuit protection are to be provided to the current converters on the low-voltage side.

Suitable earthing studs are to be provided for maintenance purposes

(earthing and short-circuiting).

All accessories - especially sensors and terminal connections - must be arranged so that they are readily accessible.

The windings must be flame-retardant and self-extinguishing. The cast-resin mixture must not contain any flame-inhibiting additives which develop toxic vapors or gases either under the influence of secondary fires or in the electric arc. A report on this subject has to be enclosed with the bid.

Moisture-proof design:

It must not be necessary to dry the winding after shut-off periods.

The protection against voltage surges and short circuits, the noise levels and the freedom from partial discharges up to twice the rated voltage must be verified by means of type tests.

The windings are to be protected by means of a temperature monitoring system, comprising the following minimum components:

- 3 PTC resistors (1 for each phase)

- 1 tripping unit with isolated change-over contacts for remote signaling (alarms).

Instrumentation and control

The instrumentation is subdivided into a local section in the converter cubicle and into a "remote" section in the control room. All the measures necessary to enable the drive to be remote-controlled and remote-monitored must be implemented, i.e. all the 24 V DC interposing relays which are required to convert the on/off commands from the instrumentation and control system, signal transducers, etc.

A suitable automatic compensation facility is to be provided, to ensure that the transfer between LOCAL mode and REMOTE mode is bumpless in both directions. The emergency shutdown function of the equipment must act on the converter directly, regardless of whether 'local' or 'remote' mode is set.

Local instrumentation and control

The following are to be provided as a minimum in the converter cubicle:

Controls

i. Local/remote converter control (key-operated switch)
ii. "On" and "off" converter controls c) Set point adjuster (speed)
iii. Incoming master switch, "on-off"
iv. All the controls necessary for internal converter settings and adjustments, as specified by the manufacturer

Indications, signals, monitoring

a) Line voltage indicator b) Output frequency
b) Output current
c) Operating status signals, in accordance with the specifications of the instrumentation and control supplier, though at least "Ready", "Drive running" and "Zero and set speed reached"
d) Motor temperature monitor - alarm Motor temperature monitor - shut- down
e) Signals concerning internal operating states of the converter, in accordance with the manufacturer's standards, though at least:
    - Over temperature
    - Line voltage monitoring
    - Line under voltage
    - Overcurrent
    - Control voltage monitoring
    - Converter protection
    - Fan monitoring
    - Incoming air temperature
    - Motor feeder interruption
    - Motor feeder short circuit
    - Earth fault
    - Motor blocked
    - Other faults

Remote control and remote indications

Account must be taken of the following types of remote control and indication in the control room, and suitable interposing relays, transducers and switchgears are to be provided in the cubicle:

a) Converter "on/off" and "local/remote"
b) Set point adjuster for speed (4 - 20 mA)
c) Remote indication for speed as 0/4 - 20 mA standard signal d) Motor current as 4 - 20 mA standard signal
d) Combined fault
e) Remote indication of the set speed potentiometer as a 0/4 - 20 mA standard signal
f) Other controls and indications

All event signals and check back signals must be made available on the terminal strip as floating change-over contacts.

System perturbation

The perturbation caused by the voltage harmonics in the feeding three-phase system, which are a result of the converter drives, must not exceed the specified limit values, i.e. 5 % for the 5^{th} harmonic voltage, 4 % for the 7^{th} and 2 % for each of the 11^{th} and 13^{th}. IEC 61000ff are also to be observed in this regard. The system perturbations are to be curbed by means of suitable measures if necessary. The Contractor is responsible for demonstrating conformance with the above-mentioned limit values.

18.0 RING MAIN UNITS

18.1.1Type of Switchgear

The ring main units shall be outdoor mounted, IP6x, metal clad, front access, fixed breaker, type tested, vacuum or SF6 breakers, internal Arc Fault Protection, with integral circuit earth, and complete with the necessary current transformers, controls and protection as specified.

18.1.2 System Parameters

The following system parameters apply:

System Frequency	50Hz
System Voltage	3.3kV nominal
Phases	3 phase, 3 wire

18.1.3 Nominal Current Ratings

The following nominal current ratings apply:

Busbars	630 Amp (minimum)
Breakers / Switch	630 Amp

18.1.4 Fault Ratings

The following minimum fault ratings apply:

Rated Short Time Withstand Current 25kA for 1 second

18.1.5 Bus Bars

All busbars shall be of the tinned copper arrangement, supported as required to maintain the fault rating, and heat shrink shrouded. Bus bar chambers shall be totally enclosed, and extendable at each end of the switchboard layout. Where construction or transport joints are provided the Contractor shall detail the

connections and provide all shroud and filling compounds. The Contractor shall note the environmental conditions.

18.1.6 Current Transformers

All current transformers shall comply with IEC60044.1 and shall be sized to provide the quiescent current to the protection relay if self-power relays are provided.

18.1.7 MV Cable Connections

The major cable connection sizes to each isolator are by Contractor design, with special attention required for ambient conditions and soil thermal resistivity in this environment at the nominal current rating. The Contractor shall supply cable terminal boxes sufficiently large to accommodate, gland and terminate these cables. Where necessary, extension boxes or separate cable entry boxes shall be provided.

The preferred arrangement is that all cables shall be lug connected to the switchgear terminals, however plug/socket arrangements may be offered if they can provide the connection to the cables shown. All sockets will be provided with the correctly sized plugs for the cable size specified for use by others in termination of cables.

18.1.8 Protection Relays

Every breaker shall contain a standard three phase over current and earth fault relay that can be set for timed and instantaneous protection functions. The relay may be self-powered, with the current transformers fitted with a separate power winding. The relay shall have at least one clean alarm contact wired to terminals for the indication of a trip condition. The Contractor shall mount and support the protection relays within the low voltage enclosures and provide all interface wiring from these relays to the trip and close controls on the breakers.

18.1.9 Operation

All isolators and earth switches shall be manually operated, and mechanically interlocked with their associated isolator or breaker.

The circuit breakers may be closed by means of a stored energy mechanism which is normally charged by a motor or via a close coil and shall also have provision for manual closing, tripping and spring charging for maintenance purposes. A maintenance handle shall be provided for this. Mechanical operation counters are required for each circuit breaker.

18.1.10 Locking, Interlocking & Earthing

All interlock mechanisms shall be mechanical and shall be clearly labelled.

Interlocks shall be provided to prevent the following operations:

- The closing of the circuit breaker or isolator unless the associated earth is removed
- The closing of the earth switch unless the associated circuit breaker or isolator is open

It must be possible to “safety” lock the circuit breaker or the isolator in the earthed position.

The circuit breaker shall not be required to be closed to earth the outgoing cable. No bus earth is required. The hole which accepts the padlock shank shall be a minimum of 5mm diameter.

18.1.11 RMU Installation

The RMU units shall be securely mounted and earthed on a concrete plinth suitably located to allow full maintenance access to the RMU. All cable entry to and from the RMU shall be via ducts embedded in the plinths.

19.0 TRANSFORMERS

19.1 Parameters

The Transformers shall be manufactured to the following parameters:

ITEM	RATING
Type of Transformer	Three winding, core type, oil immersed, step-down power transformer
Number of Phases	3
Type of Installation	Outdoors
Rated Frequency	50Hz
Nominal Voltage Radio	3.3kV/415-240V
Power Rating (Standard Ratings) at 0.8 power factor	Contractor to Advise
Cooling Method	ONAN
Cooling Medium	Mineral Oil
Radiator	Attached
Vector Group	Dyn11
Neutral Earthing	Solidly earthed
Type of tap changer	Off load tap changer (HV side)
Impedance @75oC	5 to 7%
Duty	Continuous Duty
Maximum Design ambient temperature	45°C
Maximum winding temperature rise	65°C
Maximum oil temperature rise	60°C

19.2 Transformer Construction Style

The power transformer shall be of the “industrial” type, the transformers shall be double-wound, and oil

immersed naturally cooled and hermetically sealed fully oil filled type with cable entry from the bottom.

19.3 Transformer HV & LV Cubicle Design

The transformer HV and LV cable box/cubicle shall be fitted with suitably rated bus bars sized sufficiently for the connection of all HV and LV cables. The cable box/cubicle shall be sized sufficiently to comfortably allow the installation of cables, The HV and LV cable boxes/cubicles shall be lockable with hinged doors.

19.4 Transformer Core

The core shall be constructed of high quality non-aging, high permeability silicon steel - M4 High B Grade or superior grade Cold Rolled Grain

Oriented (CRGO) steel.

The steel shall be in thin laminations of 0.27mm or less, annealed after cutting and rolled to insure smooth surfaces at the edges. Both sides of each sheet shall be insulated with a durable, heat-resistant baked enamel or varnish.

The core shall be rigidly clamped with a positive locking device to ensure adequate mechanical strength to support the windings and prevent shifting of laminations during shipment, and also to reduce vibration to a minimum during operation.

The core shall be grounded at one point and means shall be provided for possible measuring of core insulation from the top of the tank.

Adequate lifting lugs shall be provided to enable the core and winding to be lifted from the tank.

19.5 Transformer Windings

The design, construction, and treatment of windings shall give proper

consideration to all service factors, such as high dielectric and mechanical strength of insulation, coil characteristics, uniform electrostatic flux distribution, prevention of corona formation, and minimum restriction to free oil circulation.

Windings shall be subjected to a shrinking and seasoning process, so that no further shrinkage occurs during service.

Materials used in the insulation and assembly of the windings shall be insoluble, non-catalytic and chemically inactive in the hot transformer oil and shall not soften or otherwise be affected under the operating conditions.

Windings shall contain no sharp bends which might damage the insulation or produce high dielectric

stresses. The strip conductor wound on edge shall not have a width exceeding six times its thickness.

All windings after being wound and all fibrous hygroscopic materials used in the construction of the transformer shall be dried under vacuum and impregnated with hot oil. The windings shall be so designed that all coil assemblies of identical voltage ratings shall be interchangeable and field repairs to windings can be made readily without special equipment. The coils shall have high dielectric strength.

The windings, their insulation and connections shall be braced to withstand the mechanical and electrical stresses which may occur during transportation and erection, during lightning, switching surges, system faults or seismic disturbances.

An earth shield shall be installed between the HV and LV windings to reduce surge transfer and protect from inter-winding faults.

19.6 Transformer Off-Load Tap Changer

The tapping shall be selected by an 'off load' tapping switch with an external hand wheel with provision for locking on to a selected tapping. The shaft shall be adequately sealed so that no seepage of oil occurs under all conditions of service.

The voltage operating positions, together with tap change positions shall be clearly and indelibly marked.

The transformer shall be capable of delivering the rated kVA through the complete tapping range.

19.7 Transformer Tank

The transformer shall be enclosed in a suitable stiffened welded steel tank such that it can be lifted and transported without permanent deformation or oil leakage. The construction shall employ weldable mild steel and shall be of sufficient strength and rigidity to withstand moving, shipping and handling without deformation.

Lifting lugs shall be provided, suitable for the weight of the transformer, including core and windings, fittings, and with the tank filled with oil. Four jacking points must be provided in an accessible position to enable the transformer to be raised or lowered.

The base of each tank shall be so designed that it is possible to move the complete transformer unit in any direction without damage when using rollers, plates, or rails.

The transformer tank shall have a flat rectangular base with supporting rails allowing minimum possible contact with the foundations (so eliminating water build-up under base). Skids or wheels are not required. All joints other than those which may have to be opened, shall be welded. Caulking of defective welded joints will not be allowed.

The tank and cover shall be designed in such a manner as to leave no external pockets in which water can lodge, no internal pockets in which oil can remain when draining the tank or in which air can be trapped when filling the tank, and to provide easy access to all external surfaces for painting.

Integrally mounted radiators shall be provided and all mounting equipment for the radiators and

connections between the radiator and the transformer tank shall be provided.

Four holding down/fixing points shall be provided, complete with 20mm holes.

19.8 Transformer Valves & Location

The transformer shall be fitted with the following valves as a minimum requirement:

a) One 25 mm filter valve located near to the bottom of the tank and the top of the tank for online filtering

b) One 25 mm drain valve with such arrangements as may be necessary inside the tank to ensure that the tank can be completely drained of oil as far as practicable. This valve shall also be provided with an approved oil sampling device

All valves up to and including 75 mm bore shall be made of gunmetal. They shall be of full way type with screwed ends and shall be opened by turning counter clockwise when facing the hand wheel. There shall be no oil leakage when the valves are in closed position.

19.9 Transformer Joints & Gaskets

The transformers shall be of the hermetically sealed type and provided with a satisfactory lid sealing gaskets. The gasket shall of the good quality to maintain the sealing effect through its life span and shall prevent seeping of oil due to ageing and extreme operating temperature.

Gaskets provided with the transformers shall be suitable for making oil tight joints, and there would be no deleterious effects on either gaskets or oil when the gaskets are continuously in contact with hot oil. No gaskets shall be used in which the material of the gasket is mounted on a textile backing.

Use of any kind of impregnated/bonded or other kind of cork or hemp is not acceptable.

All joint faces shall be arranged to prevent the ingress of water or leakage of oil with a minimum of gasket surface exposed to the action of oil or air. Gaskets shall be designed for a life of not less than 30 years.

19.10 Transformer Oil Temperature Indicator

The transformer shall be provided with one (1) oil transformer thermometer.

The thermometer shall measure the temperature of the oil immediately below the cover (top oil). The gauge shall be mounted on the cover on the LV side and be readable from a distance of 2 meters. The gauge shall indicate the actual temperature and the maximum temperature reached and the maximum indicator shall be hand-resettable.

The instrument shall have two sets of contacts, one for alarm and one for trip. The tripping contacts are to be adjustable to close between 60°C and

120°C and re-open when the temperature has fallen by not more than 10°C. The alarm contacts shall be adjustable to close between 50°C and 100°C and to re-open when the temperature has fallen by not more than 10°C. The contacts shall be wired to a junction box attached to the transformer and clearly labelled for connection by others.

19.11 Transformer Oil Level Sight Glass

The transformer shall be provided with an oil level sight glass.

19.12 Transformer Pressure Relief Device

A suitable pressure relief device shall be provided for the rapid release of any pressure that may be generated in the tank which may endanger the equipment. If the relief device is to be mounted on the tank cover, it shall be fitted with a skirt to project at least 25 mm into the tank and of such construction as to prevent gas accumulation.

The device shall be capable of maintaining the oil tightness of the transformer under all conditions of normal service.

The instrument shall have two sets of contacts, one for alarm and one for trip. The contacts shall be wired to a junction box attached to the transformer and clearly labelled for connection by others.

19.13 Transformer Earthing Terminals

Two bare stainless steel 12 mm diameter studs shall be located at positions close to the two diagonally opposite bottom corners of the transformer tank to facilitate connection to the local earthing system. These grounding terminals shall be suitable for a bolted connection. Earthing terminals should be suitable for carrying full short circuit current for 4 seconds.

19.14 Transformer Insulating Oil

The transformers shall be filled to the required level with a new, unused, clean, standard mineral oil in compliance with IEC 60296 and transported to the site under oil.

Oil must be de-gassed before filling of transformer takes place. The oil shall be pure hydro carbon mineral oil of a naphthenic base refined especially for use in transformers. The oil shall be clean and free from matter likely to impair its properties.

Each transformer must have a sample of its oil analysed at a NATA approved facility before delivery. Tests are to include Karl Fischer water content, acidity, interfacial tension, colour, dielectric strength, resistivity at

90oc, dissolved gas analysis, and total PCB content. The total PCB content must be NOT detectable (assume detection limit is 0.1 PPM).

19.15 Transformer Bushings

Bushings shall conform to the requirements of IEC 60137. Primary and secondary bushings shall be provided in two separate cubicles sealed to no less than IP21 rating. They shall be sealed in a manner to prevent ingress of moisture and to facilitate removal. The neutral bushings and stems shall be identical to those provided for the phase terminations. Bushing palms shall be made of brass and be suitable for the bolting of conductor compression lugs.

The insulation level of bushings shall be equal to or greater than the insulation level of the winding to which they are connected.

Stress due to expansion and contraction in any part of the bushing shall not lead to deterioration or loosening of cemented joint. In case of paper insulation, care shall be taken to prevent ingress of moisture and a final coat of non-hygroscopic varnish shall be applied.

Bushings of identical voltage rating shall be interchangeable.

Each bushing shall be so coordinated with the transformer insulation that all flashover will occur outside the tank.

19.16 Transformer External Finish

The external finish of the transformer, radiators, marshalling areas/kiosks etc. shall be treated to an agreed marine grade painting system providing long term withstand to the environment.

The proposed methods shall be stated in the tender.

19.17 Transformer Rating Diagram & Valve Plates

The following plates, or an approved combined plate, shall be fixed to the

Transformer inside the low voltage cubicle:

a) A rating plate with the data specified in IEC 60076.1. This plate shall also include a space for the Employer's serial number

b) A diagram plate, showing in an approved manner, the internal connections and the voltage vector relationship of the different windings, in accordance with IEC 60076 Part 1 with the Transformer voltage ratio for the tap ranges and, if standard, a plan view of the Transformer giving the correct physical relationship of the terminals

Plates are to be stainless steel or another approved material capable for continuous outdoor service and withstanding the climatic conditions of the site.

19.18 Transformer Bund & Mounting

The Contractor shall construct a leak proof concrete bund around the base of the transformer and securely mount the transformer on a plinth within the bund. The purpose of the bund is to contain the transformer oil in the case of loss of oil from the transformer. The bund shall have a sump and a drain from the sump to an oily water separator or via a self-sealing petrochemical plug.

20.0 MANUFACTURER'S TESTING

All equipment shall be tested at the manufacturer's works accordance with the equipment supply standards.

These tests shall include:

1. Micro ohm meter tests on all busbar joints

2. Dielectric tests

3. Contact resistance on circuit breakers
4. Functional tests on all circuit breakers
5. Ratio and impedance tests on current transformers
6. Primary injection testing of all protective relays and devices.
7. Insulation resistance
8. Earth continuity
9. Functional sequence testing, interlocking testing and operational testing

SECTION VI PART D

TECHNICAL REQUIREMENTS

INSTRUMENTATION AND CONTROL SYSTEM

1.0 GENERAL

This Part of the specification covers the general requirements for instrumentation and control equipment for the Steamfield

Reference within this Part does not automatically indicate that the particular form of instrumentation is required on this project or will be acceptable for particular application.

In addition to the requirements of this Part all equipment offered to meet the requirements of instrumentation and control shall also comply where appropriate with other general technical requirements of this specification.

This specification does not however relieve the Contractor of his responsibility for the basic design and execution of the instrumentation and control system as per scope of supply in relevant chapters of this specification. The rules of good engineering practice and the relevant approved standards and regulations shall be observed.

A consistent control and instrumentation philosophy shall apply throughout the plant and shall be implemented in terms of a range of equipment exhibiting a minimum diversity of type and manufacture. The objective shall be to standardize all measurement and control equipment throughout the plant in

order to rationalize operation, maintenance and reduce spares holding.

Generally equipment shall be supplied from one composite range of measurement and control equipment as marked by a reputable manufacturer of international standing and shall have a minimum of three years of operational use on similar projects. Details of similar equipment and installations shall be provided. Where particular equipment is not included in the standard range of product of the manufacturer thus necessitating diversity of supply. This equipment shall be identified by the Contractor for approval.

The equipment shall be of modern compact design incorporating the latest developments in proven technology.

Real time indication, recording, logging and integration facilities shall be provided for all those parameters whose trends are considered necessary for safe and efficient operation of the plant and measurement of plant performance. In formulating his proposals the Contractor shall include all variables specifically required for safe start up and shut down to comply with the operational philosophy as given in particular technical requirements.

The Contractor shall list all instruments, alarm and indication initiating devices, instrument transformers etc. he proposes to supply to ensure the safe and efficient operation of the plant. He shall state the supplier he proposes for the instrumentation.

Except where specified otherwise, the design, installation and testing of the instrumentation, control and ancillary systems shall be fully in accordance with BS 6739, ISA, NEMA, IEEE standards or an equivalent standard to the Engineer's approval.

Analogue signals shall be standardized at 4-20 mA in the field.

Direct current plant status and alarm signals shall be standardized on a DC voltage level between 0and 10 volts.

Pneumatic transmission and control signals where offered, shall be of the 0.2 to 1.0 bar (3-15 psi) standard range.

Measurement and control instrumentation shall have high electromagnetic and radio frequency interference immunity and shall not be affected by mobile phone to portable radio transmitters operated in the vicinity of the equipment. Open door cubicles have to be immune to EMC influences (relevant EMC standards). Any limitations shall be stated.

All the equipment shall be suitable for the location in which it is to be mounted and in particular all outdoor equipment shall be suitable for the prevailing climatic conditions.

The appropriate class for items of control and instrumentation shall be determined from the specified or intended location and the intended class shall be stated. Instruments and devices located in hazardous areas shall be of suitable explosion proof type and intrinsically safe type.

All instruments whether for local indication or remote transmission shall be of good quality and shall have an accuracy and repeatability appropriate to their duty.

The accuracy and repeatability of each instrument offered shall be stated and be certified when supplied, by means of supporting documentation such as calibration sheets, testing certification and data sheets.

All electronic devices shall be protected against transient voltage levels/short circuits which would otherwise damage the device.

The ranges of all instruments shall be arranged, where practicable, so that normal working indication is at approximately 60% of full scale deflection with the exception of devices based on a square root relationship which shall normally work at 75%.

Measurement and control instruments shall be matched to the main plant equipment ratings in all aspects. Instrument ranges, installation codes of practice and precautionary measures for the safety of the Plant and the operation & maintenance personnel shall be observed.

Each field mounted instrument or device shall be properly labelled/ tagged as detailed in the general technical requirements. All instruments shall be identified by appropriate tag numbers; permanent non-perishable nameplates attached to each instrument shall be used for this purpose.

Further, every such instrument or device incorporating an indicator shall also be labelled with its duty description.

Each transducer shall have its own tapping point and sensor (except where this is physically impossible which shall then be assessed and approved by the Engineer). In particular all transmitters to be used for protection and control shall have their own separate tapping points.

All type of instrument devices, such as indicator, switches, transmitters, etc. shall be installed in such a manner as to facilitate easy removal of the device without causing shutdown of the process, if not related to safety measures of plant.

All instruments shall be installed and connected so that on-site calibration using portable test equipment is possible, without removal of the instrument from the process line.

2.0 REFERENCES AND STANDARDS

The works for instrumentation, control and supervisory systems will have to be designed, manufactured and tested according to the relevant codes, standards, rules, and regulations as listed below, all in latest valid edition.

In case any inconsistency or conflict between the different specifications, codes, forms or drawings and standards, the more restrictive shall be applied. The inconsistency shall be brought to the attention of the Employer for resolution. Information regarding inconsistencies not brought to Employer's attention could result in the rejection of the proposal.

- IEC 60034 Rotating electrical machines – Part 1 rating and performance
- IEC 60079 Electrical apparatus for explosive gas atmospheres Part 11: Equipment protection by intrinsic safety "i"
- IEC 60255-151 class-II for over voltage
- IEC 60529 Specification for degrees of protection provided by enclosures. IEC 60584-1 Thermocouples – reference tables

- IEC 60751 Industrial platinum resistance thermometer sensors
- IEC 61131 Programmable controllers
- IEC 61508 safety integrity level (SIL)
- ISO 2954 Mechanical vibration of rotating and reciprocating machinery.
- ISO 5167 Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full

  Part 1: General principles and requirements

  Part 2: orifice plates

  Part 3: nozzles and venturi nozzles.

  Part 4: venturi tubes

- ISO 7919 Mechanical vibration of machines.
- ISO 10716 for Mechanical vibration of rotating equipment.
- ISO 10816 Mechanical vibration – evaluation of machine vibration
- ISO 13373 Condition monitoring and diagnostics of machines – vibration condition monitoring
- API 670 for Mechanical vibration of rotating equipment.
- EN 837-1 Bourdon type pressure and vacuum gauges. EN55011 for noise disturbance
- ASME B36.10M Welded and seamless wrought steel pipe
- BS 1041 Code for temperature measurement.
- BS 3693 Recommendations for the design of scales and index.
- BS 6739 Code of Practice for instrumentation in Process Control Systems: installation, design and practice.
- Approval for BMS/ BPS by third party (TUV)

3.0 INSTRUMENTS

3.1 General

Instruments shall have the following characteristics:

- be rated at IP 65 in accordance with IEC 60529;
- be suitable for use in a geothermal environment;
- Transmitters to be Fieldbus compliant.
- All instrumentation shall be HART capable, with Cluster PLC IO modules Hart compatible. All instrument HART configuration shall be available from the DCS at the power station.

3.2 Materials of Construction

Materials used for the construction of all instruments shall be selected for their suitability for continuous operation in the corrosive atmosphere of geothermal Steamfield in a tropical environment.

Materials shall be selected so as to preclude the occurrence of galvanic or any other type of corrosion.

All components in contact with the process fluid and exposed to environment shall be 316 Stainless Steel unless otherwise specified.

Details of materials allowable for use are included in the General Technical Requirements.

3.3 Field Devices Mounting Arrangements

The contractor shall provide all mounting hardware such as bolts, brackets, nuts and washers for all devices to be installed.

The mounting arrangement shall be as per the Contractor's standard but subject to the following general requirements:

- The mounting arrangement shall be rigid and vibration free.
- All components used (posts, brackets, fixings) shall be corrosion Protected.
- All indicating instruments shall be mounted such that the display is in an accessible location.

The Contractor shall provide details of the instrument installation standards as part of the Employer's design review. Any non-standard mounting arrangements shall be subject to Employer's review and agreement.

3.4 Electrical/Pneumatic Characteristics

All analogue measurements from the process equipment that are being utilised for remote indication and control purposes shall be transmitted as a standard 4-20 mA dc output signal, unless otherwise accepted by the Owner's Representative.

Transmitters and transducers shall be solid state electronic devices suitably designed for the location and services required.

Unless specifically agreed otherwise all transmitters shall be "SMART" and be compatible with the HART protocol. All configuration parameters shall be stored in non-volatile memory.

The Contractor shall take precautions to minimise the risk of damage to the instruments and transmitters associated with electrical surges induced by lightning and or other electrical disturbances. Surge protection shall be fitted on any instrument where the risk of damage cannot be mitigated by other specific measures.

Electronic transmitters shall not mal-operate in the presence of electromagnetic or radio interference.

Electrical switch contacts shall be rated so that the minimum, switching and current carrying rating is appropriate for the required duty cycle. Unless specified otherwise switch contacts shall be DPDT rated at 10 A, 220 V AC and 5 A 24 VDC.

All wiring shall be of tinned copper throughout and not just at termination points. All termination

assemblies shall be weather-proof suitable for outdoor mounting in the environment specified. Terminations, lugs and similar exposed or likely to be exposed to the environment shall be tin- plated.

Cable entry to a field mounted devices and instruments shall be via stainless steel cable glands having a minimum rating of IP66.

3.5 Enclosures

All outdoor enclosures containing circuits with nominal voltages up to 1,000 Vac and 1,500 Vdc shall be manufactured from stainless steel and rated to IP66 to prevent the equipment performance being affected by the ingress of dust or moisture.

3.6 Instrument Junction Box

The instrument junction boxes shall be of gauge 14 316L stainless steel constructions seams continuously welded and ground smooth, with no holes or knockouts. The instrument junction box shall have seamless foam-in- place gasket for watertight and dust-tight seal. The junction boxes shall have a rolled-up lip around the three sides of the door and all sides of the box opening to exclude liquids and contaminants. All junction boxes shall have minimum environmental rating of NEMA 4X.

Screws and clamps of the junction boxes shall be of stainless steel construction. The door of the junction boxes shall only be removable by pulling the stainless steel hinge pin. All junction boxes shall have stainless steel hasp and staple for padlocking. The junction box shall be provided with external lugs with 8-mm diameter holes for box mounting.

The junction boxes shall have stainless steel panel for mounting of mega blocks, terminators, etc. The junction boxes shall have weldnuts for mounting of the panel and terminal block kits.

All junction boxes shall have a high-impact thermoplastic data pocket. All field junction boxes shall be electro-polish finished.

3.7 Device Identification Tags

All devices shall be supplied with permanently attached, stainless steel, identification tag showing:

- the device tag number
- The Manufacturer's name, model and serial numbers indelibly etched or stamped on to the tag.

Devices to be mounted in panels shall have their identification tag attached to the back plate, or the part of the instrument that will be visible from inside the panel.

Devices not mounted in panels shall have the tags attached by stainless steel wire.

3.8 Device Data Sheets

Data sheets to ISA Standards and containing detailed requirements of specific devices are to be provided in the tender.

3.9 Transmitters

General

All transmitters shall have the following general characteristics:

- SMART transmitters compatible with the HART protocol
- 24V DC loop powered
- 4 - 20 mA Output Multivariable transmitters shall only be used with Employer's agreement. Accuracy shall be 0.25%, or better, of calibrated span. This includes the combined effects of linearity, hysteresis and repeatability. The stability shall be equal or better than ± 0.25% of upper range limit, for 12 months.
  Generally, transmitters shall have local indication using an LCD display with all units in SI

Differential Pressure Transmitters

Differential transmitters shall be "smart" transmitters and be compatible with the HART protocol. The differential pressure transmitters shall be of the force balance diaphragm type.

The differential pressure transmitters shall be able to withstand a differential pressure equal to the full line pressure without affecting calibration.

An integrally mounted 316 stainless steel 3-valves or 5-valve manifold shall be supplied with each differential pressure transmitter.

Pressure Transmitters

Pressure transmitters shall be "smart" transmitters and be compatible with the HART protocol. The gage pressure transmitters shall be of the force balance diaphragm type.

The gage pressure transmitters shall be able to withstand the full line pressure without affecting calibration.

Traditional flange configuration shall be used for each gage pressure transmitter. Process connection of the gage pressure transmitter shall be ½"

FNPT.

Temperature Measurement

Temperature measuring primary elements for distant reading shall be resistance thermometers or thermocouples. The preferred types are as follows:

- BS 1904: platinum resistance thermometer elements
- BS 4937 Part 4: chrome/alumel thermocouples (type K)

If temperature transmitters are used they shall be "smart" transmitters and be compatible with the HART protocol.

Instrument Tubing & Fittings

All process connected instrument tubing shall be ½" OD and 0.049" wall thickness. It shall be seamless, 316 stainless steel, to ASTM A269. Tube lengths shall be a nominal 6m. Tube fittings and couplings shall

be

Swagelok or accepted equivalent. All fittings shall have NPT threads, unless otherwise stated, and be supplied in 316 stainless steel.

Pipework and tubing shall be neatly run and suitably supported in a manner such that no pockets or traps can occur. If either is unavoidable then the Contractor shall provide a suitable drain or vent valve that shall be easily accessible from a floor, permanent platform or walkway. Instrument piping used on liquid services shall be self-venting to the main, while gas and vapour instrument lines shall be self-draining to the main.

Movement of the elements of the Works, where applicable, must be taken into account to avoid damage to the piping and/or connected instrument. Siphon condenser seals or pigtails shall be mounted adjacent to steam pressure instruments to protect the primary element, if necessary. For steam and gas piping all impulse lines shall have a continuous fall back to the pipe. For water and liquid piping there shall be a continuous fall towards the instrument. Where these conditions cannot be met vents shall be included in high points and drains in low points of the pipework.

All connecting lines between tapping points and instruments, transmitters or test points shall have not less than two isolating valves. One isolating valve shall be located at the tapping point and one isolating valve located as near as practicable to the instrument, transmitter or test point. For tapping point valves (at the pipe work) flanged valves are preferred. For pressures greater than 20 bar, two valves shall be located at the tapping point. Tapping point valves shall preferably be ball valves.

The instrument valve located at the instrument, transmitter or test point may form part of an accepted type of instrument valve manifold, and be associated with any necessary vent, test and equalising valves.

Blow-down vent and drain valves are required in the connecting lines and instrument manifolds to all sight glasses, transmitters and instruments. Test valves are required adjacent to all instruments.

All instrument valves shall be located for easy access by maintenance personnel from a floor, permanent platform or walkway.

Isolating valves shall be capable of being locked in the fully open or fully closed position. Each test point valve shall be fitted with a screwed removable plug in the outlet.

All tapping point isolating and blow-down valves shall be supplied by the Contractor with accepted valve labels in permanent materials. The label inscription shall consist of the instrument reference, tag number and valve service (primary isolation, blow-down, etc.) See section 2.3.

All tapping points shall:

- include a port to enable “rodding out”
- include a connection to be able to fill the lines with antifreeze

Instrument air signal tubing and air supply connection tubing for pneumatics shall be 3/8” OD and 3000# seamless 316 stainless steel to ASTM A269 unless specified otherwise.

4.0 CONTROL CABLES

Control cables shall have tinned copper conductors with PVC insulation rated for 600 V and PVC overall jacket unless otherwise specified. Instrument cable, single and multiple pairs, shall have an overall shield.

Multiple pairs shall also have each pair shielded. The shields shall consist of an aluminium/mylar tape with a tinned copper drain wire. Braided copper is not allowed for the shields.

Boot lace ferrules shall be used for conductor connections to conventional terminal blocks, unless the terminal is specifically designed for another arrangement.

The Contractor shall not use copper sheathed cables.

5.0 CABINETS

Unless otherwise stated all apparatus shall be accommodated in cubicles.

Special attention shall be taken to ensure that heavy apparatus i.e. power supplies, shall be suitably supported. All the apparatus of solid state type shall be mounted on plug-in cards in cubicles. Similar racks or cubicles shall, as far as possible, be employed for all apparatus.

Cabinets shall be of fabricated steel construction of minimum thickness 2 mm, galvanized, dustproof, vermin proof to IP54 and so designed that condensation shall not affect the insulation of the terminal blocks or cables.

Sufficient space shall be included in the cubicle for terminals and cable trunking. The trunking shall not be overfilled and adequate space shall be allowed for easy removal of lower cables. All spare cables shall be contained in the trunking.

Cabinets shall be complete with all necessary terminal blocks, wiring, washers or tags, wiring ferrules, labels and door locks. All cabinets shall accept a common key for locking.

In each cabinet circuits shall be grouped and labelled according to function (i.e. system control, alarm and tripping circuits, telephone circuits, etc.), with the labels attached to the fixed portion of the terminal boards. Terminals shall be provided for connecting the screens of screened twisted pair cables or the overall screen on multicore cables and shall be adjacent to the termination of the associated twisted pair.

The lowest mounting point, plug-in group or terminal block shall be not less than 300 mm above floor level.

Racks and cubicles shall be complete with all necessary tag blocks, terminal blocks, cable glands and gland plates for small wiring and multicore cables, and earth bar with earthing connection. These items shall be located in an approved, easily accessible, position and so arranged that the terminals face the access direction for convenience during maintenance. Terminals shall be provided for connecting the screens of screened twisted pair cables or the overall screen on multicore cables.

Cubicle doors shall be provided with lift-off type hinges and arranged to lie flat back and not restrict access to the panel. They shall be secured by handles with integral locking, and they shall be sealed with a gasket of rubber or other accepted material.

A panel heater of accepted type shall be fitted in each cubicle, thermostatically controlled and with an on/off switch.

The interior of the cubicles shall be painted white or some other approved colour and a lamp shall be fitted inside each cubicle and so arranged that the wiring is illuminated as evenly as possible without dazzle. The exterior shall be finished in an approved colour preferably of light tone in keeping with the powerhouse aesthetics.

The cubicles shall be complete with all necessary internal wiring, resistances, cable boxes and gland plates, terminal boards, fixings, four cornered panel key plus locking facility, screens and accessories.

Labels shall be provided on the front and back of the panels and the outside of cubicle doors to identify them. All components, cables and control panel wiring shall be labelled to the acceptance of the Employer, and details recorded on as-built drawings.

6.0 PLC SYSTEMS

The Programmable Logic Controllers (PLC) shall be in compliance with the IEC 61131 standard (the term PLC herein being equivalent to the term PC (Programmable Controller) in the IEC 61131 standard).

The following IEC 61131 standard severity classes shall apply:

- Voltage drops and interruptions (for DC supply) PS2.
- Operating ambient temperature humidity RH-2.
- Electrostatic discharge service conditions ESD-4.

All the tests defined in the IEC 61131-2 standard shall apply and test certificates shall be provided as evidence of compliance.

It shall be possible to replace faulty modules on-line while the power supply is switched on without causing any further damage (hot swappable). It shall be possible to add and use an additional module while the controller is on- line. The modules shall be "keyed" so only the same type of module can replace a module that is removed.

Non-volatile flash memory shall be used to store the application program and configuration. Any Battery backed up RAM shall have a retention time of a minimum of 40 days.

The field wiring shall be terminated in separate rail mounted screw terminal blocks for each cable, and interconnected to the processor I/O with internal panel wiring.

Additional I/O points shall be easily obtained by plugging in additional I/O boards in slots or bases provided.

Each I/O point shall be furnished with:

a) Protective network, such as optical coupling and/or other isolating barriers.
b) Filter for noise rejection.
c) Test points and fault indication lamps.
d) Fuse protection and fuse failure detection (for inputs only, grouped fuse protection for a maximum number of 8 digital inputs or 8 digital outputs shall be accepted). Individual fuses shall be used for analog inputs and outputs
e) Modules shall monitor their own operational status and any internal error or anomalous condition shall raise an alarm.

A specialized module shall be provided to take its inputs directly from resistance temperature detectors (RTD) embedded within field equipment and to calculate the local temperature of the equipment. RTD inputs shall support 3-wire connections from 100 ohm platinum RTDs.

The PLC shall support communications with the higher level system (HMI layer) via 100BaseTX (IEEE 802.3) or Gigabit Ethernet LAN.

The PLC shall have ethernet ports to connect to IEDs. The protocols supported shall include DNP3 and Modbus/TCP.

Programming and debugging utility software, for the PLC and all Contractor supplied third party devices, shall be supplied with the PLC and this shall be installed on the main and portable engineering workstation computers.

The system shall meet the following criteria:

a) It shall be possible to connect and disconnect the programming and debugging system while the PLC is online.
b) It shall allow on-line modification of the application program.

6.1 Configuration Software, Licences, and Software Utilities

All configuration software for the PLC system, or any monitoring, calibration or adjustment software for any field instruments shall be provided. Where licenses are required for software this shall be taken out in the name of the Principle. All software shall be delivered as CD copies complete with installation software.

6.2 Electronic Equipment Assemblies

Modules and parts of all solid-state equipment shall be built up from proven modules and components. Unproven equipment will not be accepted and the Contractor shall include details of the history of the solid-state control equipment offered. In particular, they should include information on the type of system, the unit size, the in-service date and the extent of automation employed.

All components shall be conservatively rated. The surface temperature of any component shall be at least 5 degrees C lower than maximum test operating temperature of the equipment.

The printed circuit (PC) cards shall be withdrawable plug-in modules mounted on standard width racks, which when mounted in racks or cubicles shall give full clear front and rear access to the cards and their connectors.

All printed circuit (PC) cards and any other electronic assemblies shall have a conformal coating suitable to the environment.

Where it is necessary to mount equipment at the rear of card frames, the mounting shall be arranged on hinges to facilitate access to the card frames and wiring.

Withdrawable cards, modules and cable plugs shall be key coded or otherwise marked to ensure there is no possibility of replacement in the wrong position.

Card frames shall be equipped with locking devices to prevent the unplugging of boards due to vibration or accidental disturbances.

Joints in cubicle internal wiring and in wiring between cubicles will not be permitted.

The following information shall be supplied, prior to installation, for each component used:

a) Name of manufacturer/distributor.

b) Data sheet giving the complete specification for the component.

6.3 Sequence of Events

All wired digital inputs, including remote IO, shall be capable of being designated as Sequence-of-Events points. All Sequence-of-Events inputs shall be capable of resolving and time-stamping the transition of each digital input to within ±5mSec.

6.4 Power Supplies

The PLC system shall be powered from a 24VDC system.

The controllers themselves, I/O modules and control network equipment shall be powered by dual redundant 24V DC power supplies backed up by sealed lead acid batteries. The chargers for the batteries shall communicate status, alarms and voltage measurements via the communication link to the SCADA system.

Essential common DC supplies shall be powered from diode combined supplies with the diode combination being at the lowest control supply voltage.

The PLC system shall be powered from a 24VDC system.

The controllers themselves, I/O modules and control network equipment shall be powered by dual redundant 24V DC power supplies backed up by sealed lead acid batteries. The chargers for the batteries shall communicate status, alarms and voltage measurements via the communication link to the SCADA system.

Essential common DC supplies shall be powered from diode combined supplies with the diode combination being at the lowest control supply voltage.

SECTION VI PART E

TECHNICAL REQUIREMENTS

CIVIL AND STRUCTURAL WORKS

10.2 GENERAL

The general design and quality criteria given below take preference concerning the civil part over the requirements stated in the other clauses of the specification.

1.1 Scope of Work, Completeness

This specification covers the scope of all civil works in accordance with **Part E** "General" of this specification. The design and execution shall be state of the art, functional and complete in all parts in accordance with this specification.

1.2 Codes and Standards

The civil works shall be designed, manufactured and erected according to the requirements laid down in the recent relevant codes, standards, accident prevention regulations and legal regulations.

The design, all materials, constructions and installations, tests and investigations also on site, shall be as a minimum conform to the latest edition or replacement of the following Codes and Standards (listed in alphabetical order) as far as these standards, codes and regulations are available in an English language edition.

The CONTRACTOR shall provide to the Employer/Engineer a copy of all applied Codes, Standards and regulations in English language.

All materials and the design shall conform to the latest edition or replacement of the following Codes and Standards (listed in alphabetical order):

Design is generally in accordance with the following British Standards

(BS). In design of particular items, Kenyan Standards, American Standards and Codes of Practice (ACI, ASTM, AISC, USBR, AASHTO) have been applied. The following Codes, specifications and Standards shall be adopted for design:

- BS8110 (1997) Structural use of concrete
- BS8007 (1987) Design of concrete structures for retaining aqueous liquids
- BS4449 (1997) Specification for carbon steel bars for the reinforcement of concrete

- BS4482 (1985) Specification for cold reduced steel wire for the reinforcement of concrete
- BS4449 (1985) Specification of steel fabric for the reinforcement of concrete
- BS5400 (1988) Steel, concrete and composite bridges
- BS4466 (1981) Bending dimensions and scheduling of reinforcement for concrete
- BS 6399 Design Loading for Buildings
- BS 6399 Design Loading for Buildings Part 2 Wind Loading
- BS 8004 (1986) Code of practice for foundations (formerly CP 2004)
- BS 8002 (1994) Earth Retaining Structures

- Code of Practice – Earthquake Design in Kenya
- Uniform Building Code, UBC 1997
- ASCE 7-05 Minimum Design Loads for Buildings and Other Structures
- BS EN ISO 14122 Safety of Machinery, Permanent Means of
- Access to Machinery, (or OSHA Part 1910 Occupational Safety and
- Health Standards)
- BS 5950: Structural Use of Steelwork in Buildings
- Ministry of Roads and Public Works: Road Design Manual. Parts 1-4
- American Society of Testing and Materials
- BS EN ISO 1461 Hot dip galvanized coatings on fabricated iron and steel articles
- The civil-structural works shall also comply with:
- The project's Environmental and Social Impact Assessment (ESIA)
- The associated approved Environmental and Social Management Plan
- (ESMP)
- The Memorandum of Understanding between Kenya Wildlife Service and KenGen for Geothermal Development in Hell's Gate and Longonot National Parks
- Design of unreinforced concrete is in accordance with ACI 318.1-83 "Building requirement for structural plain concrete" where not covered by BS 8110 and 8007.
- Load factors and safety factors for structural design will be in accordance with the structural design codes.

1.3 Design Criteria for Layout, Arrangement, Drawings, Execution

Design Life and Importance

Design of structures shall be based on a plant working design life of 25 years.

All major structures shall be designed with an importance level of an essential or power generating facility.

All other structures such as platforms shall be given an importance factor 1.0.

Design of drainage structures, roads and slope protection works shall be based on a design life of 20 years.

The design vehicles shall be in accordance with the bridge design code, however, the roads and associated structures shall be designed for drill rigs where these may be moved around the site.

Basic requirements for all civil works

- The design of all structures under this contract shall be such that differential and total settlements or other movements shall not exceed acceptable limits and full provision shall be made for all expansion and other joints. The design shall be to the approval of the Employer/Engineer
- Structural members subjected to flexure shall be designed to have adequate stiffness to limit deflections or any deformations that affect strength or serviceability of a structure adversely. The maximum allowable deflections of structural members shall be in accordance with the relevant design standards and/or the limits prescribed by the equipment manufacturers (whichever is less)
- The foundations subjected to vibrations (the primary source of these vibrations being the unbalanced forces generated by rotating or reciprocating equipment) shall be designed such that vibrations will be neither intolerable nor troublesome to personnel, and will not cause damage to the equipment or structure.
- The natural frequency of the whole of the superstructures and foundations or parts thereof and all structures adjacent thereto shall not coincide with the operating frequency of the vibrating plant.
- The differences between frequencies and the dynamic analysis of the superstructures and foundations shall be in accordance with the relevant design standard.
- Attention shall be paid to the extremely aggressive environment. High ambient temperatures, humidity (salinity) and sand storms necessitate a close attention to design and choice of materials
- All channels, basins and basements shall be carried out with pump sumps for evacuation of leakages by manually operated drainage pumps.
- All materials used in the Works shall be of the best quality of their respective kinds as specified herein, obtained from sources and suppliers approved by the Employer/Engineer or his representative and shall comply strictly with the tests prescribed hereinafter or, where tests are not laid down in this Specification, with the requirements of the latest issue of the relevant American, British, or other Standards approved by the Employer/Engineer.
- For all materials proposed to be used in the works samples may be called for at any time by the Employer/Engineer.
- The work shall be carried out by competent personnel skilled in their various trades.
- Before commencing the works the CONTRACTOR shall ascertain the locations and nature of all existing underground services and shall take every possible precaution against any damage occurring to them or interference therewith, during the execution of the works.
- In case of existence of any equipment, components, valves, instruments etc. complete for operation & maintenance use irrespective of the frequency for operating and maintaining them suitable access to the roof shall be by means of stairways. For roofs without any equipment, components, valves, instruments etc. suitable access to the roofs of the buildings shall be provided for maintenance and inspection by means of galvanized ladders conform to BS 421.
- All rooms with fire hazard shall be provided with suitable emergency exits.

- Proper access roads shall be provided to bring in all the equipment and to take them out in case of maintenance. These access roads shall be suitable for the vehicles (cars, forklifts, trucks/trailers etc.) that will be used to reach up to the point of unloading the equipment.
- All main routings (culverts/tunnels/trenches/duct banks/ducts) shall be submitted by the CONTRACTOR for approval by the Employer/Engineer.
- If a culvert(s), and/or tunnel(s), trench(s) or any other underground services are crossing roads, the road shall be constructed as a bridge for truck loading without affecting the underground structures.
- Before starting of design works, the CONTRACTOR shall submit to the Employer/Engineer for approval the project design manual containing the design data and the detailed design criteria for all civil works. Design works shall commence only after approval of the project design manual by the Employer/Engineer.
- All civil designs and drawings, inclusive of all steel designs and drawings shall be approved by the relevant authorities of Kenya before the start of the construction. If the CONTRACTOR and/or his Subcontractor(s) starts with the production of construction elements, etc. off site and/or on site, before that approval was given, all changes in CONTRACTOR's work caused by disapproval and/or remarks will be fully on CONTRACTOR's risk.

1.3.1 Design Loads

The various types of loads are defined as follows:

Dead Load

Dead load is defined as the weight of all permanent construction members, including foundations, stairways, and fixed service equipment.

For heavy industrial work, this would include equipment, vessels, including internals, pipes, valves, and accessories, electrical and lighting conduits, switchgear, instrumentation, fireproofing, insulation; ladders, platforms, and other similar items.

Equipment and piping shall be considered empty of product load when calculating dead load. The gravity weight of soil overburden shall be considered as dead load.

Erection Dead Load

The erection dead load is the weight of the equipment at time of erection plus the weight of the foundation. The foundation weight is the combined weight of the footing, pedestal and overburden soil.

Live Load

Live load is defined as the weight superimposed by the use and occupancy of the building or other structure, but not permanently attached to it. For industrial design, live load can be defined as the load produced by personnel, moveable equipment, tools, and other items temporarily placed on the structure, but not permanently attached to it.

Crane loads shall be considered as live load unless specified otherwise, The Employer/Engineer's consent

is required in all cases for reductions of load carrying capacities and for exceeding the permissible

stresses in exceptional cases.

Product Load

The load shall be defined as the gravity load imposed by liquid, solid, or viscous materials in vessels, tanks, equipment or piping during operation.

Test Load

The test load shall be defined as the gravity load imposed by any method necessary to test vessels, tanks, equipment or piping.

Thermal Load

Thermal loads shall be defined as forces caused by changes in temperature.

The primary source of thermal loads in an industrial plant is the expansion or contraction of vessels and piping. Another source of thermal loads in a redundant structure is the expansion or contraction of the entire structure or individual structural components.

Impact Load

Any live load that can produce a dynamic effect (such as a moving load) shall be increased by an impact factor.

Truck Load

Structures accessible to trucks shall be designed to withstand the gravity, lateral and impact effects of truck loading.

Soil Load

Soil loads shall include of lateral earth pressures. Active and passive coefficients for lateral pressures shall be obtained from the project soils report. The weight of soil shall be considered as dead load.

Hydrostatic Load & Buoyancy

Hydrostatic load is the load due to water pressure. The design of structures shall include hydrostatic loads when applicable. The buoyancy load is equal to the weight of the volume of displaced water.

Wind Load

Design wind forces will depend on Facility Site wind conditions and on the shape, size, and exposure of the various structures comprising the Works and the Facility.

All building and structures shall be designed for wind loading in accordance with the following criteria:

Design Code/Standard Reference: BS 6399 Part 2

Design Wind Speed: 36m/s (3s gust) with a 10% probability of exceedance more than 50 years

The CONTRACTOR shall verify the maximum wind load from the relevant authorities.

Earthquake Loads

All buildings, structures and foundations shall be designed and adopt necessary earthquake design criteria.

Seismic design shall be in accordance with Uniform Building Code 1997: Seismic Zone: 3 (need to be confirmed by Soil Investigation Report)

Soil Profile Type: SD (need to be confirmed by Soil Investigation Report)

For civil works only:

All supporting structures shall be designed for seismic load

Dynamic Loads

Each structure shall be designed to withstand the effects of vibration and impact to which it may be subjected. Each structure and foundation supporting a compressor, turbine, pump or other machinery having significant dynamic unbalance shall be designed to resist the peak loads specified by the manufacturer. Vibration amplitudes of the supporting structure or foundation shall be kept within acceptable limits for dynamic forces that occur during normal machine operation. In the case of a tall and slender structure, there may be a need to investigate the dynamic effects of wind gusts. The vibration pad for absorption of vibration due to rotating or reciprocating machine shall be suitably designed to reach maximum thickness of material required and its complete spreading below the entire foundation.

Surge Load

Surge loads may occur in some vessels or equipment. In such cases, the magnitude and direction of the load shall be given by the equipment supplier.

Miscellaneous Loads

Miscellaneous loads shall be defined as loads that do not fit into the categories listed in this clause. Typical miscellaneous loads are loads, during erection, maintenance and repair or forces due to creep, shrinkage, or settlement.

For the design of the individual structural components realistic load combinations in accordance with the relevant design standards shall be considered.

All loadings considered in the design shall be justified with supporting details.

All computer calculations shall be followed by explanation of the program in detail.

1.3.2 Tolerances

The following tolerances for buildings and structures are binding:

- For setting-out and as-built measurements, the position shall be within the following limits:
  Foundation and vessels ± 10mm

- For elevations the following limits shall be observed: Foundations
  ± 10mm

- For settlement measurements:
  For each settlement measurement, the levelling instrument shall be checked by levelling from the center and adjusting as required. The results shall be recorded in a Surveyor's Field Book. The so called base measurement shall in all cases be carried out twice completely independently. The base measurement shall not have any point obtained by an intermediate sighting. The closing error for all levelling operations shall not exceed 3 mm and the heights of the individual points obtained from 2 levelling operations shall not differ from each other by more than 2 mm after distribution of the errors.

In the settlement measurements, one measurement is sufficient, provided the following requirement is satisfied:

- check of the starting point
- from the starting point, levelling out and back to the next settlement bolt, maximum difference 2 mm from the settlement bolt for which the height has been determined, a loop levelling (without intermediate sighting) back to the starting point, with a closing error of less than 3 mm.

  The values stated here are minimum requirements. In the case of structures which are especially sensitive to settlement or for built-in items of plant, tighter tolerances may be necessary.

1.4.3 Clearances & Dimensions

For walkways, footpath access to machinery and plants the minimum clearance shall not be less than 2.30 m in height and 100 cm in width.

Fire escape paths shall not be longer than 30 m or less than 1.0 m wide. If not indicated differently, erection routes shall be dimensioned in all directions 0.3 m greater than the biggest part which has to be transported, together with its transportation means.

The protection devices shall be in accordance with applicable safety regulations.

All platforms, galleries and stairways shall be provided with guard rails and kick plates on all sides.

Wherever possible, the angle of slope for stairways shall be standardized at about 34° or 35° to the horizontal, depending on the location and the frequency of use. No flights shall have more than 16 risers. Only stairways of secondary importance (subject to Employer/Engineer's approval) may be carried out in an angle of about 36°, corresponding to a riser of approximately 190 mm and a tread width of 250 mm. Where a stairway height exceeds 16 risers, each flight shall be equally separated by a landing.

Risers and treads shall be in accordance with the following:

	Riser		Tread	
Angle of slope	Min. (mm)	Max. (mm)	min. (mm)	Max. (mm)
34°	175	185	260	280
35°	180	190	250	270

Minimum clearance of rooms shall be 2.50 m in general, for secondary rooms 2.30 m are accepted.

1.3.4 Special Requirements for Materials to Avoid Corrosion Problems –

Reinforced Concrete

1.3.4.1 General

Due to very severe climatic conditions in the project area, special measures are necessary to protect the different materials from corrosion. In this context the following materials require protection measures:

1.3.4.2 Corrosion Protection of Reinforced Concrete

The most common type of failure of reinforced concrete is that of corrosion of the embedded reinforcing steel usually due to penetration of chlorides and sulphates into the concrete.

The following design codes shall be used for the corrosion protection of reinforced concrete structures:

- NACE RP0187-87:
  Design Considerations for Corrosion Control of Reinforcing Steel in

  Concrete Structures

- NACE RP0390-90:
  Maintenance and Rehabilitation Considerations for Corrosion Control of Existing Steel Reinforced Concrete Structures

The following special design aspects shall be considered by the CONTRACTOR:

- Concrete surfaces where seawater/seawater spray/chemicals/etc. might accumulate, shall be provided with an approved slope
- for the same reason as above, the relevant edges shall be chamfered in order to control the size and mitigate the occurrence of cracks and to ensure concrete durability, the CONTRACTOR shall implement the following general design requirements:
- limit the tensile stress in reinforcement
- use smaller reinforcing bars well distributed over the zone of maximum concrete tension
- increase minimum cover on all reinforcing steel
- use Portland cement conforming to the requirements of ASTM C150, Type I

- use very dense concrete with low water/cement ratio (i.e. 0.38 ± 0.02)
- Provide foundation tanking for any structure in contact with ground water and protective coating for above ground water level.
- provide strict measures for concrete curing to prevent plastic shrinkage and thermal gradients resulting from early age heat of hydration of fresh concrete
- protect inserts, anchor bolts and all steel items embedded in the concrete from corrosion
- prevent the usage of steel profiles in small concrete sections
- identify clearly the locations of the construction joints and expansion joints as well as their surface preparation in the drawings
- Incorporate other factors to increase concrete durability in concrete specifications, such as special measures for concrete protection in especially for hot weather concreting etc.
- Give special consideration for the protection of concrete surfaces subject to high temperatures during plant operations.

Depending on the place of use, the special corrosion protection measures for reinforced concrete shall be as follows:

1) Concrete Exposed To Underground and Ground Water

- Minimum concrete cover 75 mm
- Epoxy coated rebars or
- Cathodic prevention/protection of rebars with impressed current from an external current source.
- Micro silica additions, consisting of a powder, which added to the concrete has the property of greatly reducing its permeability. This shall be provided in accordance with the Norwegian Standard NS 3045 and
- Canadian National Standard CAN/CSA-A23.5-M86
- outside protection by tanking membranes and protection boards, with membranes extending 15 cm above ground level.

2) Concrete above Ground

- minimum concrete cover as stipulated in ACI 318
- micro silica additions
- outside protection (rendering, epoxy coating)
- epoxy coated rebars

3) Foundations for equipment, pipe racks, etc. Situated outside, but without exposure to chemicals, seawater, etc.

Minimum concrete cover 50 mm micro silica additions below ground outside protection by tanking membranes and protection boards, with membranes extending 15 cm above ground level above ground outside protection of concrete by epoxy coating, which consists of a primer penetrating into the concrete

and a compatible top coat epoxy coated rebars

4) Concrete Exposed To Chemicals

- minimum concrete cover 75 mm
- micro silica additions
- below ground outside protection by tanking membranes and protection boards, with membranes extending 15 cm above ground level
- acid/alkali resistant tiles fixed with acid/alkali resistant mortar and grouted with acid/alkali resisting grout
- epoxy coated rebars

1.3.5 Special Requirements for Materials to avoid Corrosion Problems –

Steel Structures

All outdoor steelwork including platforms, pipe bridges, stairs and ladders shall be hot dip galvanized and painted. All materials earmarked for galvanising shall be galvanised after fabrication on the same day the surface is sand blasted (or pickled). Galvanising shall occur before assembly by bolting.

The contractor to provide onsite means of measuring galvanising thickness and quality.

The contractor shall provide for witnessing of galvanising process by

Employers Representative/ Employer.

Galvanising procedures shall be in accordance with BS EN ISO 1461 and

ASTM A-123, A-153 and A-385 where applicable contractor to provide onsite means of measuring galvanizing.

The following steel structures shall be hot dip galvanized and painted according to **Part F**:

- Steel structures outside buildings/open air arrangement
- Structures with chemical and/or seawater exposure
- All secondary steel structures (pipe racks, platforms, stairs, railings, ladders, etc.)
- Complete main and secondary steel structures for water production and treatment
- All bolts/nuts (if not of stainless steel)

- The embedded items for inside conditions (no corrosive climate) shall be hot-dip galvanized and shall be adequately painted in addition.
- All anchor bolts shall have a concrete cover of at least 100 mm.

The CONTRACTOR shall provide all technical information and a complete list of all parts to be galvanized for the Employer/Engineer's approval.

Steel shall be coated by the hot-dip process in molten zinc, producing a continuous coating of uniform thickness as specified under **Part F C**orrosion Protection and Painting".

All the structures shall be painted in colours that camouflage with the environment. Colours shall be as approved by the Employers representative and Employer

1.3.5.1 Embedded Items

To avoid cathodic/anodic corrosion between different types of steel all embedded parts for normal outside and inside conditions shall be of a normal steel quality being hot-dip galvanized instead of stainless steel.

In areas with chemical attack stainless steel (316Ti/317L or better) shall be used only.

The embedded items (anchor bolts, fixing elements, etc.) for inside conditions with a non-corrosive climate, shall be hot-dip galvanized and adequately coated.

The embedded items for outside conditions with a normal climatic exposure shall be hot-dip galvanized and adequately coated.

The embedded parts for inside and outside conditions with a corrosive exposure like seawater, seawater spray etc. shall be of stainless steel (type Ti or better).

The embedded items for inside and outside structures with chemical attack shall be of stainless steel (type 316Ti or better).

1.4 Materials (Quality, Delivery, Storage, Handling)

1.4.1General

All materials and related works shall be in accordance with clause E.1.5 of this specification.

Only approved material shall be used. Unapproved material shall be rebuilt and disposed on CONTRACTOR's own charge. Each column base shall have only one size of anchor bolts and nuts.

1.4.2 New/Virgin Materials

Only new/virgin materials shall be used and no recycled material is allowed.

All materials shall be proofed and tested with design certification. Materials shall conform to the requirements and functional in any case.

1.4.3 Material without Long Time Proofing

New materials without long time proofing shall be for approval by the Employer/Engineer before start of construction. The CONTRACTOR shall inform about their use by writing, stating precisely why and how those shall be used.

1.4.4 Materials without Design Certification

If new materials are not yet generally certified by the building authorities but have a specific authorization they shall be forwarded for approval to the Employer/Engineer before start of construction. The CONTRACTORs shall inform about their use by writing, stating precisely why and how those shall be used instead of the state-of-the-art materials.

1.4.5 Samples

The CONTRACTOR shall provide samples of all materials, embedded parts and installations, etc. for the Employer/Engineer's approval before start of construction.

All samples shall be collected and stored in a "sample room" and all approvals shall be consecutively recorded.

1.4.6 Initial Equipment

The specification is drawn up on the assumption that the scope of the initial equipment and consumption materials is to be provided complete in every respect; everything required for the use and care of the installations shall be supplied, even if this is not expressly specified in the documentation.

1.5 Execution (Assembling, Installation)

All civil execution works shall be in accordance with clause D.1.6 of this specification in line with the latest Health, Safety and Environmental rules (HSE).

1.6 QA & QC

All quality assurance and quality control activities for civil works shall be in accordance with Part D.1.7 of this specification.

Before starting of design works, the CONTRACTOR shall submit to the Employer/Engineer for approval the project design manual containing the design data and the detailed design criteria for all civil works. Design works shall commence only after approval of the project design manual by the Employer/Engineer.

2.0 SITE INSTALLATION/DEMOBILIZATION

2.1Scope of Work, Completeness

Site installations with necessary facilities, logistics & short-time pre-assembling, work preparation and storage of equipment or material shall be located on Lay down area. The effected cross transports, inclusive of unloading and offloading, lifts and intermediate storage shall form part of the Proposal; no extra charge for those transports will be accepted by the EMPLOYER. The CONTRACTOR shall be responsible for obtaining all No Objection Certificates (NOC) from various authorities.

After finalization of the works, the Lay down Area shall be reinstated.

For coordination reasons Contractor's site installation plan shall include all relevant information of the complete site installation pertaining to all related works and not merely for civil works.

The scope of work is including all supplies (drinking water, mixing water, gas, diesel oil, electricity, etc.) and disposal (rubbish, waste, sewage, polluted fluids, chemicals, etc.).

2.2 Basic Cleaning

Basic cleaning includes associated outdoor installations and secured surfaces to be taken over without complaint. Advertising boards and stickers, temporary protective coatings and claddings, remains and splashes of paint, shall be removed with water or suitable solvents.

3.0 SITE SUPERVISION/SURVEY/INVESTIGATIONS

3.1 Settlement Measurements

Levelling bolts shall be installed by the CONTRACTOR immediately after construction of foundation slabs and shall be protected from damage by a suitable cover. For the levelling bolts the requirements of DIN 18708 are to be met.

On all installations having foundations smaller than 5m² at least one levelling bolt shall be installed at 1.00 m above finished ground surface. Buildings and bigger installations shall have a minimum of 4 levelling bolts. Additional levelling bolts shall be provided on buildings departed by structural joints or depending upon the importance of the installations.

The position and thus the total number of surveying points shall be decided by the Employer/Engineer in co-operation with the CONTRACTOR, on the basis of the settlement report.

The civil engineering CONTRACTOR shall mark the position of all settlement bolts on his shuttering drawings and shall ensure that these surveying points are not built in as construction proceeds.

In order to keep the number of points which are to be levelled to a minimum, settlement bolts shall be installed on a specific grid. For all measurements the requirements of DIN 4107 shall be met.

Measurements of all levelling bolts are to be executed:

- immediately after setting of the bolt
- immediately after finishing of construction of the building
- prior to the erection of mechanical equipment
- several times during the erection period of the mechanical equipment
- after completion of the buildings/structures and erection of all equipment
- Once before the plant is handed over to the EMPLOYER.

4.0 EARTH WORK

4.1Fill Material

The fill materials used are to be examined and approved. Excavated materials can be used if they are treated physically to fulfil the requirements.

Select Fill

Select fill shall have the following properties:

Hard rock material, broken or classified and well graded (Coefficient of uniformity C_u not less than 6), non-cohesive and content of fines limited to 7% free of soluble salts (content less than 3%), soils free of organic matter (limit 2%). Decomposing or compressible materials shall not be used.

All material shall be of such nature and character that it can be compacted to the specified densities in a reasonable length of time. It shall be free of highly plastic clays, of all materials subject to decay, decomposition or dissolution, and of cinders or other materials which will corrode piping or other metal.

The intention is to use select fill below structures, roads, parking areas etc.

Ordinary Fill

Ordinary fill shall have the following properties:

Natural inorganic soils: salt content not greater than 5%, organic matter less than 3%. For other properties see under 'Select fill'. The intention is to use ordinary fill for non-built areas.

Special Fill

Special fill material shall be gravel or crushed rock (for other properties see under 'Select fill').

The intention is to use special fill e.g. as sub-base material for tanks and roads.

Rip-Rap/Rock Fill

Rip-rap shall be of a size suitable for the place where it is to being used, as determined by the speed of the current, wave height and depth of water. Rip-rap shall be of deformable and yielding construction, using round stones if the intention is to safeguard the underlying ground against scour. If the rock infill shall be used as a foundation for structural components, the aim shall be to secure effective bedding of angular stones under water. The stones shall be weather- and water- proof and shall not suffer any ill effects through the action of seawater. Filter rules are to be observed.

4.1 Execution of Earthworks

The works shall be excavated either by hand or by use of excavating plant and tools acceptable to the Employer/Engineer.

Excavation by hand may be required close to existing installations and/or underground services, but subject to special instruction of the Employer/Engineer.

The CONTRACTOR shall use special instruments/equipment to detect underground live cables of both high and low voltage cables and telephone cables etc. to prevent accidental damage.

The CONTRACTOR shall carry out all kind of earth - and rockwork for the following particular works as defined hereafter (where applicable):

- clearing and grubbing
- excavation of top soil
- open cut excavation
- backfilling

- safety precaution during earthwork
- mining or underground excavation (if required)
- grading
- replacement of material
- trench excavation for service lines
- embankments
- archaeological findings

4.1.1 Safety Precaution

The CONTRACTOR shall be responsible for all necessary safety measures.

Proper strutting, sheeting and bracing, including re-arrangement of the installations when necessary, stabilization and protection of slopes, methods of excavation to reduce risks of slides, etc. shall be to the CONTRACTOR's debit. The additional moving of soil resulting from such damages will not be paid for.

4.1.2 Over Excavation

If somewhere, and for any reason, excavation are executed beyond the established lines and without the Employer/Engineer's previous approval, the CONTRACTOR shall at his own expenses backfill with approved material (including required compaction) or with lean concrete to Employer/Engineer approval, the volume corresponding to over-excavation. He shall not receive payment for over-excavation not ordered.

4.1.3 Stockpiles & Disposal

The CONTRACTOR shall not have the right either to additional payment or to claim because of work involved in stockpiling materials, re-use or for carting to the waste disposal areas. Soil unfit for re-use shall be removed to sites approved by the Employer and shall not be permanently deposited elsewhere. The CONTRACTOR shall trim and form the edges of spoil to profiles and levels as directed by the Employer/Engineer.

The placing of materials within the waste disposal areas shall be made in layers not exceeding 0.50 m in thickness in order to obtain an appreciable degree of compaction by means of transportation equipment and/or if required by appropriate compaction equipment.

All traffic to or from the waste disposal areas shall run over the surface of such areas in order to achieve compaction.

4.1.4 Preparation of Foundations

All rock surfaces on which or against which concrete is to be poured shall be carefully cleaned and roughened to the Employer/Engineer's satisfaction.

The rock surface shall be free of oil, stagnant or running water, mud, loose rock, residue and impurities or any other improper material. Rock faults, depressions, and fractures shall be cleaned to a depth equal to their widths and to sound rock at both sides.

Immediately before concrete placing, all rock surfaces shall be thoroughly cleaned by means of air and

water jets, wire brushes, sand jets or by any other devices necessary to clean the foundation and keep it free of water, but shall be moistened prior to placing concrete.

All earth surfaces, against which concrete is to be poured, shall be clean and free of any detrimental impurities, organic matter or unsuitable material. Immediately after excavation, all such surfaces shall be moistened and treated as directed by the Employer/Engineer and then protected by means of a lean concrete layer, 5 cm in thickness. No concrete is to be poured until formation is inspected and approved by the Employer/Engineer.

4.1.5 Filling & Backfilling

Foundations and structures shall be backfilled as shown on the drawings with approved material compacted in layers by suitable equipment until optimum stability has been obtained to the satisfaction of the Employer/Engineer. Compacting shall be carried out with special care by means of pneumatic or mechanical rollers or other compactors of a type previously approved by the Employer/Engineer. Minimum weight of a plate compactor if used for compaction shall be 750 kg.

For embankments a minimum compaction degree of 95% proctor density shall be achieved.

The thickness of fill layers, number of passes and type of equipment to be used shall be proposed to the Employer/Engineer after compaction tests have been made.

Surfaces receiving fill layers shall, if smooth, be previously scarified to obtain a good key between the new fill layer and the sub-grade.

Backfilling of foundation work with approved materials shall be carried out only after foundations have been inspected by the Employer/Engineer.

4.1.6 Soil Replacement

The material to be used for replacement of soil shall not contain soluble or swelling components such as clays, or organic matters. Sand gravel mixtures of favourable grain size distribution shall be used in exchange. Prior to the commencement of work, three samples shall be taken from the anticipated borrow area and tested in respect of proctor density, optimum moisture content, grain size distribution and content of soluble matters. These three samples shall cover the approximate variation of materials to be expected within the borrow area.

The fill material shall be placed in horizontal layers of no more than 25 cm in compacted thickness. The fill moisture content shall be controlled and adjusted in order to achieve a maximum of compaction. Fresh water shall be used for watering of soils.

The fill material shall be compacted by vibratory roller (min. weight 10T. One proctor and three density tests shall be made at every fourth fill layer prior to continuation of filling work. The testing location will be indicated by the Employer/Engineer. The CONTRACTOR shall either provide all required laboratory facilities and staff to perform the tests or he shall co-operate with an experienced soil testing laboratory, subject to the approval of the Employer/Engineer.

The results of the tests shall be made available to the Employer/Engineer within 24 hours of the tests. Filling work may be continued in case all tests performed show satisfactory results.

4.1.7 Pipe Bed Preparation

Pipe beds shall be constructed to guarantee the uniform transmission of loads. The bearing section for supported profiles shall cover at least an arc of 90°.

Pipes shall be bedded in an earth foundation of uniform density and carefully shaped by means of a template supported at the desired grade, to fit the lower part of the pipe exterior.

Where rock in either ledge or boulder formation is encountered, it shall be removed below grade and replaced with suitable materials in such a manner as to provide a compacted earth cushion having a thickness under the pipe of not less than one quarter of outside pipe diameter with a minimum allowable thickness of 20 cm if not otherwise specified.

Where a firm foundation is not possible at the grade established due to soft, spongy or other unstable soil, all such unstable soil under the pipe and for a width of at least one diameter on each side of the pipe shall be removed and replaced with suitable selected materials as approved by the Employer/Engineer, properly compacted to provide adequate support for the pipe.

4.1.8 Blasting

The CONTRACTOR shall not obtain or make use of any explosives without the express permission in writing by the relevant authorities of Kenya.

The CONTRACTOR shall comply strictly with the regulation as required by the authorities regarding purchase, storage, issuance and use of explosives and transport of same to and from site, and shall be deemed to have included in his Proposal all costs arising from the use, storage and transport of explosives as well as from supervision of blasting by security forces.

Blasting shall furthermore be strictly and in every case subject to the Employer/Engineer's permission.

All blasting shall be carried out by approved experts only and the CONTRACTOR shall be fully liable for any claims arising from damage or alleged damage, injury to the public etc. due to blasting.

The CONTRACTOR shall be insured with an approved insurance EMPLOYER against all claims with respect to damage and injury arising from blasting.

Fuses, detonators or blasting caps shall not be transported or stored together with dynamite or other explosives. The location and design of the storage places, the transportation methods and the precautions that shall be taken to prevent accidents shall be subject to the Employer/Engineer's approval, but it is understood that this approval does not exempt the CONTRACTOR of his responsibility with regard to the handling of dynamite or other explosives.

Drilling and blasting plans shall be submitted well in advance for the Employer/Engineer's approval prior to commencement of any blasting work.

When blasting is carried out, trees, structures etc. in exposed position shall be adequately protected from damage.

Drilling and blasting shall be arranged and, where necessary, the rock being blasted shall be protected so as to prevent any scattering of the rock liable to cause injury to the public or damage to dwellings, buildings and other property and the works.

Blasting shall be carried out carefully to avoid the loosening of rock surfaces that are to remain intact, particularly in those cases where concrete is to be placed directly against these rock surfaces.

4.1.9 Protection of Existing Utilities & Services

During construction the CONTRACTOR shall provide all protection for existing utilities and services as may be required by his construction operations. Permanent protection of certain items shall be as included under other clauses or as instructed by the Employer/Engineer.

In addition to the requirements as specified, herein the CONTRACTOR shall comply with the following requirements.

- Use all necessary precautionary and protective measures required to maintain existing utilities, services and appurtenances that shall be kept in operation. In particular the CONTRACTOR shall take adequate measures to prevent undermining of utilities and services presently in services
- Protect existing or new utilities and services where required by the CONTRACTOR's operations and/or as directed by the Employer/Engineer. The CONTRACTOR shall be responsible for bracing and supporting utilities and services to prevent settlement, displacement or damage.

4.1.10 Dust Control

The CONTRACTOR shall use all means necessary to control dust on roads, construction areas and borrow pits.

Surfaces shall be regularly watered to prevent dust becoming a nuisance for the public and interfering with the proper execution of the works.

4.2 Quality Control and Testing

4.2.1 General

The Control of working and tests operations shall be carried out by the

CONTRACTOR in the presence of the Employer/Engineer.

The CONTRACTOR shall prepare sheets for statistical analysis of the field and laboratory tests, and shall

submit the sheets to the Employer/Engineer for approval. Controlling will consist of field and laboratory tests, such as compaction and density tests, grain-size distribution, and shear tests.

If not otherwise specified under relevant items the following min. tests have to be carried out:

- one (1) test analysing the ingredients of the water used for performance of the work
- three (3) tests for specific gravity of soil as per ASTM D 854 latest issue
- one (1) test for bearing capacity of soil for static load
- three (3) tests for grain size analysis of soils, if "Replacement of Material" is required as per ASTM D 422-63
- Three (3) tests for density of soil in place of sand cone method for each second layer of "Backfilling and/or replacement of material and/or roadwork" are required as per ASTM D 1556 latest issue.

All tests shall be recorded in forms acceptable to the Employer/Engineer.

Tests shall be performed for each 500m^3 of fill but not less than once per shift.

4.2.2 Testing of Select Fill

Select fill, as specified herein shall be provided as follows:

- as fill or backfill within the limits of the structure/building and below basement floors as shown on the drawings to bring the subgrade up to the required elevation or for filling or backfilling against foundations walls and around footings
- As fill beneath foundation slabs or basement floors either to bring local low areas to grade or to replace disturbed or unsuitable soil.

Place select fill in layers of approx. 20 cm (compacted thickness) and compact to the max. Requirement as per DIN 18196 and DIN 1054 or to 100% of maximum dry density according to AASHTO T180 Method 'D'.

Quality control shall establish all of the following values:

- unit dry weight
- heavy dynamic soundings acc. to DIN 4094-1: 20 blows per 10 cm penetration or alternatively, for dutch cone penetration tests acc. to DIN 4094, 20 MN/m^2 point resistance

- plate load test:
- E_{V2} not less than 120 MN/m^2
- E_{V2}/E_{V1} smaller than 2.2 where:
- E_{V1} being the modules of deformation of the first loading process and
  - E_{V2} being the modules of deformation of the second loading process (reloading after relieving once).

4.2.3 Testing of Ordinary Fill

Ordinary fill, as specified herein above, is required for all fill and backfill where special fill or select fill have not been specified on the drawings. Place ordinary fill and compact to the max. Requirement as per DIN 18196 and DIN 1054 or to 95 % of maximum dry density according to AASHTO T180 Method 'D'.

Quality control shall establish all of the following values:

- unit dry weight
- Heavy dynamic soundings as per DIN 4094-1: 16 blows per 10 cm penetration or alternatively, for dutch cone penetration tests, 16 MN/m² point esistance. These values are valid only for non-cohesive soils with silt content lower than 15% plate load test:
    - E_{v2} not less than 60 MN/m² for non-cohesive soils (silt content lower than 15%)
    - E_{V2} not less than 45 MN/m² for cohesive soils
    - E_{V2}/E_{V1} smaller than 2.2 for non-cohesive soils
    - E_{V2}/E_{V1} smaller than 2.5 for cohesive soils

Tests shall be performed for each 500 m^3 of fill but not less than once per shift.

4.6.4 Quality Assurance for Vibro Techniques

Before starting the compaction works, the CONTRACTOR has to prove by tests whether he is able to improve the underground to the above requirements. The test program and vibro pattern is to be proposed by the CONTRACTOR and to be approved by the Engineer, and shall contain a trial compaction, dutch cone tests (before and after the treatment) and big scale load tests comprising at least 4 compaction points covered by a concrete footing.

Placing of suitable soil for capping layer after the vibro floatation or vibro compaction method of soil improvement shall be carried out.

By the vibro compaction, the soil is improved to meet the following dutch cone resistance requirements below the foundation level (in addition to other requirements):

- from 0 to 3 meters: cone resistance increasing linearly to 10 MN/m²
- from 3 to 5 meters: 10 MN/m²
- from 5 to 7 meters:15 MN/m²
- beyond 7:20 MN/m²

The resistance for the first 3 m shall be 10 MN/m², when the tests are done from a level more than 2 m above the foundation level. The results are judged to be successful if not more than 10% of the measured values are below the above requirements. The tests will be performed in the most unfavourable location of a probe group. The number of sounding tests shall be at least one per 100 m², at least 5 for one structure.

Big scale plate load tests are performed, for quality control purposes, at least one per 25,000 m² improved area, at least 3. These tests shall comprise 4 compaction points which shall be loaded to twice the permissible soil pressure.

All test results shall be compiled in test reports, where values obtained are compared with requested values (in diagrams as far as possible, E_s- values derived via settlement calculation from test results).

A method statement and quality control program shall be prepared by the CONTRACTOR and approved by the Employer/Engineer prior to start of vibro works containing at least the above requirements and information about the following:

- description of large scale load test including load steps/waiting time data recording of probe number and depth, date and time of execution, installation time for every probe, gravel consumption (if applicable), power consumption versus time or depth (automatically recorded) etc.

5.0 FOUNDATIONS

5.1 Execution of Foundations

5.1.1 Survey of Foundation Bottom

The soil conditions met during the foundation works especially in the foundation bottom level shall be checked by the CONTRACTOR's soil engineer, recorded and compared with previous known or investigated results. If essential differences occur, which could be detrimental to the structures, the CONTRACTOR has to inform the Employer/Engineer and to propose further measures. Foundation works in such areas are to be continued only after approval of such measures by the Employer/Engineer.

If there is any doubt about the soil quality or if discrepancies appear with regard to the previous decisions or investigations stated by the Employer/Engineer, then additional measures are to be taken after consulting the Employer/Engineer (e.g. additional excavation and lean concrete fill).

Immediately prior to concreting any footing, the CONTRACTOR has to verify the specified soil conditions below the foundation level by a sounding or any other suited method approved by the Employer/Engineer.

If e.g. soil replacement of fill was executed, the sounding shall penetrate that layer completely and being continued at least up to 1 m into the natural soil. The sounding result is to be shown in a diagram and to be presented to the Employer/Engineer prior to concreting. The aim of such soundings is to finally check the proper execution of the foundation measures and to detect any disturbance probably caused by trenching, pits etc. subsequently execute.

For soil improvement works i.e. execution of special foundations (except replacement method) only special contractors (or subcontractors) are acceptable subject to providing proof of experience in successful execution of such works in the form of a detailed description and references. Together with the description and the references a detailed execution program including quality control measures relating to the actual site conditions is to be transferred to the Employer/Engineer for approval.

5.1.2 Foundations at different Depths

Foundations at different levels shall be based beyond a load spread angle of

30°- 45° (against the horizontal) depending on the quality of material. Otherwise, the load influence (e.g. earth pressure from above and settlements due to lateral movements) of the higher level structures on the lower ones shall be taken into consideration.

5.1.3 Replacement

If unsuitable soils are encountered below the foundation level or basement floor, they are to be replaced by select fill material layer wise compacted to the required density as per DIN 1054 down to the bearing soil level.

Materials and compaction method as well as quality control are described in clause 'Earth and Rockworks' of this Part. Select fill shall be employed below all structures (footings and basement floors).

5.2 Settlement Observation

For settlement observation see clause “Settlement Measurements” of this Part.

Settlements of all relevant structures shall be measured, recorded and shown in diagrams according to DIN 4107 "Subsoil; settlement observations during and after construction of structures".

6.0 PILING WORKS

6.1 Materials for Piling

6.1.1 Materials

All materials to be used for the piling works shall meet the requirements as specified under clause "Concrete Works" hereafter.

The origin and quality of steel reinforcement, cement, aggregates, mix water, grouting, and eventual admixtures, will be approved by the Employer/Engineer and have to conform to all applicable standards.

6.1.2 Steel Reinforcement

The piles shall be longitudinally reinforced on the whole length. The pile reinforcement drawings for execution shall be submitted by the CONTRACTOR and approved by the Employer/Engineer.

The length of longitudinal bars above cut-off level is based on the required in raft embedded length according to relevant specifications.

Steel reinforcement used for cast in situ concrete piles consists of high yield steel conforming to clause "Reinforcing steel" of clause "Concrete works" hereafter.

The concrete cover to reinforcement shall be not less than 75 mm and not more than 100 mm.

The minimum ratio of longitudinal bars is 0.8% of the pile cross section, with a minimum of 6 bars not less than 12 mm in diameter. The minimum spacing between longitudinal bars is 15 cm

Helical binding shall be used with a minimum diameter of 10 mm and a maximum pitch of 15 cm.

Reinforcement cage:

- The stirrups shall fit tightly to the longitudinal bars and be fixed to them by steel wires or by welding.

Installation of the reinforcement:

- When the reinforcement cage of a pile is constituted of several parts, the assembling of these parts has to be made before or during the installation within the tube, taking into account the necessary overlapping between the parts.
- The reinforcement cage shall be perfectly centered within the borehole so that the cover over all reinforcement, including binding wire, is not less than 10 cm of concrete. The longitudinal bars may be held apart by spreader forks not more than 1.5 m apart. In any case, the spreader forks and the centering pieces have to be of the same corrosion resistance as the pile steel reinforcement.
- Before installation of the reinforcement cage, the CONTRACTOR checks the complete cleaning of the bottom of the hole. All disturbed soils and debris have to be removed from the hole.
- The reinforcement cage is put into the hole in only one operation. The cage shall remain stable during concreting and removal of the temporary casing. The handling of the cage during loading, unloading and installation within the holes has to be made with care in order to reduce the deformation and to avoid the breaking of the weldings or the binding wires.

6.1.3 Concrete Composition

The proportioning of the concrete mixed by the CONTRACTOR to obtain the specified characteristics and an adequate workability has to be submitted to the approval of the Employer/Engineer.

The concrete shall be as per clause 5.10, "Concrete Works" specified herein.

Concrete composition, production, transport and control testing shall conform to relevant British Standards. The workability measured by standardized procedures shall be adequate for the method of placing used. The water/cement ratio shall not exceed 0.42.

6.2 Execution of Piling Works

6.2.1Program

The program of piling work shall be submitted to the approval of the

Employer/Engineer four weeks before the start of the piling works. Sequence of piling shall be stated.

Three working days prior to the end of each week, the CONTRACTOR shall submit to the Employer/Engineer the detailed piling program for the next week, including adequate notice of his intention to work outside normal hours and at weekends.

When a modification occurs in the program, the CONTRACTOR shall immediately inform the Employer/Engineer. No modifications of the program shall be made without the Employer/Engineer's approval.

6.2.2 Pile Measurements

The lump sum price includes the mobilization/demobilization of all equipment, the setting up on each pile location, and the actual execution of the piles (including boring, installation of the steel reinforcement with embedded length in the raft, anchorage in the rock/soil, supplying and installation of the concrete

etc.).

6.6.3 Qualification

The pile installation shall be undertaken using proven techniques and equipment and shall be implemented by specialist personnel who have extensive experience in carrying out such work. The CONTRACTOR shall provide qualified personnel i.e. a foreman for every piling crew, who shall always be present during the works, as well as a professional engineer, well experienced in piling works, for supervision.

6.2.4 Staking Out-Tolerances

The landmarks to be used for the implementation of the piles shall be effective, solid and well protected.

The method of location of the piles is a duty of the CONTRACTOR. The setting out has to be carried out from the main grid lines of the proposed structures.

The maximum allowed deviation of the piles center from the theoretical location shown on the setting out drawing is 50 mm in any direction. The maximum permitted deviation of the completed pile from the vertical is 20°mm per meter (2.0%).

6.2.5 Cut-off

The piles shall be concreted up to a minimum of 60 cm above the cut-off level.

The cut-off shall eliminate all polluted or poor characteristics concrete at the top of the pile and shall be carried 10 cm into sound concrete. When this sound concrete is found below the cut-off level, the CONTRACTOR shall realize, at his own expenses, a new concreting up to the cut-off level with a full connection to the pile. Any repair shall be approved by the

Employer/Engineer.

The concreting of the raft may start only after the cut-off of the pile and after obtaining a satisfactory resistance of the pile concrete.

The cut-off shall be carefully performed according to a method approved by the Employer/Engineer. The concrete in the head of the pile shall be carefully broken away from the reinforcement which shall then be cleaned and bent as shown on the drawings or as directed. The concrete surface at the cut-off level shall be horizontal, plane and free from all loose aggregate.

6.2.6 Working Platform

The areas where piling operations are to be carried out shall be levelled and kept clear of water to provide a dry stable working platform for the plant and equipment operation.

After completion of the piling works the project site shall be cleaned and all excavated material due to these works shall be removed by the

CONTRACTOR.

6.2.7 Rejection

If a pile is rejected by the Employer/Engineer, the CONTRACTOR has to replace it by others in the vicinity of the rejected pile on instruction of the Employer/Engineer and at no expense for the Employer/Engineer.

The CONTRACTOR shall bear the cost of:

- re-design of pile caps
- extra cost of construction involved due to unsatisfactory or incorrectly positioned piles

6.2.8 Driven Piles – Damages to Neighboring Piles during Driving

In case of damages to the adjacent piles, for example observation of concrete raising in the neighbouring piles, the CONTRACTOR shall alter the driving sequence.

Particular dispositions may be needed and decided with the agreement of the

Employer/Engineer.

The pile driving is carried out following a sequence in order to avoid, as much as possible, increasing of the driving resistance for the last piles.

6.2.9 Driving Procedure

Each pile has to be driven continuously until the specified depth has been reached.

The CONTRACTOR immediately informs the Employer/Engineer in case any unexpected change in driving characteristics occurs and proposes methods to solve the problem. A detailed record of the driving resistance over the full length of the nearest available pile will be taken if required by the Employer/Engineer.

At the start of work (more or less the first 20 piles), sets of blows recordings are taken at intervals during the last 3 meters of the driving to establish the behavior of the piles.

The CONTRACTOR gives adequate notice and provides all facilities to enable the Employer/Engineer to check driving resistances; a set of blows recordings is taken only in the presence of the Employer/Engineer unless otherwise approved.

The final set of blows has to be recorded for each pile either as the penetration in millimetres per 10 blows or as the number of blows required to produce a penetration of 25 mm (see item on piling record of these specifications).

The CONTRACTOR shall take the necessary dispositions to avoid any water or ground insertion into the tube or the concrete.

6.2.10 Concreting of Piles

Before starting concreting, the CONTRACTOR has to check the implantation of the driven tube and verify that no water or soil is present within the tube. A special procedure shall permit to execute this control at any moment.

The poured concrete volume needed by the concreting of each pile has to be measured and noted in the piling record.

In case of successive pouring of dry concrete with tamping, a minimum thickness of concrete shall be maintained within the tube to avoid any insertion of soil or water at the base of the tube. In any case, this thickness shall be larger than the half-diameter of the tube.

In case of continuous pouring of concrete, the concrete has to fill the tube in order that the pile is continuous up to the top level when the tube is removed. If the tube is not long enough to contain a sufficient concrete volume, the complement of concrete is added after raising of the tube over the needed length. The basis of the tube is always 1m below the concrete level except at the cut-off level. The concreting curve is usually drawn up by the CONTRACTOR for one pile by each 50 piles. If the concrete consumption is not normal (under- volume or more than 30% of over volume), special procedures shall be taken by the CONTRACTOR in agreement with the Employer/Engineer.

In case of successive pouring with tamping, the concreting curve is drawn up by measuring the quantities of each pouring of concrete (max. 0.5 m^3) versus the top level of concrete into the tube.

In case of continuous pouring over the full length of the tube, the concreting curve is drawn up by measuring the concrete top level every time the tube is raised over 2 m.

The concrete needed by the concreting of a pile has to be supplied regularly. The waiting times between the concrete trucks may not exceed half an hour. No concreting interruption will be tolerated.

Before starting the concreting, the bottom of the hole has to be cleaned. All loose or disturbed soil shall be removed from the base of the hole. This operation shall be executed immediately before starting the concreting. It means after the introduction of the steel reinforcement cage and not only at the end of the drilling.

If the checking at the base of the pile shows a penetration of sediments between the rock and the end of the steel casing, the CONTRACTOR shall submit to the approval of the Employer/Engineer any method in order to ensure the sealing of the casing within the rock.

All concrete shall be placed by tremie pipe; the starting of the concreting by this method has to be particularly well executed. The good quality of concrete at the base of the pile is of main concern with this operation.

After concreting of each pile, the concrete volume shall be checked in relation with the theoretical bore-hole volume; for this purpose, a concrete- curve shall be drawn up for each pile, truck by truck. A complete concrete curve shall be established from the measurements of concrete consumption every meter on the length of the pile for 1 pile each 50 piles.

The concrete- curves (truck by truck and meter by meter) shall be daily provided to the Employer/Engineer and joined to the piling record.

If the concrete consumption is not normal (under-volumes or more than 30% of over-volumes), special procedures shall be taken by the CONTRACTOR in agreement with the employer/Engineer.

Water level within the hole shall be permanently higher than the groundwater level during concreting.

The hopper and pipe of the tremie shall be clean and water-tight (also the joints between elements). The inner diameter of the tremie pipe shall be at least equal to 4 diameters of the concrete aggregates and shall be never smaller than 15 cm.

The length of the tremie pipe shall be equal to the length of the pile. Before concreting, the pipe shall reach the bottom of the hole and shall be then raised in 15 cm steps. The pipe shall never be located less than 1.5 meter below the level of workable concrete within the pipe.

At all times, a sufficient quantity of workable concrete shall be maintained within the pipe to ensure that the pressure from it exceeds that of the water.

During the extraction, the base of temporary casing shall be located at least

1 meter below the level of fresh concrete.

6.1.11Concrete Control

The compression resistance of 15 cm side concrete cubes has to reach the minimal values of 35N/mm² after 28 days.

For each group of 5 piles, 6 representative cube samples shall at least be taken, 3 shall be tested after 28 days, and the others shall be stored for other tests to be specified by the Employer/Engineer. All costs relative to these control tests are within the scope of the

CONTRACTOR.

6.2 Pile Testing and Records

6.2.1 Piling Records

For each pile, a piling record book giving the main checked values during execution shall be drawn up and updated by the CONTRACTOR with all the work hazards and incidents. That record book shall be submitted daily to the approval of the Employer/Engineer as the execution proceeds.

This record book shall include for each pile details on:

- location, reference number (corresponding to the number fixed on the
- drawing), type and diameter of the pile;
- length of the temporary casing;
- date and hour of start and end of each operation drilling, reinforcement setting, concreting;
- level from which the pile is bored or driven (platform level);
- level at the pile base;
- top level of the concreted pile before the cut-off operation;
- used materials (driving or drilling tools, concreting equipment);
- cleaning results of the bottom of the hole before putting down the reinforcement cage and before concreting;
- nature and description of the encountered soils;
- poured concrete volume and theoretical volume (measured concrete curves);
- behaviour, workability, fluidity of concrete, results of the compression tests;
- water level within the hole before concreting;
- for driven piles, the refusals corresponding to the three last sets of blows
- (10 hammer blows) shall be noted for each pile; for one pile from each
- 20 piles, a driving diagram shall be drown up;

- Type of boring-chisel, lengths of piles where chisel has been used.

Records shall be submitted in duplicate to the Employer/Engineer every following working day until 9 a.m.

The CONTRACTOR shall submit to the approval of the Employer/Engineer a proposal of piling record sheets including all the details mentioned above.

6.7.2 Test Piles & Pile Testing

The CONTRACTOR shall execute static loading tests in the following quantity:

- up to 10 working piles 1 test
- up to 30 working piles 2 tests
- more than 30 working piles 3 tests

The pile(s) to be tested shall be approved by the Employer/Engineer. The procedure to be followed is provided by ASTM D 1143 or by BS 8004 art. 7.5.5.

The maximum test load shall be 2.5 times the working load for preliminary piles (total settlement is not exceeding 7 mm after 24 hours of full load application) and 1.5 times the working load for work piles (total settlement is not exceeding 5 mm after 24 hours of full load application). Integrity tests are to be performed on 100% of the piles.

The loading materials and equipment, the measurement devices and procedures have to be submitted to the Employer/Engineer's approval by the CONTRACTOR.

All tests shall be carried out only under the direction of an experienced and qualified supervisor familiar with the test equipment and test procedure. All personnel operating the test equipment shall have been trained in that field.

The number of increments of load shall be at least four, with a decreasing of load down to zero after each increment.

If tests prove unsuccessful, the CONTRACTOR shall propose all necessary adaptation to the foundations. These proposals shall be submitted to the Employer/Engineer. All costs requested to perform the foundation adaptation shall be at the CONTRACTOR's expense.

7.0 CONCRETE WORKS

7.1 Scope of Work, Completeness

This specification covers the scope of concrete works in accordance with clause B04 “General” of this specification. The design and execution shall be state of the art, functional and complete in all parts in accordance with this specification.

All concrete for the works shall employ the use of Sulphur resisting cement

CEMIII unless directed otherwise by the Employers representative

The following works are covered by this clause:

- furnishing and storage of materials
- equipment and labour for processing of aggregate, mixing, testing, transport, pouring, vibrating, compacting, finishing and curing of concrete

7.2 Civil Design/Engineering

The design and engineering shall be state of the art in accordance with all relevant codes and standards, functional and complete as mentioned above.

In general the specifications for concrete works are based on American standards (ACI and ASTM) mainly ACI 305R, 318/318R, British Standards (BS) mainly BS 8110 part 1 "Structural use of concrete" Dimensional tolerances.

The European Standard BS EN 197-1 which is entitled "Cement - Part 1

Composition, specification and conformity criteria for common cements" was published in 2000 and replaced a number of former British Standards which were withdrawn on 1st April 2002.

The Standards withdrawn in April 2002 were: BS 12:1996 Specification
for Portland cement

BS 4246: 1996 Specification for high slag blast furnace cement

BS 6588: 1996 Specification for Portland pulverised fuel ash cement

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BS 7583: 1996 Specification for Portland limestone cement

BS 146 (Specification for blast furnace slag cements outside the scope of

BS EN 197-1) and BS 6610 (Pozzolanic pulverised fuel ash cement) will continue to co-exist with modified requirements. For the foreseeable future BS 4027 (Specification for sulphate resisting Portland cement) will continue in an unmodified form.

7.2.1Concrete with Special Properties

7.2.1.1 General Requirements

The precondition for obtaining concrete with special properties is that it has to be made with the

appropriate composition, that it is placed in such a way that segregation does not occur and further that it is fully compacted and given appropriate curing.

7.2.1.2 Concrete with increased resistance to chemical attack

This concrete shall meet the provisions of DIN 1045. Liquids, soils and vapours aggressive to concrete shall be judged in accordance with DIN 4030 and be classified according to 'mild', 'severe' and 'very severe' attacks.

The resistance of concrete to chemical attack depends on its imperviousness. The concrete shall be at least sufficiently dense to ensure that the maximum depth of water penetration tested according to DIN 1048, does not exceed 5 mm (5 cm) in the case of mild attack nor 3 mm (3 cm) when exposed to severe attack. The values in brackets are for concrete without micro silica admixtures.

Water aggressive to concrete shall be kept away from the fresh concrete. Concrete which is exposed for a prolonged period to "very severe" chemical attack shall be protected against direct access of the aggressive substances incompliance with the requirements of DIN 4030, DIN 1045 and BS 8110 Part 1.

This protection, which is to be laid as protection to all concrete surfaces in contact with the ground, shall consist of an approved self-adhesive pressure sensitive waterproofing membrane. The membrane shall adhere to all concrete surfaces, including undersides of structures and other surfaces where concrete is cast in contact with the membrane.

Such membranes shall be preferably pre applied to blinding concrete and/or in conjunction with post applies to walls as approved by the

Employer/Engineer.

The waterproof membranes shall be installed in strict accordance with manufacturer's instructions.

The membranes shall extend 15 cm above ground level. When setting forms and reinforcing steel, caution shall be exercised to avoid damage to the impervious membrane. The surface of the impervious membrane extending outside the forms shall be protected during subsequent operations.

Any puncture or damaged areas shall be cleaned and patched according to manufacturer's instructions.

7.2.1.3 Concrete with High Wearing Resistance

Concrete which is exposed to severe mechanical action, e.g., due to intensive traffic, sliding of bulk materials, frequent impact blows or movements of heavy objects, or due to fast-flowing water carrying solids, or other causes, shall possess high wearing resistance and correspond at least to grade 35.

The aggregate up to 4 mm size shall consist predominantly of quartz or materials of at least equal hardness; the coarser particles shall consist of stone or artificial materials possessing high abrasion resistance. In the case of particularly severe mechanical action it will be necessary to use special hard materials. The particles of all types of aggregate shall have a moderately rough surface and be of compact shape. The combined aggregate shall be as coarsely graded as possible.

Furthermore, the concrete shall be as stiff as possible, in order that there will be no concentration of

cement slurry or water in the top layer. The concrete shall be kept moist for at least 7 days after placing.

7.2.1.4 Finishing of Concrete Surfaces

The concrete face shall have the finish indicated on the drawings or in the specifications.

All surfaces which may come into contact with oil or oily water shall be adequately protected (paint, etc.). The finished surface of all concrete work shall be sound and free from defects. No plastering, cement wash or mortar shall be applied to cover defective concrete faces. The repair works shall be executed to the approval of the Employer/Engineer.

Unless instructed to the contrary, the face of the fair-faced concrete placed against shuttering shall be rubbed down with a carborundum stone immediately upon removal of the shuttering to remove fins or other irregularities. All fair-faced concrete shall be protected by epoxy coating as shown above. The face of the concrete for which shuttering is not provided, other than slabs, shall be smoothed with a wooden flat to give a finish equal to that of the rubbed down face where shuttering is provided. The cavities left by formwork fixing devices are to be made good closing the hole with plastic plugs and epoxy mortar. In watertight concrete structures the formwork fixing devices are of such a design as not to leave any holes after removing the shuttering.

All exterior corners (angles of 90° or less) of reinforced concrete shall be chamfered (25 mm x 25 mm).

The top or final surface of all concrete works shall be finished by screeding, or floating, or trowelling or grinding, or tooling as approved by the Employer/Engineer.

Dry cement or cement and sand shall not be used to dry excess water on the concrete surface.

Floors and slabs, which are required to be finished smooth, shall be troweled just before the setting of the concrete.

Screeding: shall be executed by moving a straight edge or template by hand or by mechanical means immediately after compaction of the concrete.

Floating: shall follow screeding, but shall not be started until some stiffening of the concrete has taken place.

Troweling: Where specified as necessary, the floating shall be followed by finishing until a smooth surface free from defects is obtained.

Grinding and tooling: Where specified, the methods to produce the desired surface shall be approved by the Employer/Engineer. The grinding and/or tooling shall not start until the concrete has hardened sufficiently to prevent dislodgement of the aggregate.

Chiselling: Wherever possible all chiselling works shall be carried out with mechanical devices.

7.2.2 Bar-bending Schedules

The CONTRACTOR shall prepare bar bending schedules based on the detailed reinforcement drawings. These shall be presented to the Employer/Engineer for approval at an early stage in the contract, certainly before finalization of his order for reinforcement for that particular part of the work. Approval of these schedules by the Employer/Engineer in no way absolves the CONTRACTOR from full responsibility for their completeness and correctness in every way nor shall any claim for extra cost or time be allowed on the grounds of such errors of discrepancies which may arise between drawings and schedules.

7.3 Codes and Standards

Design and execution shall be in accordance with all relevant standards.

ASTM C 29* Test method for unit weight and voids in aggregate

ASTM C 88* Test method for soundness of aggregates by use of magnesium sulphate

ASTM C 117* Test method for materials finer than 75 mm sieve in mineral aggregates by washing

ASTM C 131 Test method for resistance to degradation of small size coarse aggregate by abrasion and impact in the Los Angeles machine.

ASTM C 136* Test method for sieve analysis of fine and coarse aggregates

ASTM P 214* Proposed test method for accelerated detection of potentially deleterious expansion of mortar bars due to alkali silica reaction

ASTM C 289* Test method for potential reactivity of aggregates (chemical method)

ASTM C 127 Test method for specific gravity and absorption of coarse aggregate

BS 812 Part 1 Elongation index

BS 812 Flakiness index

Section 105.1

BS 1377 Sec 3.2 Total sulphate content of soil (crush sample

Test 9* such that all material shall pass a 2 mm sieve)

BS 812 Part 4 Chloride content of aggregate. Appendix C*

ASTM C 40 Test method for organic impurities in fine aggregates for concrete

ASTM C 87 Test method for effect of organic impurities in fine aggregate on the strength or mortar

ASTM C 128 Test method of specific gravity and absorption of fine aggregate.

Reinforcing steel used in reinforced concrete shall comply with the following standards:

British Standards:

BS 4449 "Hot rolled steel bars for the reinforcement of concrete"

BS 4482 "Hard drawn mild steel wire for the reinforcement of concrete"

BS 4483 "Steel fabric for the reinforcement of concrete"

BS 4461 "Cold worked steel bars for the reinforcement of concrete"

7.4 Concrete Materials

7.4.1Quality of materials

BS 812 Flakiness index Section 105.1

BS 1377 Sec 3.2 Total sulphate content of soil (crush sample

Test 9* such that all material shall pass a 2 mm sieve)

BS 812 Part 4 Chloride content of aggregate. Appendix C*

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7.4 Concrete Materials

7.4.1 Quality of materials

All materials used for concrete and reinforced concrete structures shall be of the best quality, free from defects likely to undermine the strength and duration of service of the works. The materials furnished shall at least comply with the agreed standards, and with all requirements described in this Employers Requirement's.

All concrete for the works shall employ the use of sulphur resisting cement

CEM III unless directed otherwise by the Owner's Engineer.

Any concrete that fails the proposed tests shall be demolished and redone at the Contractors cost.

7.4.2 Storage of materials

All materials shall be stored and handled in a manner that will prevent contamination and/or deterioration. Deteriorated and/or contaminated material shall not be used for the concrete and shall be removed from the site at the expense of the CONTRACTOR.

7.4.3 Cement

The cement used for concrete, reinforced concrete, mortar, grout and plaster works shall be a sulphate resisting Portland Cement (CEM III Blast furnace cement) in accordance BS EN 197-1.

7.4.3.1 Sampling & Testing Of Cement

All deliveries of cement to the concrete supplier shall be accompanied by a certified mill test report and shall include all of the physical and chemical properties as required by tables 1, 2, 3 and 4 of ASTM C150 for type I cement.

The manufacturer's test certificate will normally be accepted as proof of compliance with the specification, but the Employer/Engineer may order further tests of a character specified in the appropriate American, European, British or German standards. The confirmatory tests are to be conducted by a recognized quality control organization. The CONTRACTOR shall bear all expenses required for the preparation, dispatch, and tests of the samples. In case the results of such tests show any sample to be inferior to specifications, the whole consignment from which the sample was taken shall not be used and shall be immediately removed from the site.

7.4.3.2 Delivery & Storage Of Cement

The following information shall be provided for all cement shipments

(either whole or part) which are intended for delivery to site: date of manufacture, date of original loading, destinations en-route, date of unloading, intended date of delivery to site.

Cement which has been manufactured for longer than 6 months on the proposed date of delivery to the site shall be inspected, sampled and tested for approval purposes before delivery to the site.

The CONTRACTOR shall obtain and provide to the Employer/Engineer the manufacturer's Bulk Average Test Certificate for each consignment of cement to the works. The certificates shall be provided before the consignments are required for use and shall show the chemical composition and physical properties determined in accordance with the relevant standard.

Samples shall be taken from each consignment of cement and tested as directed by the Employer/Engineer in an approved independent laboratory.

When bulk cement deliveries are proposed the CONTRACTOR shall provide all information required by the Employer/Engineer concerning off- site storage and loading arrangements and shall provide reasonable facilities for the Employer/Engineer to inspect these arrangements for approval purposes.

Consignments shall be used in the order in which they were delivered.

All bagged cement shall be stored in a weatherproof building having dense impervious bituminous or concrete floors which shall be kept swept clean at all times. The storage arrangements shall be fully completed and approved by the Employer/Engineer before any cement is delivered to site.

Each consignment of cement shall be separately stored for ease of access, identification, inspection, and sampling. Sufficient stocks shall be maintained on site to ensure the proper progress of the works and the stock holdings shall be to the approval of the Employer/Engineer.

If bagged cement is stored in silos it shall be charged into the silos through a

6.3 mm mesh screen which is welded or bolted to and covers the entire feed area of the silo charging hopper.

Cement stored in silos shall be adequately protected against rain, humidity and dewfall, and all silo charging and discharging points shall be properly sealed. Silo aeration equipment shall if available, incorporate de- humidifiers.

No cement from any consignment shall be used in permanent works without the approval of the Employer/Engineer.

Cement which contains air-set or hardened lumps, re-powdered air-set material, foreign matter or which has been contaminated or is otherwise unsatisfactory in the opinion of the Employer/Engineer will be rejected and shall be removed from site without delay.

The CONTRACTOR shall be responsible for satisfying himself that the performance characteristics of cement are not such as to necessitate excessive cement content or be likely to cause or accentuate any undesirable properties in the fresh or hardened concrete notwithstanding apparent compliance with this specification.

Bulk cement shall be used for structures, bagged cement shall be used for masonry, plaster etc.

7.4.4 Water for Concrete Production

Water used for mixing and curing shall be potable. Potable water shall be used for the production of concrete and processing of aggregate provided that the following requirements are satisfied: Water used for mixing and curing shall be potable.

Potable water shall be used for the production of concrete and processing of aggregate provided that the following requirements are satisfied:

- The compressive strength of 50 mm cubes made and tested in accordance with ASTM C 109, using the proposed water shall not be less than 90 percent of similar cubes made with distilled water.
- The setting time of mortars made and tested in accordance with ASTM C 191 and containing the proposed water shall not be more than 1 hour earlier nor more than 1-1/2 hours later than mortar made with distilled water.
- The following chemical limits shall not be exceeded:

Chlorides (CL^{--})	< 300 ppm
Sulphates (SO_4)	< 750 ppm
Sum of alkali carbonates and bicarbonates ($NaCO_3 + NaHCO_3$)	< 750 ppm Dissolved solids
excluding the above	< 2000 ppm
Suspended solids	< 2000 ppm

The concrete supplier shall provide chemical and physical test data for each source of water to be used prior to use.

When water is transported in tank trucks, each unit shall be accompanied by a chemical test report indicating compliance with the above requirements.

All water to be analysed by an independent laboratory before any work commences and at intervals as directed by the Employer/Engineer tests and quality of water shall be in accordance with BS3148 or DIN 1045 and 4030.

7.4.5 Aggregates

The aggregates for concrete shall be crushed mountain rock subject to

Employer/Engineer's approval.

The aggregate to be used in the work shall be supplied from an established pit or quarry. The aggregate source shall have a minimum five (5) years history of satisfactory performance in structural concrete and consistency of supply.

The concrete supplier shall obtain from the aggregate producer, or otherwise provide current test, examination, inspection reports performed and certified by an approved laboratory for submittal to the Employer/Engineer.

As a minimum, this information shall include the following items:

As a minimum, this information shall include the following items:

Item 1 A comprehensive description, with current photographs of the pit or

quarry, including but not limited to, identification by name and location, type of deposit, age, potential reserves, primary products by size including average gradation based on previous six (6) months production and the range for each sieve size; mining methods, process equipment, quality control organization and laboratory; the primary and alternate means of product transportation; listing of primary and secondary users of the product.

Item 2 Petrographic examination in accordance with ASTM C 255 performed by a qualified concrete

aggregate petrographer. This report shall address all items contained in ASTM C 295, section 15. This report shall be based on material produced and examined within the previous six (6) months and shall be representative of the current production.

Item 3 Coarse aggregate shall be sampled from current production in accordance with ASTM D 75. Three (20 mm, 10 mm and 5 mm) nominal maximum size (NMS) aggregates shall be sampled and tested as follows:

Fine Aggregate

Fine Aggregate (Dune Sand) shall be sampled from the intended source and tested as herein specified. The material shall be subjected to all relevant tests (minimum those marked with an asterisk in clause "Codes and Standards" of clause 9 "Concrete Works" above.)

Aggregates when subjected to the tests defined in items above, unless otherwise approved by the Employer/Engineer shall meet the following requirements.

Testing is to be carried out at the following intervals:

Type	Coarse Agg	Fine Agg
Grading	Daily	Daily
Specific gravity	7 days	7 days
Magn. sulphate soundness	30 days	-
Clay silt and dust content	Daily	daily
Shape (elongation and flakiness)	3.5 days	-
Los angeles abrasion	Initial stage only	Initial stage only
Moisture content	2 days	2 days
Drying shrinkage	Initial only	Initial only
Organic impurities	30 days	30 days
10% fines value for concrete	7 days	-

*Combined grading also on a daily basis.

7.4.5.1 Storage & Handling of Aggregates

Cement and densified silica fume shall be stored in separate weather-tight buildings, bins or silos that shall exclude moisture and contaminants. At least two cement silos are required with enough storage for a total of 400 metric tons of cements.

Aggregate stockpiles shall be arranged and used in a manner to avoid segregation and to prevent contamination with other materials or with other sizes of like aggregates. Aggregate delivery trucks shall be covered to prevent windblown contamination. Aggregate stockpiles shall be located relative to prevailing winds to mitigate the accumulation of wind-borne dust.

Adequate storage shall be provided for each aggregate. The aggregate storage area shall be on concrete pavement sloped to drain excessive moisture. The aggregate storage area shall provide bulkheads to separate piles and protect against windblown contaminants. Provision shall be made to shade and sprinkle the aggregates with potable water.

Aggregate stockpiles shall be built in successive horizontal layers not exceeding 1 m in thickness, with each layer being completed before the next is started. No vehicles shall be allowed to operate on top of the stockpiles.

Rescreening Course Aggregate

Rescreening and washing of coarse aggregates is required, if necessary, to reduce total chloride and/or sulphate contents to a level less than the maximum allowed by the specifications. If rescreening is required, the screening and washing shall be just prior to transferring aggregate to batch plant bins. Aggregates shall be dewatered over a screen to remove excess water before being stored in the batch plant bins.

Natural or manufactured sand shall be allowed to drain until it has reached a somewhat uniform moisture content before it is used.

Liquid admixtures shall be stored in such a manner to avoid contamination, evaporation and segregation in accordance with the manufacturers' recommendations.

7.4.5.2 Fine Aggregate

Fine aggregate source shall be manufactured crushed stone or rock sand, excluding fines which are by products/rejects of coarse aggregate production. The crushed stone sand shall be graded from fine to course with the coarse sizes predominating to give maximum density.

The amount of fine particles as ascertained by the laboratory sedimentation method shall not exceed 10% for crushed stone nor 4% for natural sand.

The amount of material passing a BS No.200 sieve (75 micron) when tested in accordance with BS 812 (decantation method), shall not exceed the following limits:

Crushed stone sand

- concrete subject to abrasion 1% by weight
- all other concrete 3% by weight

There shall be no clay or fine silt present. The amount of hollow shells likely to form voids or remain partially unfilled and present in material retained on a BS No.7 sieve, determined by direct visual separation, shall not exceed 3% by weight of the entire sample.

Fine aggregate shall not contain appreciable amounts of flaky and or elongated particles.

The water absorption of fine aggregate, determined in accordance with BS

812 shall not exceed 2.0% by weight.

Fine aggregate subjected to five cycles of the soundness test, specified in

ASTM C88, shall not show a loss exceeding 10% when sodium sulphate solution is used and 15% when magnesium sulphate solution is used, except where approved otherwise.

Tests are to be executed in accordance with BS 812. The grading of fine aggregate for concrete work shall comply with the requirements of BS 882.

The grading of the aggregates shall be such as to produce a concrete of the specified proportions which will work readily into position without segregation and without the use of an excessive water content. The grading shall be controlled throughout the work so that it conforms closely to that used for the preliminary tests.

A check on the moisture content of sand shall be made at least once a day before concreting. The amount of water to be added to the concrete mix shall be adjusted accordingly. Any washing, screening, classifying and other operations on the fine aggregate required to meet this specification shall be done by the CONTRACTOR. Washing is required if the content of salt adhering to the aggregate is found to be unacceptably high.

7.4.5.3 Coarse Aggregate

Coarse aggregate shall be crushed or uncrushed gravel or crushed mountain rock and shall be free from decomposed stone, clay, earth or other deleterious substances. The specific gravity of the coarse aggregate shall not be less than 2.5 t/m^3. Aggregate of crushed natural stone is deemed adequate if the stone reveals a crushing strength of 1000 kg/cm^2 when tested. Friable, flaky and laminated pieces, mica and shale shall only be present in such quantities as not to affect the strength and durability of the concrete.

The grading of coarse aggregate for concrete shall comply with the requirements of table 1 of the BS 882.

Samples of aggregates shall be submitted to the Employer/Engineer, together with sieve analysis showing the proportion by weight passing sieves. When aggregates which are satisfactory to the Employer/Engineer have been selected, the CONTRACTOR shall secure his entire supply of each material from the same source so as to maintain the same quality and grading throughout the work. Should it become necessary to change the source or characteristics of the material supplied this shall only be done after additional tests.

7.4.6 Concrete Additives

7.4.6.1 Use of Concrete Additives

Concrete additives approved by the Employer/Engineer shall be used to improve consistency, workability, quality and strength of the concrete.

Chemical admixtures manufacturer shall provide certified test reports from qualified independent laboratories showing actual test results indicating material that complies in all respects with the applicable specification.

Admixtures used in concrete shall conform to the appropriate specification and requirements as indicated below:

a. Air entraining admixtures shall conform to ASTM C 260
b. Water-reducing and retarding admixtures shall conform to ASTM C494. Accelerating admixtures shall not be used. Type F or Type G high range water reducers shall conform to ASTM C 1017 and shall be as approved by the Employer/Engineer.
c. High-range water reducers shall be naphthalene-sulfonated polymer based material. No admixtures containing chlorides shall be used
d. Chemical admixture suppliers shall provide certified test reports with each shipment indicating compliance with the appropriate specification. The test reports shall include the chloride content of the admixture, specific gravity and solids content
e. Silica fume may be either a condensed form or other approved products.

Micro silica shall meet the following requirements:

SiO_2 (min) % 9 0

SO_3 (max) % 1.0

C (max) % 6.0

In order to avoid any problem, which may occur due to the improper use of micro silica, all the possible problems related to the use of micro silica shall be coordinated with a specialist of micro silica supplier. Mainly the following matters shall be coordinated:

- micro silica content in % by weight (minimum 8% of cement
- weight)
- mixing of concrete
- curing, etc.

Written evidence of this coordination is to be provided to the

Employer/Engineer

f) Fibres

Polypropylene fibres shall be collated, fibrillated polypropylene fibre as approved by the Employer/Engineer

g) Corrosion inhibitors:

Reinforced concrete subject to contact with seawater and brine, as a result of submergence, splashing, spry, leakage from piping or plant, or from any other cause, shall have a proprietary concrete corrosion inhibiting compound incorporated into to concrete mix.

The corrosion inhibitor shall be appropriate to the protection of steel reinforcement against corrosion throughout the 25 year design life of the structures. The corrosion inhibitor shall be compatible with the required concrete mix and shall be appropriate to the environmental exposure. The product shall carry a British Board of Agreement Certificate for the intended usage. Before incorporating corrosion inhibitor into any concrete mix the CONTRACTOR shall submit details for review and written consent by the Employer/Engineer. The dosage of corrosion inhibitor shall be about 10 litres of inhibitor per cubic meter of concrete in conformance with Manufacturer's recommendation and as approved by the

Employer/Engineer.

Admixtures used in production of concrete shall be the same as used in establishing the required concrete mix and shall be used in accordance with the manufacturers' directions.

7.4.6.2 Accelerating & Retarding Additives

Such additives shall only be used in case of necessity and after obtaining the written approval of the Employer/Engineer

7.4.6.3 Plasticisers & Air Entraining Additives

Plasticizers and air entrainers are intended to reduce bleeding of free water at the surface. It shall only be used after the written approval of the Employer/Engineer and in accordance with the manufacturer's instructions.

7.5 Concrete Production

7.5.1Concrete Mixes

7.5.1.1Proportions & Mixing

The mix proportions are to be determined by proper mix design based on the requirements for strength, workability and the particular site in which the concrete is to be placed. The mix design shall be carried out by the CONTRACTOR's Concrete Engineer. The design of mixes shall be based on the principles of BS 5328.

Concrete Classification

Concrete Class	Cube strength at 28 days in MPa	Maximum free water/cement ratio	Max. nominal aggregate size in mm	Min. cement content in Kg/m^3
L	20	-	25	280
S_1	35	0.40	20	380
S_2	40	0.40	20	400
P_1	40	0.40	20	400
P_2	40	0.40	20	400

Classes of Concrete:

L - Plain concrete used for lean concrete, blinding, screeds, backfill etc.

S_1 - Reinforced concrete for general use

S_2 - Reinforced concrete in contact with seawater and groundwater

P_1 - Reinforced concrete for piles

P_2 - Precast concrete

Concrete aggregates and cement shall be proportioned and batched by weight. Water and liquid additives shall be proportioned. If the CONTRACTOR wishes to use cement in bulk, his method of obtaining the correct proportions of cement shall be approved by the Employer/Engineer before use.

7.5.1.2 Consistency of Concrete

The amount of water used in the concrete shall be adjusted as required to ensure such a consistency that it can be readily transported placed and compacted without segregation of the materials or bleeding of free water at the surface. Addition of water to compensate for stiffening of the concrete before placing shall not be permitted. Consistency of the concrete shall be checked by slump tests and shall not exceed the values given by BS 1881, Part 2 or DIN 1045, Part 1.

7.5.1.3 Mixing of Concrete

The cement and aggregate shall be thoroughly mixed in a batch-type pull mill mixer. The capacity of the mixer shall not be less than 1 (one) cubic meter and the total capacity of the batching mixing plant shall be such to accommodate the various concrete quantities to be cast in a continuous way and shall comply with the requirements of BS 1305 or DIN 459.

The water shall not be added until all the aggregate and cement are in the drum. Mixing shall continue until the concrete is uniform in colour and for not less than 1 (one) minute after all the materials and water are in the drum.

Partly set or excessively wet concrete shall not be used. No concrete shall be mixed by hand.

7.5.2 Transport of Concrete

Immediately after mixing, the concrete shall be conveyed to the place of use as rapidly as possible using methods which will prevent the segregation, loss or contamination of materials.

The concrete shall be placed and compacted within 90 minutes of the addition of water to the mix. Any concrete left unplaced after this time shall be rejected and removed from the site.

The concrete shall be transported in dumpers or trucks. Before using concrete pumps, placer pipelines, chutes or spouts it is necessary to have the written approval of the Employer/Engineer.

The CONTRACTOR shall obtain permission at least 24 hours in advance of any concrete pour.

7.5.3 Concreting Operations

7.5.3.1Inspection Prior To Concreting

All concreting methods shall be subject to the approval of the Employer/Engineer.

Concrete placing shall not be started until the Employer/Engineer has approved all preparation of forms, reinforcement, joints and all mixing, conveying, spreading, curing, finishing and protection equipment.

7.5.3.2 Placing of Concrete

Concrete shall be placed in the forms as close as possible to its final position

in a single operation to the full thickness of slabs and beams and shall be placed in horizontal layers, not exceeding 2.5m height in a single pour in walls, columns and similar members.

The CONTRACTOR shall organize the pouring of concrete in such a manner that once concreting of a section has started the operation shall be continuous and each operation shall be completed prior to a stoppage.

The Temperature of concrete shall not exceed 30°C measured at discharge into the works. Concrete shall not be placed when the ambient temperature is 40°C or above, or is above 37°C and is rising.

The maximum allowable temperature of any point within any cast element is 60°C. The maximum allowable temperature differential between any two points in the same element is 15°C. Additional temperature control measures during construction (such as the use of insulated formwork) will be required. CONTRACTOR to prepare a process control chart and method statement verifying measures to achieve these requirements.

Temperature monitoring of concrete work is required where:

a) The minimum dimension of any casting is 0.8 meters or more, or

b) Where otherwise instructed by the Employer/Engineer.

Where specified on the drawings, construction, expansion or contraction joints shall be provided and the concrete shall be poured continuously between two adjacent joints. No joints other than shown on the drawings shall be permitted. Stoppage (cold) joints formed between two concreting operations separated by more than 6 hours' time shall be subject to the same treatment as the construction joints.

Concrete shall not be dropped into place from a height exceeding 2 meters. Trunking and chutes to Employer/Engineer's approval shall be used for any concrete to be deposited from a height exceeding 2 m.

Concrete which has partially hardened shall not be exposed to injurious vibration or shock, except for controlled re-vibration where specified. When concreting of a certain large structural element is specified strictly as to be poured continuously, then the concreting operations shall be organized for day and night working, in long shifts, as necessary.

7.5.3.3 Compaction & Mechanical Vibration of Concrete

As concrete is being placed it shall be compacted by mechanical vibrators, to obtain a dense material free from honeycombing, free from water and air holes. For compacting the concrete, internal vibrators shall be used operating within a range of 5,000 to 10,000 cycles per minute.

The CONTRACTOR shall ensure that the vibrators are used in such a manner that the reinforcement is not displaced, the formwork not damaged and no segregation caused, but complete compaction of the concrete is achieved. Mechanical vibrators for coated rebars shall be with plastic cap.

7.5.3.4 Construction Joints

The number of construction joints shall be kept as low as possible consistent with reasonable precautions

against shrinkage. Concreting shall be carried out continuously up to construction joints.

Where it is necessary to introduce construction joints, careful consideration shall be given to their exact location, which shall be indicated on the drawings. Alternatively, the location of joints shall be subject to agreement between the Employer/Engineer and the CONTRACTOR before any work commences. Construction joints shall be at right angles to the general direction of the member and shall take due account of shear and other stresses.

Concrete shall not be allowed to run to a feather edge and vertical joints shall be formed against a stop board.

The top surface of a layer of concrete shall be level and reasonably flat unless design considerations make this undesirable. Joint lines shall be so arranged that they coincide with features of the finished work.

If a kicker (i.e. a starter stub) is used it shall be at least 70mm high and carefully constructed. The kicker shall be incorporated with the previous concrete. Where possible, the formwork shall be designed to facilitate the preparation of the joint surface, as the optimum time for treatment is usually two to four hours after placing.

The maximum horizontal length of wall to be poured in one operation in any one direction is 7.5 meters. A period of 7 days to be allowed between adjacent pours except where water stops are provided when this can be reduced with Employer/Engineer's approval. Alternatively a gap of 600mm wide shall be left between adjacent pours and filled after 7 days from the date of formation subject to Employer/Engineers approval.

Immediately prior to recommencement of concreting on a joint, the surface of the concrete against which new concrete will be cast shall be free from laitance and shall be roughened to the extent that the largest aggregate is exposed but not disturbed. Care shall be taken that the joint surface is clean immediately before the fresh concrete is placed against it.

Particular care shall be taken in the placing of the new concrete close to the joint. This concrete shall be particularly well compacted and if possible a vibrator shall be used.

Where the Employer/Engineer considers that special preparation is necessary, i.e. for an in situ structural connection, preparation shall be carried out preferably when the concrete has set but not hardened, by spraying with a fine spray of water or brushing with a stiff brush, which is sufficient to remove the outer mortar skin and expose the larger aggregate. Where this treatment is impracticable, sand blasting or a needle gun shall be used to remove the surface skin and laitance. Hacking of hardened surfaces shall be avoided.

A record shall be kept on site of the time and date of placing the concrete in each section of the work.

7.5.3.5 Expansion & Contraction Joints

The expansion joints, contraction joints and other permanent structure joints shall be provided in positions as shown in the drawings.

Joints shall be straight and vertical, except where other specified, and concrete surfaces on both sides of the joint shall be flush. Where necessary, water stops of a type approved by the Employer/Engineer shall

be embedded in the concrete. All structures in the underground shall have external water stoppers. The water stop shall be made of high-quality material which shall obtain its resilience through the service life of the structure for the double function of movement and sealing. The surface of water stops shall be carefully rounded to ensure tightness of the joint even under heavy water pressure. To ensure a good tightness with or without movement of the joints the water stop shall be provided with anchor parts. The cross section of the water stops shall be determined in accordance with the presumed maximum water pressure and joint movements. The complete works of fixed and welded connections shall be carried out strictly in accordance with the manufacturer's instructions.

All joints between structural steel and concrete parts shall be sealed by a suitable permanent flexible compound.

Link seal requirement shall be provided for water tightness between the

Duct/cellar/wall boxes.

7.5.3.6 Concreting at Night

When approval is given to carry out concreting operations (under control of the Employer/Engineer) at night or in places where daylight is excluded, the

CONTRACTOR has to provide adequate lighting at all points of mixing, transportation and placing of concrete.

7.5.3.7 Concreting in High Ambient Temperature

"ACI standard 305 - concreting in hot weather" shall apply. The temperature of the mixed concrete shall not exceed 30 degreesC. The CONTRACTOR shall take special measures in the mixing, placing and curing of concrete. These measures shall include the shading of aggregates, spraying of aggregates with water, cooling of the mix constituents (introduction of ice to the mixing water) and reduction of transportation time to the minimum. During placing suitable measures shall be provided to prevent premature setting of concrete placed in contact with hot surfaces. All concreting areas, formwork and reinforcement shall be shielded from the direct rays of the sun and sprayed with water when necessary.

In general the cover of rebars shall be as per ACI 318, BS 8110 or DIN 1045 taking into account the site conditions (high temperature, humidity), but not less than required in 1.4.4. Special requirements for materials to avoid corrosion problems.

The minimum concrete cover shall be as follows:

- concrete parts above ground (external surface) 50 mm
- concrete exposed to underground and groundwater 75 mm

- concrete exposed to seawater and seawater spray 100 mm
- slabs (internal) 30 mm
- beams and coils (internal) 40 mm

Immediately after the compaction of the concrete has been finished, the

CONTRACTOR shall ensure adequate protection from the weather. Excessive drying can lead to crack formation as a result of plastic contraction. The concrete surface shall be covered with a layer of sacking, canvas, straw mats or similar absorbent material, special protection sprays kept constantly moist for at least 7 days.

Curing compounds or other methods of preventing evaporation may be used if approved by the Employer/Engineer. Where formwork cannot be removed within 24 hours after placing the concrete, the formwork shall be kept shaded from the direct rays of the sun and shall be sprayed with water.

Employer/Engineer's approval to the use of a particular curing compound and to the method of application will only be given after the CONTRACTOR has completed satisfactory site trials and a sample panel has stood for at least 28 days.

Where large sections of concrete are poured, special precautions to the approval of the Employer/Engineer shall be taken to reduce and dissipate the heat generated by the setting and hardening of the concrete (e.g. built-in cooling water pipe system).

The minimum amount of reinforcement shall be present to prevent shrinking cracks.

No load of any kind, however light, shall be allowed on concrete which has not properly set and the CONTRACTOR shall prevent any load to be imposed on the concrete structures until it has been declared by the Employer/Engineer to be ready to carry loads.

7.5.3.9 Repair of Damaged or Defective Concrete

Concrete which has completed its final setting shall be inspected by the Employer/Engineer and any cracks, honeycomb areas, segregations, etc. shall be marked. No repairs shall be carried out until directed by the Employer/Engineer.

7.5.3.10 Concreting Underwater

Underwater placing of concrete is allowed only for un-reinforced components, the placing being effected exclusively with stationary tremies and shall be in accordance with the requirements of DIN 1045, Section 6.5.7.8 and Clause "Strength of concrete" above.

Underwater concrete shall comply with the following characteristics:

- the quantity of cement shall be not less than 400 kg/m³ when using aggregate mixes with a maximum particle size of 20 mm,

- the water-cement ratio shall not exceed 0.40,
- preferred aggregates are those with continuous grading curves lying approximately in the middle of the favourable range,

Underwater concrete is to be placed continuously without interruption. For water depths up to 1m the concrete may be placed without tremie. In the case of water depths exceeding 1 m the concrete is to be placed in such a way that it does not fall freely through the water. The tremies shall at all times dip sufficiently far into the freshly placed concrete to ensure that the concrete emerging from the tremie does not come into contact with the water.

All work connected with the placing of concrete under water shall be designed, directed and inspected with due regard to local circumstances and purposes. Work shall not proceed until all phases and methods to be used in the placing operations have been approved by the Employer/Engineer.

7.5.4 Reinforcing Steel

7.5.4.1 General

The types to be used are shown on the construction drawings and shall be:

- deformed bars - Grade 460
- mesh reinforcement - Grade 460

7.5.4.2 Binding Wire

Plastic coated binding wires to be used for epoxy coated rebars.

7.5.4.3 Reinforcement Supports

Reinforcement supports shall include all spacers, chairs, ties, slab bolster, clips, chair bars, and other devices for properly assembling, placing, spacing, supporting, and fastening the reinforcement.

Spacers shall be cast from concrete of the same quality as that in which they will be embedded. Spacers for coated reinforcement shall be of PVC fitting for the coated reinforcement.

Concrete block spacers shall be cast in metal moulds with an approved means of separating blocks and of ensuring that the blocks are of the proper size.

Coated binding wire shall be incorporated into the blocks to enable them to be securely attached to vertical or horizontal bars and the CONTRACTOR shall demonstrate both that the blocks are of the requisite strength and that the means of attachment to the reinforcement are adequate.

7.5.4.4 Stock of Reinforcing Steel

In order to ensure due progress of the works, the CONTRACTOR shall at all times maintain on the site a stock of reinforcing steel sufficient for the following month's work. No reinforcing steel shall be used upon the works until it has been accepted as satisfactory by the Employer/Engineer.

7.5.4.5 Rejection

The Employer/Engineer will reject any reinforcement steel as the result of any failed test therefore not withstanding the manufacturer's or coating applicator's certificates.

The CONTRACTOR shall remove all rejected reinforcing steel from the site without delay at his own expense.

7.5.4.6 Production Handling

Bars shall be handled and stored in a manner to prevent damage to the coating. Bars or coating damaged in handling or other operations shall be satisfactorily repaired at no additional cost to the EMPLOYER. All systems for handling the coated bars shall have padded contact areas wherever possible. All bundling bands shall be padded and all bundles shall be lifted with a strong-back or spreader bar with a minimum of three supports to the bundle. The bars or bundles shall not be dropped or dragged. Extra care in handling of these bars will be beneficial to the CONTRACTOR in reducing or eliminating in-place coating repairs.

7.5.4.7 Storage

All bars for reinforcement and steel fabric reinforcement shall be stored on the site under cover on timber or concrete supports suitably spaced and of sufficient height to keep the steel not less than 150 mm clear of the ground.

7.5.4.8 Bending Reinforcement

Steel reinforcement required to bent shall be bent cold and in such a manner and using plastic or rubber coated formers that there is no direct steel/rebar contact and that neither bar nor coating is in any way damaged, all in accordance with the recommendations of the coating factory and to the approval of the Employer/Engineer. Standard radii shall be according to BS 4466 unless ordered otherwise by the Employer/Engineer.

7.5.4.9 Potential Gradient Reinforcement

Potential gradient reinforcement shall be provided for the earthing of the base slabs, whenever electro-mechanical equipment is installed.

The system shall comprise:

- copper tapes 40 mm x 3 mm as a closed ring into the outer foundations, plus a grid of approximately 10/20 cm welded below the top reinforcement layer of the base slab
- Copper cables min. 70 mm² connecting with the earthing network and leadouts at 0.70 m above graded surface

7.6 Quality Control

7.6.1Trial Mixes

Before concreting commences, the CONTRACTOR shall, at his own expense, make trial mixes to determine the mix proportions required to produce the strengths specified for each class of concrete and for each degree of workability required to allow placing, transporting and compacting of the concrete with the equipment he proposes to use in any particular situation. Only materials which the CONTRACTOR intends to use for concreting (including all admixtures) shall be used in the trial mixes.

Test cubes from trial mixes shall be made and tested in accordance with BS 1881, Part 3 or DIN 1048, Part 2.

As per BS 5328, three separate batches of concrete shall be made, workability of each batch determined and three test cubes shall be made from each batch for each age (e.g. for 7 and 28 days) at which tests are required. The strength shall conform to target mean strength as per BS 5328 - Requirements for designed mixes.

The appropriate strength requirements may be considered to be satisfied if none of the strengths of the cubes is below the required characteristic strength and if the average strength of the nine cubes is not less than recommended by BS 5328, trial mixes.

7.6.2 Quality & Testing

No more than 5% of the test results may fall below the 28 day specified strength. Making and curing of test specimens shall be in accordance with BS 1881 Parts 108, 109, 110 and 111.

All mixes can only be placed following approval by the Employer/Engineer. The mean strength shall exceed the characteristic strength by a margin of 1.64 times the standards deviation expected from the batching plant.

However no standard deviation less than 3.5 Nmm^2 shall be used as a basis for designing a mix.

7.6.3 Trial Mixes & Field Tests

Sufficient laboratory trial mixes shall be effected to show that concrete complies fully with the specified performance criteria.

The following tests are to be included:

· Bleeding (non-vibrated concrete) as per ASTM C232 < 0.5%

· Drying shrinkage (BRE Digest 357)

· Air content < 1%

· Slump : piles 170 ± 25 mm, regular work 80 ± 20 mm

· Fresh and hardened concrete densities

· Absorption BS 1881 Part 122 (< 2%)

· Initial surface absorption BS 1881 Part 5

· Absorption (I.S.A.T.) 10 min.: 0.05 $ml/m^2/sec$

30 min.: 0.02 $ml/m^2/sec$

60 min.: 0.005 $ml/m^2/sec$

120 min.: 0.003 $ml/m^2/sec$

· Water penetration DIN 1048 : < 5 mm (with micro silica)

< 50 mm (without micro silica)

· AASHTO T277 rapid chloride : < 800 coulombs

· Field trial mixes are to be carried out under full-scale site conditions as per BS 1881 (for structural concrete only).

· Where directed by the Employer/Engineer, concrete incorporating re- enforcement details shall be cored to assess stratification of mixes. Cores of 150 x 200 mm (dia. and length) are to be used.

· Each trial mix shall have 9 x (150 x 150 mm) cubes taken to measure 24 hours/7 days and 28 day compressive strengths. These trials shall be run for three consecutive days (for structural concrete only).

· At least 3 x sets of field trials shall be tested according to the provisions laid down in laboratory testing.

· The average 28 day characteristic strength for trial mixes shall be higher by 10 N/mm² than that for cubes taken in the field. Failure to comply shall result in the mix having to be re-designed.

All test results will have to comply before approval can be given.

7.6.4 Laboratory

The CONTRACTOR shall establish and maintain a field laboratory on the site and this laboratory shall be available at all time to the Employer/Engineer. The laboratory shall have qualified technicians to carry out all tests and shall be adequately equipped to ensure that all necessary testing work can be carried out in compliance with the standards.

7.6.5 Strength of Concrete

7.6.5.1Testing of Fresh Concrete by Means of Test Cubes

All test cubes shall be made and tested for compressive strength in accordance with BS 1881 - Method of testing concrete or DIN 1048, Part 1 - Test methods for concrete, fresh concrete, hardened concrete as separately prepared test specimens.

The minimum required strength for different classes of concrete is as shown in clause "General description and proportions and mixing" above.

The grade of concrete required will depend partly on the particular use and the characteristic strength needed to provide the structure with adequate ultimate strength and partly on the exposure conditions and the cover provided to any reinforcement.

A minimum of seven test cubes shall be made on each concreting day (from the same mix) and for at least each 40 m^3 of concrete mixed.

In addition a minimum of 3 cubes for water permeability and 1 cube for chloride permeability shall be made on each concreting day (from the same mix) and for at least each 40 m^3 of concrete mixed.

For columns, beams and cantilevers seven (7) cubes for every 15 m^3 of concrete poured shall be taken. The concrete for test samples shall be taken directly from the concrete mixer and shall be handled

(vibrated etc.) under similar conditions to those prevailing during the construction. The moulds for the test cubes shall be made of steel. Tests shall be carried out in an approved laboratory.

The strength level of each type and each strength concrete will be evaluated separately and the concrete strength will be considered satisfactory if:

- any individual strength test result as defined above is greater than 85% of the specific minimum cube strength (characteristic strength)
- and the average strength of any group of three consecutive test cubes exceeds the specified characteristic strength by not less than 0.5 times the current margin as per BS 5328.

If the results are less than those specified, the Employer/Engineer will suspend all concreting work and order further tests. Any concrete found not to comply with the specification shall be broken out and replaced to the satisfaction of the Employer/Engineer.

The CONTRACTOR shall pay all costs incurred in making, curing, delivering and testing of concrete cubes.

7.6.5.2 Testing of Concrete in Structures

The types of tests described hereinafter are applicable to the finished parts of the structure. They may be used in routine inspection and for quality control.

Type of tests:

- Cutting cores. The procedure used shall comply with the requirements of DIN 1048, Part 2 or an approved equivalent standard
- Gamma radiography. The testing shall be carried out in accordance with the requirements of Part 3 of BS 4408 or equivalent
- Ultrasonic test. Such tests may be used to obtain approximate indications of the strength of the concrete in the structure (BS 4408, Part 5)
- Electromagnetic cover measuring devices. Such tests may be used to verify the position of the reinforcement and shall be in accordance with the requirements of design (BS 4408, Part 1)
- Rebound hammer test. Such tests may be used to obtain approximate indications of the strength of the concrete
- Load tests of structures or parts of structures. If the results of the above mentioned check tests show that the quality of the materials is inadequate or if other defects are revealed, the Employer/Engineer may require a loading test to be made.

For the purpose of testing floors, roofs and similar structures and their supports, the test load shall be equivalent to the sum of the characteristic dead load and one-and-a quarter times the characteristic imposed load for which the works or part thereof to be tested have been designed.

Wherever certain procedures for testing of parts in structures (e.g. piles) are required by standards or codes of practice, these are to be followed. All tests shall be conducted in the presence of the Employer/Engineer.

For a test on a floor, roof or similar construction the result shall be deemed to be satisfactory if upon removal of the load the residual deflection does not exceed one-quarter of the maximum deflection after maintaining the load in position for twenty-four hours. If the residual deflection exceeds this amount, the test shall be repeated, and the result shall be deemed to be satisfactory if the residual deflection after removal of the load for the second time does not exceed one-quarter of the maximum deflection occurring during the second test.

If the result of the test is not satisfactory, the Employer/Engineer shall instruct that the part of the works concerned be taken down or cut and reconstructed to comply with this specification. The CONTRACTOR shall at his own cost take down or cut out and reconstruct the defective work.

The Employer/Engineer may require other tests to be made. Number of samples, tests and types will be as per Employer/Engineer requirements.

All the costs for the above mentioned tests shall be borne by the CONTRACTOR.

7.6.6 Reinforcement – Certificates

Each consignment of steel reinforcement shall be accompanied by a test certificate from the manufacturer showing that the steel has been tested and analysed and the date of such tests and analyses and that such tests and analyses comply in all respects with the standards.

The following tests shall be carried out on reinforcement

• cst analysis	BS 4449/4461
• carbon equivalent value	BS 4449/4461
• tensile strength, yield stress, elongation	BS 18
• bend test	BS 4449/4461
• bond classification	BS 4449/4461
• chemical analysis	

At the same time the CONTRACTOR shall furnish written certification from the coating applicator that the coated reinforcement bars were cleaned, coated and tested in accordance with the requirements of this specification.

8.0 PRECAST CONCRETE

8.1General

Precast panels and structural members shall be manufactured in an approved plant, under controlled conditions of temperature and humidity. Manufacturing facilities, materials and procedure shall be subject to inspection, approval or rejection by the Employer/Engineer prior to the beginning of or during production. Structural design of precast members and anchorage shall be submitted to the Employer/Engineer.

The design and manufacture of precast concrete components shall be in accordance with the recommendations contained in BS 8110 or approved equivalent.

Included in the lump sum are the costs of moulds, reinforcement, transportation, storing, replacement of damaged pieces and all necessary fittings and embedded parts necessary for anchoring of units as well as erection. Embedded parts for anchoring shall be of stainless steel.

8.2 Civil Design/Engineering

The design and engineering shall be state of the art in accordance with all relevant codes and standards, functional and complete as mentioned above.

8.3 Codes and Standards

Design and execution shall be in accordance with all relevant standards as specified in clause B04.0.

8.4 Design Criteria for Layout, Arrangement, Drawings, Execution

8.4.1 Structural Precast Concrete

The possibility is allowed to the CONTRACTOR to use precast concrete elements, provided the following requirements are met:

- concrete strength equivalent or superior to structural reinforced concrete
- materials shall comply with BS and specifications of British Standard code of practice CP 116 and otherwise with the requirements of Clause "Concrete Works" above
- All elements shall come from the same plant.

The CONTRACTOR shall mention in his bid the origin of the precast elements he will use during the construction and references in similar works. The choice of the supplier shall be submitted to the Employer/Engineer's approval. Pre-stressed concrete shall not be used.

8.4.2 Exposed Concrete Panels

Concrete shall be composed of cement, water, fine and coarse aggregate, water reducing admixture and air-entraining admixture.

The design of concrete mixtures will be based on the water-cement ratio necessary to secure

- a plastic workable mixture suitable for the specific conditions of placement
- When properly cured, a product having durability, impermeability and strength, in accordance with the requirements of the structures covered by these specifications.

Materials shall comply with the requirements of Clause “Concrete Works” above.

8.5 Shop Drawings

The CONTRACTOR shall prepare and submit to the Employer/Engineer for approval, shop drawings showing in detail, profiles, sections, jointing, cast- in items, reinforcing, anchorage and fastenings to be employed in this work. The manufacturer shall be fully responsible for the design of any supplementary steel reinforcement required to withstand handling and erection stresses. This reinforcement shall be clearly indicated on the shop drawings.

Approval of shop drawings shall not relieve the CONTRACTOR of responsibility or liability for structural failures of fastening devices supplied by him or for damage of any kind during handling and erection.

8.6 Execution of Precast Concrete

8.6.1 Samples

Three samples each showing texture and colour of proposed finish shall be submitted to the Employer/Engineer. Samples submitted for approval shall be 12 cm thick by 60 cm square and shall be labelled to indicate the name of the project, the Employer and the Manufacturer.

8.6.2 Fabrication

Casting forms shall be of rigid steel construction, designed to produce the shapes as detailed on the drawings and approved on shop drawings. Dimensional tolerances of fully cured panels shall not exceed the following

- overall height or width — plus or minus 3 mm
- thickness — plus or minus 3 mm
- bow or warp — 3 mm in 3.00m with a maximum of
- insert location — plus or minus 3mm.

Provide chamfered edges at all vertical joints as shown on the drawings. Also provide splays, drips, reglets, pipe sleeves and other special shapes where necessary.

The CONTRACTOR shall place and secure in the forms all anchors, clips, inserts, reglets, lifting devices, stud bolts, shear ties and other devices and accessories required for handling and installing the units. All anchoring, fastening and lifting devices shall be securely welded to the steel reinforcement in the precast units.

Provide all reglets to receive flashings, etc., dowels and splines, sill slots, goose-neck anchors, anchor clips and anchor straps, sill clips, vertical slots at joints, and all accessories for a complete installation.

Complete panels shall be protected from drying and shall remain in the forms until concrete has attained sufficient strength to permit handling of panels without damage.

Before placing concrete, care shall be taken to determine that all embedded items are firmly and securely fastened in place as indicated on the drawings or required by the Employer/Engineer.

All embedded items shall be thoroughly clean and free of oil and other foreign matter such as loose

coatings or rust, paint, and scale. The embedding of wood in concrete shall be avoided unless specifically directed or authorized by the Employer/Engineer.

8.6.3 Repair & Patching

Any concrete which is not formed as shown on the drawings, or for any reason, is out of alignment or level, or shows a defective surface, shall be considered as not conforming to the intent of these specifications and shall be removed from the job by the CONTRACTOR, at his expense, unless the Employer/Engineer grants permission to patch the defective area, which shall be done in accordance with the following procedure.

Permission to patch any such area shall not be considered a waiver of the Employer/Engineer's right to require complete removal of the defective work if the patching does not, in his opinion, satisfactorily restore the quality and appearance of the surface.

After removing forms, all concrete surfaces shall be inspected and any voids, stone pockets or other defective areas permitted by the Employer/Engineer to be patched shall be patched.

Where necessary, defective areas shall be chipped away to a depth of not less than 2.5 cm with the edges perpendicular to the surface. The area to be patched and the surrounding area shall be wetted to prevent absorption of water from the patching mortar.

A grout of equal parts cement and sand, with sufficient water to produce a brushing consistency, shall then be well brushed onto the surface followed immediately by the patching mortar.

Mortar shall only be used for smaller blow holes and not for major patch. For major patches materials for repair shall be for approval by the Employer/Engineer.

The patch shall be made of the same material and of approximately the same proportions as used for the concrete, except that the coarse aggregate shall be omitted. The mortar shall not be richer than one part cement to 3 parts sand.

The amount of mixing water shall be as little as consistent with the requirements of handling and placing.

The mortar shall be re-tempered without the addition of water by allowing it to stand for a period of one hour during which time it shall be mixed occasionally with a trowel to prevent setting.

The mortar shall be thoroughly compacted into place and screeded off as to leave the patch slightly higher than the surrounding surface.

It shall then be left undisturbed for a period of one to two hours to permit initial shrinkage before being finally finished.

The patch shall be finished in such a manner as to match the adjoining surface.

8.6.4 Concrete Finish

The aspect of the architectural prefabricated elements shall conform to the sample of finish selected and

agreed upon by the CONTRACTOR and the Employer/Engineer.

All precast concrete faces shall be protected by epoxy coating of approved type, which consist of primer penetrating into the concrete and a compatible top coat.

After erection of these elements, the appearance of the whole shall be uniform as to shade and colour. Elements shall have neither chips, cracks nor other defects. Elements not conforming to these requirements will be removed and replaced without cost to the Employer.

Interior face of panels shall be left as cast, except that fins or ridges shall be removed and any void or defects touched up to provide a smooth uniform surface.

8.6.5 Erection

Erection of precast panels shall be performed under the direct supervision of the manufacturer of the panels.

Panels shall be handled, transported and stored in a vertical position. Setting and levelling devices shall be as shown and approved on shop drawings and shall be completely concealed in the finished installation.

Panels shall be set plumb along vertical edges and exterior faces with uniform horizontal and vertical joints. Anchor shall be placed by bolting to inserts. All panels shall be carefully hoisted into position by means of hoist bars to the anchor bolts. The panels shall be plumb and in true alignment. Levelling wedges shall be placed between the panels and grade beam.

8.6.6 Other Precast Concrete Elements

The work consists of furnishing all design, materials and labour necessary for placing precast concrete, mainly the precast concrete items specified in the particular requirements or evidently required for the completion of all civil works.

Materials, labour and in any other respects the concrete itself will conform to clause “Concrete works” above.

On removal of the moulds the precast concrete units shall be examined and all surfaces that will be permanently visible shall be fan faced, having a smooth and dense finish of uniform texture free from holes, fins and shutter staining.

8.6.7 Storage & Delivery

Precast units shall be handled, transported and stored in a manner to avoid undue strains, hair cracking, staining or other damage. Damaged or defective units shall be repaired or replaced by manufacturer at no additional cost to the Employer.

Units shall be delivered from plant to project site in accordance with schedule and proper setting sequence.

Precast units shall be stored on clean blocking, off the ground and protected from dust, dirt and other staining materials.

8.6.8 Precast Duct Covers

The covers shall be precast concrete slabs of appropriate length adapted to the culvert or duct sizes. Their width shall be standardized to 40 cm.

Handling of covers shall be made with the "slot solution", i.e. without lifting eyes of reinforcing steel.

Two types are foreseen:

- Reinforced concrete slabs in areas not accessible by trucks. The superior edges shall be chamfered
- Reinforced concrete slabs for road crossings. In this case, the superior edges shall be reinforced by angle irons. The slabs shall be able to withstand an axle load (SWL 60) in accordance with DIN 1072.

9.0 CONCRETE PIPES

9.1 General

The work to be performed under this heading consists of furnishing and installing pre-cast reinforced concrete pipes with all fittings and connections. Pipes shall be supplied from manufacturers. The manufacturer shall furnish a certificate confirming that the pipes and all fittings supplied comply with the requirements of the standards.

9.3 Codes and Standards

BS	556	Concrete cylindrical pipes and fittings
ASTM	C 76 - 77	Reinforced concrete culvert, storm drain and sewer pipe
ASTM	C 443	Joints.

9.4 Design Criteria for Layout, Arrangement, Drawings, Execution

9.5 Materials for Concrete Pipes

The pipes shall be reinforced concrete pipes.

- cement shall comply with all requirements of CP 116
- aggregates the coarse and fine aggregates shall comply with all the requirements of BS 882
- reinforcement shall consist of rolled steel bars conforming to the requirement of BS 4449 and as specified under specification "Concrete Works"
- Concrete strength shall not be less than 40 N/mm^2.

9.6 Execution of Pipes (Assembling, Installation)

9.6.1 Mixing

Concrete mixing and casting shall be as specified for the reinforced concrete. Concrete cubes shall be taken, tested as specified before and according to the BS 1881 and BS 556 for water absorption.

9.6.2 Moulds and manufacture

The moulds and method of manufacture shall be such that the form and dimensions of the finished works are accurate. The surface and edges shall be clean and true, the ends are square with the longitudinal axis and the concrete shall be dense and homogeneous.

9.6.3 Joints

The joints shall be of such design and the ends of the concrete pipe sections formed such that when the sections are laid together, they will make a continuous line with a smooth interior free from appreciable irregularities in the flow line.

Joints shall be of bell and spigot type

Joints shall be as per ASTM C 443 with flexible gasket.

9.6.4 Installation

Excavations, backfilling and protection shall be as specified. After the completion of work, the CONTRACTOR shall backfill the excavated area and compact the fill to the original ground level.

- All pipes shall be examined for damage immediately before laying. All defective pipes shall be immediately removed from the site, at the CONTRACTOR's expense. The pipes used in the works shall be free from cracks and neatly finished at the ends.
- Unless otherwise specified, all pipes shall be laid on straight lines and at a uniform gradient between the pits. Trenches shall be of such width as to enable the proper jointing of the pipes and if necessary the excavation shall be enlarged at the sockets. For pipes laid without concrete bedding, the trench bottom shall be excavated to a uniform gradient 30 cm below the invert level and backfilled with sand. The pipes shall be laid only in dry trenches and shall be clean before laying.
- As far as applicable and directed by the Employer/Engineer, drains shall be submitted to a pressure test for water- tightness before any protection is placed. The manholes shall be tested separately as directed by the Employer/Engineer. Drainage and connections shall not leak under normal conditions.

9.7 Inspection and Testing of Pipes

9.7.1 Inspection

The quality of materials, the process of manufacture, and finished pipe shall be subject to inspection and approval by the Employer/Engineer before laying and the pipe shall be subject to rejection on account of failure to conform to any of the specification requirements.

The pipes will be rejected if

- cracks are passing through the wall
- defects that indicate imperfect proportioning, mixing and moulding

- Surface defects indicating honey-combed or open texture damaged or cracked ends where such damage would prevent making satisfactory joints.

9.7.2 Marking

The date of casting shall be clearly marked on each section of pipe.

10.0 STEEL WORK

10.1 Scope of Work, Completeness

This specification covers the scope of steel works in accordance with clause B04 "General" of this specification. The design and execution shall be state of the art, functional and complete in all parts in accordance with this specification.

10.2 Civil Design/Engineering

The design and engineering shall be state of the art in accordance with all relevant codes and standards, functional and complete as mentioned above.

All work shall be carried out in accordance with the requirements on the drawings, the relevant British Standards or German Standards or approved equivalents and with the Employer/Engineer's instructions. In the case of structural steelwork, care shall be taken that all parts in the assembly fit accurately together and corresponding parts shall preferably be interchangeable. Forcible correction to fit the members together will not be allowed.

The CONTRACTOR shall submit to the Employer/Engineer for approval the country of origin and manufacturer of the steel he proposes to supply.

The CONTRACTOR has to design, prepare and submit the complete shop drawings to the Employer/Engineer to get the approval before start of the fabrication.

10.3 Codes and Standards

Design and execution shall be in accordance with all relevant standards as specified in clause B04.0.

Structural steelwork and testing shall comply with the relevant clauses of the following Standards (further standards are applicable as appropriate) unless otherwise specified:

American Standards:

A.I.S.C.	Specification for the design, fabrication and erection of structural steel for buildings
A.I.S.I.	American Iron and Steel Institute
ASTM A36, A529	Structural carbon steel

ASTM A441, A572 High-strength low alloy steel

ASTM A242, A588 Corrosion resistant high-strength low alloy steel

ASTM A307 Common bolts and nuts ASTM A325 High-strength bolts and nuts A.W.S. D1.1 Structural welding code. Steel.

European Standards:

Euro Code 3 "Design of Steel Structures

Euro Code 4 "Design of Composite Steel and Concrete Structures"

British Standards:

BS 4 Structural steel sections

BS 5400 Steel girder bridges

BS 5950 Structural use of steelwork in building

BS 449 Part 2, The use of structural steel in building.

Add. No.1. The use of cold formed steel sections in building

C.P. 117 Composite construction in structural steel and concrete

BS 6399 Chapter V Loading

BS 3692 ISO metric precision hexagon bolts, screws and nuts

BS 4190 ISO metric black hexagon bolts screws and nuts

BS 4395 High strength friction grip bolts

BS 4604 The use of high strength friction grip bolts in structural steelwork

BS 499 Welding terms and symbols

BS 639 Covered electrodes for the manual metal arc welding of mild steel and medium tensile steel

BS 709 Methods of testing fusion welded joints and weld metal in steel

BS 4479 Design of metal articles that are to be coated. BS 4165 Electric wires and fluxes for the submerged arc

welding of mild steel and medium carbon steel. BS 4570 Fusion welding of steel castings

BS 4360	Weldable structural steel
BS 5135	Metal-arc welding of carbon and carbon manganese steels.
BS 6323	Steel tubes for mechanical, structural and general engineering purposes
BS 5135	General requirements for metal-arc welding

German Standards:

DIN EN 10025	Steels for general structural purposes quality specifications
DIN 18800 Part 1 to 7	Steel structures, design and construction
DIN 18801	Structural steel in building; design and construction
DIN 18 335	Part C, Steel structural works; General technical specifications
DIN 4132	Crane ways, steel support structures, principles of calculation, structural design and execution
DIN 1910	Part 2, Welding of metals, processes
DIN 1912	Fusion welding

and the relevant section standards regarding the clauses used.

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10.4 Design Criteria for Layout, Arrangement, Drawings, Execution

10.4.1 General

The design and construction of steel structures shall be based on

- BS 5950 Design of Steel Structures
- Euro Code 3, "Design of Steel Structures"
- Euro Code 4, "Design of Composite Steel and Concrete Structures" (DIN V ENV 1993-1-1, DIN V ENV 1993-1-2, DIN V ENV 1994-1-1 and DIN V ENV 1994-1-2)
- Or British Standards conform to these EUROCODES.

Basis for the execution of all works shall be DIN 18 800, "Structural Steel Work"

- Part 1: “Design and Construction”
- Part 2: “Analysis of Safety Against Buckling of Linear Members and Frames”
- Part 3: “Analysis of Safety Against Buckling of Plates”
- Part 4: “Analysis of Safety Against Buckling of Shells”
- Part 5: “Composite Structures”
- and Part 7: “Execution and CONTRACTOR’s Qualification”

Steel and steel properties shall comply with requirements of DIN EN 10

025, and DIN EN 10 027, “Designation System for Steels” and the standards of the DIN 18 800 series. Reference Standards indicated shall also be observed.

All steel shall be carefully stored and handled so that pieces are not subjected to excessive stresses or damage.

The CONTRACTOR shall include for the preparation of all shop details by competent persons.

Every drawing shall show the number and sizes of all bolts, complete details of welds, type of electrodes, welding procedure, and any other relevant information.

The CONTRACTOR shall be responsible for the correctness of his shop details and site connections. The steelwork shall be manufactured by a specialist firm prior approved by the Employer/Engineer. As much of the work of manufacturing of the steelwork as is reasonably and technically practicable shall be executed in the manufacturer's works, and facilities for inspection by the Employer/Engineer shall be provided.

All steelwork before and after manufacturing shall be smooth, undeformed, straight and free from cracks, twist and burrs.

All steelwork shall be cut and fabricated to a tolerance of $\pm$1.5 mm in its length. Each plate shall be truly at right angles to the longitudinal axis of the section. No work shall be painted, packed or dispatched from the manufacturer's works until it has been tested, and complies with, or has been certified to comply with, all the tests and requirements of the standard applicable to the material specified and until it has been inspected and passed by the Employer/Engineer.

10.4.2 Pre-engineered Steel Structures – Design Loads

Pre-engineered steel structures shall be approved by the EMPLOYER’s Employer/Engineer. All pre-engineered constructions shall be in accordance with the specification of steel works, especially the description of material, etc.

10.5 Steel Works Materials

10.5.1 General

As far as possible standard profiles shall be used according to the static calculations.

If steel members like columns and beams are to be oversized and coated with a corrosion protection system instead of the usual galvanizing, the CONTRACTOR shall do a corrosion protection study and calculation to work out the necessary over-sizing of the profiles. (See clause 1.4.5 above).

The steel members shall be of hot rolled and not built-up sections for the main structures.

Minimum plate thickness for steel structures shall be 6 mm for webs and

8 mm for flanges respectively.

Serrated members shall be used for slip resistance both in platforms and stairs.

The following standards may further apply to Structural Steel Works:

DIN	4114	Steel Structures, stability
	15018	Cranes
	4132	Crane runways
BS	449	Structural steel in buildings
	4	Structural steel sections
	3692	Bolts, screws and nuts
Welding shall be in accordance with Structural Welding Code of American Welding Society (AWS D1.1) ASTM A-325 for high strength friction bolts and ASTM A-307 for other bolts may be considered		

10.5.2 General Items

- All structures shall be designed with future dismantling in mind, for reasons of maintenance and alterations.
- Detailing shall be corrosion conscious and "pockets" which will hold water should be avoided.
- All structural steel shall be provided with 2 mm minimum radii to edges and remove arises to holes.
- For major structures, no steel section under 6 mm thickness shall be used, including webs of standard sections
- These designs shall be shared with the employer/ER for review.

10.5.3 Steel Specifications

All miscellaneous steel shall conform to grade DIN EN 10 027 S 235 or equivalent standards as BS, ASTM, JIS, etc.

The following listing summarizes material standards and specifications, as well as minimum material requirements for design, manufacture and erection:

MEMBER	STANDARD	MATERIAL
Built-up Members	DIN EN 10 027-1	all steel brands S235 and S355
	Formerly DIN 17100 and EN 10 025	Formerly St, USt & RSt37-2, St37-3, St52-3 or Fe360B, BFU, BFN, C & D1, and Fe 510
Hot Rolled Members	DIN 1024 Series DIN 1025 Series	all steel brands S235 and S355,
	DIN 1026 Series DIN 1027 Series	Formerly St, USt & RSt37-2, St37-3 and St52-3; or Fe360B, BFU BFN, C & D1, and Fe 510
	DIN 1029 Series	
Tubes	DIN EN 10 210-1,2	S235 and S355
Bolts and Anchor Bolts	DIN ISO 898, DIN 18 800-1	4.6 ($f_y \geq 240$ N/mm²) 5.6 ($f_y \geq 300$ N/mm²)
High Strength Bolts	DIN ISO 898, DIN 18 800-1	8.8 (fy ≥640 N/mm²) 10.9 ($f_y \geq 900$
Stud Bolts	DIN 32 500, Part 1 & DIN 18 800-1	4.8 (fy ≥320 N/mm²)
	DIN 32 500, Part 3 & DIN 18 800-1	St 37-3 per DIN 17 100, ($f_y \geq 350$ N/mm²)

10.5.4 Corrosion Protection

All outdoor steelwork including platforms, pipe bridges, stairs and ladders shall be hot dip galvanised and painted. All materials earmarked for galvanising shall be galvanised after fabrication on the same day the

surface is sand blasted (or pickled). Galvanising shall occur before assembly by bolting.

Galvanising procedures shall be in accordance with BS EN ISO 1461 and

ASTM A-123, A-153 and A-385 where applicable.

Contractor to provide onsite means of measuring galvanising thickness and quality.

Contractor shall provide for witnessing of galvanising process by Employers Representative/ Employer

All the structures shall be painted in colours that camouflage with the environment. Colours shall be as approved by the Employers representative and Employer

10.5.5 Galvanizing

The following steel structures shall be hot dip galvanized and painted.

- Steel structures outside buildings/open air arrangement
- Structures with chemical and/or seawater exposure
- All secondary steels (pipe racks, platforms, stairs, railings, ladders, etc.)
- All bolts/nuts (if not of stainless steel).

The CONTRACTOR shall provide all technical information and a complete list of all parts to be galvanized for the Employer/Engineer's approval.

Steel shall be coated by the hot-dip process in molten zinc, producing a continuous coating of uniform thickness.

Coating shall be of best commercial quality free from injury, flux and uncoated spots and of such quality as will endure, without penetration of the coating, not less than 4 immersions in copper sulphate, conforming to ASTM A 239.

10.6.2 Connections

Field connections shall be friction-type connections with ASTM A-325 or equivalent- bolting with heavy hexagonal head bolts. Connections at building expansion joints shall be slotted with shoulder bolts with locknuts. The slots shall be of sufficient length to permit movement of sliding, member in both directions from the neutral position, of 25 mm.

Where no reactions or moments are called the connections for indicated sections shall be designed with maximum number of fasteners of 7/8" ($M^2$2) minimum diameter.

Beam Connections of AISC Manual of Steel Construction or equivalent, unless governed by material thickness or otherwise detailed on the drawings. No connections shall have less than two bolts.

Diagonal bracing shall be properly drawn by shortening the member 1/16" every 10 ft. of member length. The connections at end bracings shall develop the force due to the design load, but not less than 50 percent of the effective strength of the member. If no load is indicated, the latter condition shall govern.

In accordance with the structural design, the steel structure may be either a frame structure and/or a

braced structure. Following notes shall be considered during execution and erection of structural steel works:

1. Co-ordination of the design of the structural steel members with the design of related concrete structures

2. Checking of anchor bolts and their setting prior to casting pedestals/foundations

3. Complete erection of the steel structure in accordance with the approved erection drawings

The steel structures shall be fabricated in a workshop according to the approved shop drawings.

The size of construction members shall be of the maximum admissible size for the transport to and handling at site. Fabricated steel structures shall be pre-assembled in the workshop to such an extent to ensure proper field erection, and shall be dismantled (non-welded/bolted members only) for transportation, during which the CONTRACTOR shall reasonably protect the steel structure from damages. The steel structure shall be suitable packed, covered or coated, and any damage and corrosion during transportation shall be the responsibility of the CONTRACTOR and shall be rectified to the satisfaction of Employer/Engineer.

Where possible, torque wrenches shall be used for tightening of bolt connections. Structural steel members delivered to the site shall be evenly supported and stacked on timber to avoid deformation.

Bolts, nuts, washers, rivets and other identical items of structural steel required to be incorporated into concrete shall be delivered to the Site well in advance.

Bolts, pins, packings, tools, insulation material, electrical parts, motors, parts with electrical devices, attached instruments, welding equipment and material, etc. shall be stored inside closed stores.

All metal parts shall be interconnected to the Station earthing by an approved method in electrical specifications.

Tolerances shall be kept in accordance with the relevant stipulation of DIN 18800 or BS 449 and within the specified limits on the drawings.

10.6.2.1 Cutting

Cutting may be by shearing, cropping, sawing or machine flame cutting. Hand flame cutting is subject to the approval of the Employer/Engineer.

Cut edges on rolled products shall be given a finishing operation by a metal cutting method (e.g. by planning, milling, grinding or filing). Notches and cracks are to be eliminated in the same way. Small surface defects such as grooves and other types of unevenness may be removed by grinding. The use of welding to fill in defects is generally not permitted.

10.6.2.2 Bolt Holes

All holes are to be drilled and not punched after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, provided the holes are punched 2 mm less in diameter that the required size and reamed after assembly to the full diameter. The thickness of material punched shall not exceed 10 mm. For tolerances the requirements of BS 449 Part 2 shall be observed.

10.6.2.3 Bolting

The threaded portion of each bolt shall project through the nut at least one thread. Approved high strength friction grip bolts, preferably the type with indicated load are to be used where specified and are to be tightened strictly in accordance with the manufacturer's instructions and the pertaining regulations. The surfaces in contact shall not be painted and shall be free from oil, dirt, loose rust, burrs and other defects which would prevent solid seating of the parts or interfere with the development of friction between them.

When connections are made using high strength friction grip bolts the "provisional directions for the calculation, execution and structural design of friction grip bolted fastenings (high strength friction grip fastenings)" prepared by the German Committee for Steel Construction are to be observed.

Bolts with nipped ends shall be used for boiler structures and pipe rack structures to ensure accuracy of torque.

10.6.2.4 Welding

The execution and testing of welding shall be in accordance with the following standards:

British Standards BS 5135 or German Standards DIN 18800 and DIN EN 10025. All welds, unless otherwise stated are to be continuous minimum 6 mm fillet weld and shall be dressed smooth, free from porosity, cracks, holes and finished to match adjacent surfaces. When welding operations are completed, all welding flux shall be removed without delay.

After welding, the components shall possess the shape planned for them preferably without any subsequent dressing. The cooling of welds shall not be accelerated by any special measures.

Site welding is to be restricted to the absolute minimum. The examination of welded work and the inspection of welds during and after manufacture is to be carried out by responsible specialist welding engineers. Welding shall be carried out by expert tradesmen and in strict accordance with the current code of practice.

For the further processing of weatherproof structural steels, such as hot shaping, and for welding and flame-cutting, the "Directions for the supply, working and application of weatherproof structural steels - DA ST-Ri-007" shall be taken into account.

Welding on site will be allowed in exceptional circumstances with the permission of the Employer/Engineer. Normally metal arc welding shall be carried out, and only if and where specifically permitted by the

The positioning and levelling of all steelwork and the accurate placing of every part of the structure shall be in accordance with the approved drawings and to the satisfaction of the Employer/Engineer.

During erection, the work shall be securely bolted or otherwise fastened and if necessary temporarily braced, so as to make adequate provision for all erection stresses and conditions. Neither permanent bolting nor welding shall be done until proper alignment has been obtained.

The CONTRACTOR shall supply all necessary scaffolding, temporary supports and staging, tools, temporary connections, erection plant, service bolts, nuts, washers, anchorage cables, bracing and all other materials necessary to carry out the work and shall remove the same as the progress of the erection

permits.

Steelwork damaged due to inadequate precautions being taken during the storage, transport and erection of the steelwork shall be made good to the satisfaction of the Employer/Engineer at the CONTRACTOR's expense.

All shop connections shall be made by electric welding. All site connections shall be bolted unless otherwise specified in drawings or by the Employer/Engineer.

Encased steelwork and steel in foundations shall be solidly encased in concrete, with a minimum cover of 100 mm.

10.6.4.1 Footings

Foundation bolts and plates or steel stubs shall be provided for all columns and shall be firmly keyed and grouted into concrete foundation blocks.

Erection shall include the setting of all columns and bases, and erection of all structural steel as called for under the Contract for furnishing and delivery of structural steel.

The CONTRACTOR shall set column bases and beam plates on steel wedges or angle screeds, to accurate elevations approximately 4 cm clear of masonry or concrete. Wooden wedges shall not be used.

Anchor bolts and other identical items of structural steel required to be built into concrete with instructions and/or templates for their installation shall be delivered to the respective trades in proper time to avoid delay in the work. The structural steel erector shall verify the position of anchor bolts before concrete or grout are poured.

All anchor bolts shall be placed to be clear from encroachment of rebars provided in the pedestal in both directions.

Levelling of base plates shall be by means of levelling screws. Setting procedures shall be as approved by the Employer/Engineer.

Shims for columns base plates, equipment base and at any other locations shall only be of non-corrosive material, in case of dissimilar metal to galvanized base plate, suitable protection shall be provided. No carbon steel or other corrosive metal embodiments are permitted.

Grouting shall be in accordance with Clause "Concrete Work" of this Specification.

10.6.4.2 Aligning & Plumbing

The CONTRACTOR shall provide all necessary guys and braces to insure the alignment and stability of the structural steel members until all are properly connected and riveted. All temporary guys and bracings shall take care of all dead load, wind load, seismic load and erection stresses, and shall remain in place until, in the opinion of the Employer/Engineer they can be removed without danger to the stability of the structure.

After erection, no column shall have a deviation from the vertical exceeding 1 to 1000 of the total height of the column.

Approved steel gauges of the stud type shall be provided to enable the Employer/Engineer to carry out such checking of members as he may consider necessary.

10.6.4.3 Correction of Errors

Correction of minor misfits and a reasonable amount of reaming and cutting of excess stock from rivets will be considered as a legitimate part of erection. Any error that may occur in shop work which prevent the proper assembling and fitting of parts by moderate use of drift pins, or a moderate amount of reaming and slight chipping or cutting shall immediately be called to the attention of the Employer/Engineer and approval of the method or procedure of correction shall be obtained or such method or procedure shall not be employed. The use of cutting torches to enlarge or alter bolt or rivet holes shall be prohibited.

10.6.5 Rejection

Any steelwork which in the opinion of the Employer/Engineer is not in accordance with the requirements of the Standards or with the Specification, shall be mandatorily rejected and removed from the site at the CONTRACTOR's expense.

10.7 Tests

The manufacturer's test certificate for all steelwork shall be supplied to the Employer/Engineer. The certificates shall state the manufacturing process and shall include a test sheet giving the results of the mechanical tests and the chemical composition. The CONTRACTOR shall provide free of charge any supplementary tests reasonably required by the Employer/Engineer. The samples shall be tested at an independent testing station in accordance with BS 5400 - BS 4872 or DIN EN 10025, DIN 18800 and DIN 18801. If the results of the tests are unsatisfactory the whole quantity of steel which the sample represents shall be rejected at the expense of the CONTRACTOR. No steelwork shall be delivered from the manufacturer's works until it has been tested and the results comply with the requirements of the relevant BS or DIN. The Employer/Engineer shall at all reasonable time have free access to the manufacturer's works for inspection during all phases of the execution works. The CONTRACTOR shall supply free of charge all labour and tools required in connection with the inspection and testing of the steelwork.

Apparatus, equipment and tools required for testing (e.g. for X-rays) shall be part of the scope of supply, with following tests at least required for welds:

- X-ray tests for each heavy load bearing structure member: min. for 20% of all welds
- Also refer to other clauses of this specification for welding and in general for testing, the most stringent of which shall apply.

11.0 SMALL NON-STRUCTURAL STEEL PARTS

11.1General

This sub-clause refers to the specification covering the provision of all materials and labour in relation to the supply, manufacture, on site of articles made of steel or cast iron.

All steel structures and parts specified under this sub-clause shall be hot dip galvanized and painted or stainless steel according to clause “Corrosion protection and painting" of Clause "General" above.

The list of small items to be furnished shall contain but not be limited to the following:

- Steel sections, bent plate sections and square bars for construction of:
- structural steel stairs, platforms and walkways
- railing for stairs, platforms, walkways and protection around floor openings
- corner and edge protection for concrete steps and concrete
- support of any equipment foundation
- joint covers
- anchors, ties, hangers, inserts, slots, embedded steel parts, etc.
- Steel pipes and plain round bars for making guard rails and ladders
- Steel plates, chequered and/or flat, for fabrication of removable covers
- Open steel grating for metal steps, platforms, walkways.

11.2 Design/Engineering

11.2.1 Special requirements

The dimensions of steel parts, etc., shall be as shown in the drawings or as specified by the Employer/Engineer.

11.3 Codes and Standards

All works shall be in accordance of clause B04.0 and clause B04.10 “Steel

Works” of this specification.

11.4 Design Criteria

11.4.1 Steel Sections & Plates

Steel sections may be required in various standard profiles and shall comply with the relevant standards specified herein. In general, these sections shall be straight, with exact measurements and made of mild steel as described under clause "Structural Steel" above.

Where required, mild steel plates shall be bent to special profile forms. These bent plates shall be used particularly on stairs, and also on doors and window frames.

It shall be possible to bend a strip of the plate, when cold, to an angle of 180° around a bar the diameter of which is equal to the thickness of the plate, without causing any fracture.

All necessary care and precautions shall be taken in shipping, transporting and erection of all metalwork to avoid damage to the priming and finishing paintwork. Surface treatment and painting before and after delivery to site shall be in accordance with the requirements specified under clause 1.1.25 “Corrosion Protection and Painting” of Clause "General" above.

11.4.2 Access Plates

All grating shall be Heavy duty FRP access plates. Cut-outs and openings required in FRP plates shall be shop formed and adequately reinforced as per the approved drawings or Employer/Engineer's instructions.

FRP shall in all cases be supported by a properly formed steel kerb running continuously throughout the supported length. The FRP flooring shall be provided with proper and adequate lifting eyes.

The arrangement of panels, unless otherwise prescribed, shall allow the ready removal of every unit by not more than two men.

11.4.3 Duct Covers

Where duct runs are required in concrete, properly designed duct covers are to be used. Duct covers shall have securely fixed kerbs with lugs for building into the concrete. The covers shall have a minimum load-carrying capacity of 500 kg/m² and shall be capable of supporting the loads of adjoining machinery or traffic. The covers shall have properly shaped and formed keyholes for lifting and shall be divided into convenient lengths for handling without damage. The top of the covers shall be flush with the finished surface of the floor.

11.4.4 Rails for Crane Tracks

All steel sections for rails and tracks shall be of an approved type, obtained from an approved manufacturer to meet the performance requirements stipulated in this specification clause.

When rails for track of the travelling cranes are to be provided with a normal or special steel profile, the requirements of DIN 15 049, DIN 15 050, DIN 15 070, DIN 5902 sheet 1, DIN 5901 sheet 1 and 5 - 36 shall be observed.

11.4.5 Metal Parts Embedded in Concrete

The embedded items (anchor bolts, fixing elements, etc.) for outside conditions and for inside conditions with seawater wetting, chemicals, etc. shall be of stainless steel (material No. 316 Ti conforming to AiSi). The embedded items for inside conditions (without corrosive climate) shall be hot dip galvanized and shall be epoxy painted in addition.

All anchor bolts shall have a concrete cover of at least 10 cm.

11.4.6 Ladders

Ladders shall be provided by the CONTRACTOR all to heights and accesses as required in the design, e.g. to reach roofs, basements, emergency exits, etc. Side-rails of ladders shall consist of 65 x 12 mm flat bars, or angles L 60/8 or L 75/10 according to the approved design. Rungs shall be of 25 mm diameter ribbed bars, tenoned into the side rails and securely welded. Rungs shall be 0.4 m long between side-rails and spaced 28 cm.

Ladders shall be securely fastened at top and bottom into the wall and shall have intermediate clips or flats and fastenings spaced not more than 2.0 m apart. Clips or flats shall be riveted or welded to the side.

The safety cage shall be constructed from 55 x 6 mm flat steel bar hoops, bent to the specified radius and spaced uniformly and horizontally at a maximum of 1.5 m and 5 equally spaced 40 x 6 mm vertical flat bars, welded to the inside face of hoops to provide a smooth and snag-free interior of the cage.

11.4.7 Steel Stairs

Main stairways shall have a minimum stair tread width of 1100 mm; other stairways shall have a minimum width of 800 mm.

Steel stairs shall have an inclination not exceeding 45° to the horizontal.

No flight of stairs shall have more than 16 risers. Where a stairway requires more than 16 risers each flight shall have an approximately equal number of risers and shall be separated by a landing. Risings shall be between 170 mm and 190 mm and goings shall be between 260 mm and 290 mm in width.

11.4.8 Steel Pipe Railings

Steel pipe railing shall always be installed on both sides of all walkways, stairs and platforms, and shall be made of steel pipes of 32 mm internal diameter and minimum thickness of 4 mm. The top rail shall be at a height of not less than 1100 mm from the walkway or platform level. Rails over stairs shall have the top level at a height of 900 mm above the nose of the tread. Two intermediate rails shall be installed between the top rail and the toe plate or channel. A pattern of symmetry shall be accomplished when locating pipe posts and the distance between pipe posts shall not exceed 1200 mm.

Pipe railing shall consist of standard steel pipe with flush, continuous, welded joints, ground smooth hot dip galvanized and painted. Exposed bottom ends of pipe posts shall be closed where required.

Wall pipe and handrail shall be returned to a wall and be provided with necessary secure anchors. The CONTRACTOR shall provide necessary handrail brackets of malleable iron and anchors. All accessories such as floor flanges, etc., required for pipe railing shall be furnished.

All hand railings shall be continued to the end vertical posts with smooth curvature to prevent accidents.

Installation of pipe railings shall be done in a substantial and rigid manner. Stands on concrete shall be set in pipe sleeves, not less than 4 inches deep, with the sleeves cast into the concrete and of a size fitting snugly around

Ladders shall be constructed staggered with landings at every 10m in height. Ladders exceeding 2.5 m length shall be equipped with safety cages starting 2.50 m above ground or floor, and extending over the full height of the stringers with an unobstructed inside diameter of at least 0.7 m. and thus rigidly supporting the pipe shall have a flange on the foot secured to the concrete by countersunk, flat-head machine screws in expansion metal sleeves.

Stands on metal shall have a plate or flange welded to the foot and secured by counter-sunk, flat-head machine screws tapped into the supporting members, or as indicated on the drawings.

Removable sections shall be made in sections as above specified. On steel, foot plates shall be welded to the stands and fastened with cap screws.

11.4.9 Security Fencing

Security fences shall be 2400 mm high with 40 NB galvanised tube posts at 3000mm centres, set 600 mm minimum into concrete. Tubes shall be drilled to take 3 strands 2.5 HT wire at 900 centres on lower portion and 3 strands RT150HT barbed wire at 150 centres above. Galvanised chain netting 1800 mm wide shall be clipped to the wire strands.

Posts at corners shall be 50 NB and stayed as required. Purpose designed gates with locking hardware shall be supplied at access points.

Alternative designs to the above will be considered.

All fenced areas shall have vehicle access gates provided for each access road entering the area. The access gates shall be suitable for large vehicles used for well drilling. No less than 3 personnel access gates shall be provided around each fenced area for health and safety egress.

All gates shall be lockable. The Contractor shall provide all locks and locking attachments, with the locks being to KenGen's security system standards.

11.5 Non-Structural Steel Materials (Quality, Delivery, Storage, Handling)

The requirements for materials of structural steel as specified above are applicable to all steel sections, bars, plates, pipes and any non-structural sections as far as their quality, source, dimensions, mechanical characteristics and their delivery, handling, storage and tests on site are concerned.

12. ROADS AND OTHER PAVED AREAS

12.1Scope of Work, Completeness

This specification covers roads, parking places, walkways and corresponding facilities in accordance with clause B04 "General" of this specification. The design and execution shall be state of the art, functional and complete in all parts in accordance with this specification.

Paving and surfacing required for this work includes but is not necessarily limited to supply, storage and transport of materials, equipment, mixing and placing, all tests, workmanship and finishing of roads and surfacing.

The actual thickness of road-courses shall be calculated based on the final results of the soil investigation, loading assumptions, intensity of traffic, design life, etc.

12.2 Civil Design/Engineering

The design and engineering shall be state of the art in accordance with all relevant codes and standards, functional and complete as mentioned above.

12.2.1 Sub-base

Sub-base material shall be crushed rock or other approved local material having suitable properties and confirming to the following grading:-

BS Sieve Passing	Percentage by Weight mm

75	100
37.5	85 - 100
10	45 - 100
5	25 - 85
0.6	8 - 45
0.075	0 - 10

When tested to BS 882 the material shall have a minimum "ten percent fines" value of 5. The material passing the 0.425 sieve shall have a plasticity index of less than 6.

12.2.2 Wet Mix Road Base

Wet Mix road base material shall consist of crushed gravel or crushed rock and shall be suitably proportioned to confirm to the following grading as approved by the Employer/Engineer.

BS Sieve Size Passing	Percentage by Weight mm
50	100
37.5	90 - 100
20	60 - 80
10	40 - 60
5.00	25 - 40
2.36	15 - 30
0.600	8 - 22
0.075	0 - 8

The fraction passing the 0.075 mm sieve shall not be greater than two-thirds of the fraction passing the 0.425 mm sieve.

Material constituents shall comply with the following maximum limits:

For material passing the 0.425 mm sieve:

liquid limit	25%
linear shrinkage	3%
plasticity index	6%

stone size aggregate	50 mm
aggregate crushing value	25%
water absorption	2%
flakiness index	35%
elongation index	35%
Mg S04 soundness	15%

For coarse material:

Quarry won material shall be extracted from faces and areas approved by the Employer/Engineer. The aggregate crushing value shall be monitored by regular testing of material prior to its inclusion in the construction.

The material shall be spread evenly on the sub-base in layers not exceeding

150 mm compacted thickness. Segregation shall be avoided during transport and placing and any segregation evident after compaction shall be corrected by vibrating in non-plastic fines or made good by removing and replacing with properly graded material.

The base shall be compacted by approved plant to a dry density which shall be not less than 98% relative compaction (or the requirements of DIN 1054) and until movement of the surface ceases and the surface is closed. The completed layer shall have an in-situ CBR of not less than 80%.

The final surface shall be shaped and finished true to line and level within a tolerance of $\pm$ 10 mm to the levels shown on the drawings.

12.2.3 Chlorides & Sulphates

The level of the acid-soluble chloride (as NaCI) (BS 812: Part 117) in the sub-base and road base layers shall not exceed 3.5% and 0.5% by weight respectively.

The level of acid-soluble sulphate (as S03) (BS 812: Part 118) in the sub- base and road base raiders shall not exceed 2.0% and 0.5% by weight respectively.

Potable water shall be used to reach the optimum moisture content for compaction purposes.

12.2.4 Hard Shoulders

The material used for any hard shoulders shall comply with the specification for wet-mix road base.

12.2.5 Bitumen Macadam – General

Aggregate shall be hard, clean, durable crushed rock or gravel, and sand all in accordance with BS 4987 and shall be obtained from approved source which shall not include quarries containing significant proportions of weather bed, decomposed or extensively fractured materials. The CONTRACTOR shall propose a suitable source, or sources, and samples shall be obtained for specified testing before arrangements for obtaining aggregate are approved. Laboratory tests shall be made at regular intervals to confirm the suitability of aggregate.

The CONTRACTOR shall obtain whatever permissions are necessary for the exploitation of quarries and borrow-pits and shall pay royalties, fees, way leaves and the like. The CONTRACTOR shall operate the quarry or pit in an approved manner and provide sufficient evidence by means of boreholes, test holes and the like to show that the quarry contains aggregate of the required quality and quantity to complete the Works, and he may be required to produce a geological map. The aggregate winning and processing operations shall not constitute a danger to health or safety either during or after completion of the Works, nor interfere with others.

When quarrying operations are complete, the CONTRACTOR shall leave the quarry in a safe condition by, inter alia:

a) Barring down all faces so that no loose rock remains on any face
b) Bringing down overhanging rock safely
c) Ensuring that the quarry is free draining and that no water can accumulate; or, in the case of a quarry below ground level, minimizing the accumulation of water and draining to approved areas. Warning notices in Arabic and English may be required at any concentrations of water which constitute a hazard
d) Stockpiling surplus rock material to a height not greater than 5 meters with stable side slopes.

Aggregate and chippings for surface dressing, shall be stored so that segregation, intermixing of different aggregates and contamination by dirt and other foreign materials is prevented. In general, each size of aggregate shall be stored separately.

Coarse aggregate is defined as that fraction retained on a 3.5 mm BS sieve. It shall have physical properties which do not exceed the following test values when tested in accordance with BS 812:

	Wearing Course	Base Course
aggregate crushing value	20%	25%
flakiness index	25%	30%
elongation index	25%	30%
water absorption	2%	2%

Coarse aggregate may contain up to 15% of pieces with one uncrushed face in each grading size when tested in accordance with Test Method DM-301. Aggregate obtained from quarried rock shall be deemed to satisfy this requirement.

Separate coarse and fine aggregate fractions shall be tested for soundness in accordance with ASTM C 88.

After 5 cycles of immersion in magnesium sulphate solution and drying, the loss of weight expressed as a percentage of the initial weight shall not exceed 12%. Any filler, if approved for use, shall comply with BS 4987 (1973).

The aggregate grading for binder shall comply with the following:

Finished thickness of binder (mm) Grading [BS 4987 (1973)]

60 Table 21

Wearing course shall be of 40mm finished thickness, the aggregate grading shall be as follows:

BS Test Sieve (mm)	Grading (20mm nominal size)
	% by weight passing
28	100
20	95 - 100
14	70 - 90
10	55 - 75
6.3	40 - 60
3.35	25 - 40
1.18	15 - 30
0.075	2 -6

Bitumen shall be of Grade 60/70 penetration with properties corresponding to an interpolation between Grade 50 and Grade 70 as defined in BS 3690. The specific gravity and temperature/viscosity relationship shall be provided.

The frequency of testing of the penetration index shall be two tests per delivery of bitumen. The PI range shall be -1 to +1.

12.2.6 Design of Bitumen Macadam

Design mixes shall be submitted for approval and proved by means of laboratory, plant and field trials. Tracking tests may also be required.

The mixes shall be tested in accordance with the following methods:

- preparation and testing of Marshall Specimens: ASTM D 1559 using 75 blows per face
- bulk Specific Gravity of specimens: ASTM C 1188
- the values for specific gravities of the aggregates to be used in calculating the voids shall be taken as the mean of the Bulk, Apparent and Effective Specific Gravities as

defined in the American Asphalt Institute publication "Mix Design Methods for Asphaltic Concrete"

- The adhesion of bitumen to aggregate shall be proven by comparing the stability of specimens cured in water and air for eight days at 18 degrees C. The ratio of stability in the two shall not be less than 0.65
- wearing course mix shall be subjected to further Marshall tests at 80 degrees C after oven heating for a period of 2 hours; the stability/flow
- ratio shall not fall below 270 at this temperature
- Mixes with a bitumen content corresponding to the maximum allowable for the selected job mix shall be compacted to refusal, or to 600 blows per face whichever shall be reached first, and the resulting voids-in-mix values shall be not less than 3%.

The designed mixes shall comply with the following:

	Binder Course	Wearing Course
Voids in mix	7 - 10	5 - 8
Voids in mixed aggregate %	14 - 20	14 -20
Minimum stability (kg)	750	1000
Flow (mm)	2 - 4	2 - 4
Minimum stability flow ratio (kg/niTn)	270	320
Bitumen content (% of total mix)	3.3 –4.0	3.5 – 4.2
Voids filled with Bitumen (%)	48 - 60	48- 60

After a design mix has been approved and adopted as a job mix, the maximum permitted deviations from the job mix shall be as follows: Permitted Deviations

Sieve size:	
6.3 mm or larger	±5%
3.35 mm	± 4%
0.6 mm to 1.18mm	± 3%
0.075mm to 0.3mm	± 2% Smaller than 0.075mm
± 1% Bitumen	± 0.2% Voids in mix ± 1%

The application of the above deviation percentages shall not result in values falling outside those specified in the clause covering the design and testing of bitumen macadam mixes.

Chlorides and Sulphates shall comply with clause “Chlorides and Sulphates” above.

12.3 Codes and Standards

Design and execution shall be in accordance with all relevant standards as specified in clause B04.0.

12.4 Design Criteria for Layout, Arrangement, Drawings, Execution

Design and execution shall be in accordance with all relevant design criteria as specified in clause B04.1.3.

12.5 Execution (Assembling, Installation)

All execution works shall be in accordance with clause B04.1.6 of this specification.

12.5.1 Compaction of Sub-Grade

The area of the Works shall be cleared of any material or obstructions which in the opinion of the Employer/Engineer might adversely affect the stability of the fill or pavement, and the top layer removed to a depth of 300 mm (or more if the design so required).

The sub-grade and formation shall be checked and accepted by the Employer/Engineer before placing and spreading operations are started. Any ruts or soft areas caused by improper drainage conditions, hauling or any other cause shall be corrected and rolled to the required compaction before sub-base is placed thereon.

The formation shall be compacted to a dry density of at least 95% of the maximum dry density as determined in BS 1377: Test 13 (BS 'Heavy' compaction) and a CBR of 15%.

Where the CONTRACTOR is unable to achieve this degree of compaction to the formation level further excavation shall be carried out to a depth to be defined by the Employer/Engineer (but not less than 300 mm). Selected backfill will thereafter be placed and compacted to the requirements of this Clause.

Where the land contours require it, fill in embankment shall be placed and compacted with minimum embankment slope of 1: 4.

Compaction shall be carried out by means approved by the Employer/Engineer. All construction equipment shall operate over the full width of the formation to ensure uniform compaction.

12.5.2 Sub-Base

The material shall be spread evenly on the preceding material in layers not exceeding 150 mm compacted thickness. The minimum thickness of this layer shall be 150 mm after compaction.

Segregation shall be avoided during transport and placing and any segregation evident after compaction shall be corrected by vibrating in fines or made good by removing and replacing with properly graded material. If necessary the material shall be spread using a spreader box or paving machine to minimize segregation and enable an even depth and the level tolerance to be achieved.

The sub-base shall be compacted by approved plant to a dry density which shall not be less than 98% relative compaction until movement of the surface ceases and the surface is closed. The CBR value shall be at least 30% at the maximum moisture content which in the opinion of the Employer/Engineer will

occur after completion of the Works.

Where the sub-grade can be compacted as specified by available plant to give a stable load bearing surface which will resists deformation during sub- base placing and with in-situ CBR values of greater than 30%, the sub-base layer may be reduced to 100 mm thickness at the option of the Employer/Engineer.

12.5.3 Placing of Road Base

Wet mix road base material shall be crushed and mixed by approved mechanical placing plant. Water for adjusting the moisture content shall be added at the mixer. If required, the moisture content shall be adjusted to allow for evaporation road base loss during transportation. After mixing, the material shall be removed from the mixer and transported to the placing location without delay. The moisture content at the time of laying shall be within $\pm$ 0.5% of the optimum value determined in accordance with the Vibrating Hammer Method described in BA l377, Test 14.

Vehicles carrying the plant-mixed material shall be of a capacity suited to the output of the mixing plant and the site conditions, and shall be capable of discharging cleanly. After mixing is complete, the materials shall be removed at once from the mixer, transported directly to the point where it is to be laid and protected from the weather both during transit from the mixer to the laying site and whilst awaiting tipping. The distance between mixing plant and job site shall not exceed 20 km.

The compaction procedure and plant shall be proved by trials at the commencement of the Works. The weight, type and number of passes of compaction plant shall be varied to determine the optimum compaction effort.

Road base material shall be placed and spread evenly, without delay, using a paving machine, or spreader box operated with a mechanism which level off the material at an even depth and it shall be spread in layers not exceeding 200 mm compacted thickness. Segregation shall be made good by removal and replacement. The road base shall achieve a minimum dry density of 981 of the maximum laboratory dry density and an in-situ CBR value of not less than 80%.

Special care shall be taken to obtain full compaction in the vicinity of both longitudinal and transverse joints.

The completed surfaces of all layers shall be well-closed and free from movement under compaction plant, and shall have no compaction planes, ridges, cracks or loose material. All loose segregated or otherwise defective areas shall be made good to the full thickness of the layer and be re- compacted.

Before placing the next construction layer or applying prime coat, the road base shall be mechanically swept, then cleaned with compressed air to remove loose material. As soon as possible after cleaning of the surface, the road base shall be sealed by the application of a prime coat as specified. Should the surface of the material be allowed to dry out before the seal is applied, it shall be lightly watered and re-compacted immediately prior to spraying with prime coat. Should the full depth of layer be allowed to dry out, it shall be removed and replaced, at the CONTRACTOR's expense, with fresh material. Watering and re-mixing in place will not be permitted.

12.5.4 Mixing & Laying Of Bitumen Macadam

The mixing and placing of bitumen macadam shall be carried out in accordance with the

requirements of BS 4987 (1973).

The aggregate and bitumen shall be mixed in an approved plant of the batch type. Constituents shall be proportioned by weight; the bitumen may be proportioned by a metering pump. Facilities shall be provided in the mixer to enable the sampling of hot aggregates.

Bitumen and aggregates shall not be heated to above 150°C and 170°C, respectively, and the temperature difference between them at the time of mixing shall not exceed 15°C. The mixing temperature shall be established from the bitumen viscosity/temperature graph in accordance with ASTM D2170 and ASTM D1559. Approved facilities for continuous measurement of temperatures shall be provided.

The batching plant and equipment shall be properly maintained and cleaned and shall be provided with means of checking the accuracy of weighing mechanisms and metering devices. These shall be checked at monthly intervals or as directed.

Bitumen macadam shall be transported in clean vehicles. Dust, coated dust,

oil or water may be used on vehicle bodies to facilitate discharge, but the amounts shall be kept to a minimum and any excess shall be removed by tipping or brushing.

Heat loss shall be minimized during transit and the macadam shall not be discharged into the paver at a temperature less than 120 degrees C.

Bitumen macadam shall generally be spread, levelled and tamped by approved self-propelled pavers.

Immediately after arrival at the site, the macadam shall be supplied continuously to the paver and placed without delay. The rate of the delivery of material to the paver shall be regulated so that the paver may operate continuously and it shall be adjusted to provide an even and uniform flow of material across the full laving width, freedom from dragging or tearing of the material and minimum segregation.

Excess material arising from placing base course shall be removed by brooming or light raking. Over-raking causing segregation of the material shall not occur. The excess shall be discarded and not used elsewhere.

Hand-raking or wearing course material which has been laid by a paver and the addition of material by hand-spreading for adjustment of level will require prior approval.

If the abutting lane or succeeding strip is not placed on the same day, the joint shall be cut back to an even line. Loosened material shall be discarded. The joint shall be brushed with a very light coat of hot bitumen before the next strip is placed. The whole face of the joint shall be treated before fresh macadam is placed against it. Joints shall be formed only in compacted material and fresh material placed against a cut face shall be properly compacted.

Joints in wearing course shall be offset by at least 300mm from parallel joints in the layer beneath.

Hand-laying of macadam will be permitted only for laying courses of irregular shape and varying thickness, and in confined areas where a paver cannot operate.

The CONTRACTOR shall obtain approval of compaction methods and plant by carrying out trials to

demonstrate consistent achievement of the requirements. The degree of compaction achieved during the trials shall be not less than 1% greater than that required during the course of the Works. The methods and plant shall not be changed without approval.

After placing, the macadam shall be compacted to the thickness shown on the Drawings by rolling to a density of not less than 98% of the maximum density of the approved daily Marshall laboratory density.

Should any individual core, tested in accordance with the clause titled "Testing of Bitumen Macadam", not have the specified degree of compaction, additional cores may be taken in adjacent locations, at the discretion of the Employer/Engineer.

Should the bitumen macadam fail to achieve the specified density, at the discretion of the Employer/Engineer re-rolling may be allowed subject to the following conditions.

a) The densification to be achieved shall be 1% or less.
b) Only PTRs shall be used, weighing no greater than 18 tonnes.
c) Re-rolling shall take place within 72 hours after the time of the initial rolling of the bitumen macadam.
d) Re-rolling shall take place at the time of day when the bitumen macadam has attained it maximum natural temperature.
e) Re-rolling shall be applied for a maximum of two hours.
f) Re-rolling shall be carried out in the presence of the Employer/Engineer's Representative and a Representative from the

   Client's Materials Testing Laboratory.

g) The section of the works in question shall be cored for density determination immediately after the completion of re-rolling.
h) If, after re-testing, the density achieved is equal to or greater than 99.5% of the specified density, the bitumen macadam will be accepted in the Works subject to a 20% reduction in the billed rates. If, on other hand the density achieved is less than 99.5% of the specified density, the bitumen macadam shall be removed and new material to the specification laid at the CONTRACTOR's cost.

Before pavement construction is commenced, a trial area of each pavement materials shall be laid. The extent and location of these areas shall be as approved. The materials, mix proportions, plant and methods shall be those which are proposed for the main work.

A priming coat of grade MC 30 petroleum bitumen shall be applied to the road base at the rate of 0.55 to.7 litre per m^2, before placing macadam. The binder course, shall not be laid until the priming coat has been cured.

The binder course shall be prepared to receive the wearing course by removal of dust and deleterious materials by air jetting or other approved means.

A tack coat of grade MC 30 cut-back bitumen or SS1H emulsion shall be applied to the binder course at the rate of 0.25 to 0.35 litre per m^2 before placing, the wearing course. The wearing course shall not be laid until the tack coat has cured. The wearing, course shall adhere satisfactorily to the base course.

If approval has been given for macadam to be placed at night, approved lighting shall be provided at locations where mixing, laving and testing operations are in progress.

The horizontal alignment of the road as constructed shall not deviate by more than ± 10nim from the true alignment as given by the dimensions on the Drawings. The rate of deviation shall not exceed 1 in 1000.

The required levels of base course and wearing course shall be determined from the finished road surfaces calculated from the vertical profiles and the cross falls shown on the Drawings. The permitted vertical deviation from the true level of any point shall be ± 5mm for base course and ± 3mm for wearing course.

The thickness of the individual layers of base course and wearing course shall not vary by more than 5 mm from the theoretical thickness of the respective layers.

The combined thickness of binding course and wearing course layers shall not vary from the theoretical combined thickness by more than 10% of that thickness, or by 10mm, whichever is less.

The numbers of permitted longitudinal irregularities in the wearing course, base course and hard shoulder surfaces shall not exceed the figures in the following table.

	Wearing Course		Binder Course				
Irregularity	3mm		6mm	4mm		7mm	
Length m	300	75	75	300	75	300	75
Number of irregularities	20	9	1	40	18	4	2

An irregularity is a variation greater than 3mm or 7mm in the longitudinal profile of the road surface as measured from a 3in long straight edge.

No irregularities exceeding 8 mm shall be permitted.

Wearing courses shall also be measured transversely for irregularities by a 3 in straight edge placed at right angle to the center line of the road. The maximum permissible deviation in this case shall not exceed 3mm.

Traffic shall not be allowed to run on any surfaces without approval.

12.5.5 Final Surfacing of Bitumen Macadam

The Bitumen Macadam binder course shall be kept clean and uncontaminated as long as it remains uncovered by a wearing course. Should the binder course become contaminated the CONTRACTOR shall make good by cleaning to the satisfaction of the Employer/Engineer and if this is impracticable by removing the layer and replacing it to specification.

When all heavy plant has been delivered and all soft, fatty or otherwise objectionable areas of the road have been reinstated and made good to the satisfaction of the Employer/Engineer, the wearing course shall be laid.

12.5.6 Jointing New To Existing Pavement

Where new pavement is required to join into existing road construction, the joint shall be formed and treated in accordance with the Drawings.

Unless shown otherwise on the Drawings, each layer of existing bituminous course shall be cut back to a clean vertical face and coated with hot bitumen of a grade suitable for the purpose immediately before laying adjacent new bituminous material.

If cutting back of the existing pavement layers is required to form a stepped pattern, the lower layers of bituminous courses shall be prepared to receive the new covering coats by removal of dust and deleterious materials by air jetting or other approved means, and shall be coated with bituminous tack coat.

Exposed existing road base surfaces shall be scarified then re-compacted and sealed with bituminous prime coat in accordance with road base specification.

12.5.7 Overlays

Overlays shall be placed in accordance with the requirements for placing bitumen macadam.

In addition to the requirements for base course preparation, the area to be overlaid shall be cleaned by soaking with potable water and mechanical brushing while wet. This operation shall be carried out twice and shall be followed by air-jetting. Where the existing pavement layer is smooth or where bitumen, oil, rubber, dust etc. has accumulated, the area shall be cold-planed to a nominal depth of 10 mm, to provide a key for the overlay.

A bituminous tack coat shall be applied to the prepared surface before the overlay is laid.

Overlays shall be laid to achieve the minimum specified thickness. Protrusions of the existing pavement shall be removed to give the minimum depth required. Holes and local depressions shall be cut out to at least 25mm depth and filled with base course or wearing course material, as appropriate, prior to commencement of the overlaying course.

12.5.8 Interlocking Paving Blocks

Roads and areas to be paved with interlocking concrete blocks shall be excavated and placed with 300 mm depth of compacted material at the exact levels and falls required for the finished work.

If parts of the base are found to be unstable the CONTRACTOR shall excavate further to a firm bed and fill with layers of fine crushed rock or aggregate, thoroughly compacted. The upper surface of the base shall reflect the exact profile, fall or contour of the final paving as irregularities shall not be compensated for by varying the depth of sand bedding.

Compaction of formation and base for interlocking concrete slabs shall be as Clauses (Compaction of Sub-Grade), (Road Base), (Tests on Sub-Base and Road Base).

A stable edge shall be provided to retain the paving units and sand bedding by means of precast concrete edging unit or kerbs set in-situ concrete.

The sand bedding shall be a fine, well graded sand in a dry to moist condition and laid to an un-compacted thickness of 50 mm.

Samples of the paving blocks are to be submitted to the Employer/Engineer for his approval. No orders shall be placed with the manufacturers until the Employer/Engineer's approval has been given.

The mix for paving blocks shall contain a water repelling additive. The paving blocks shall be laid

in accordance with the manufacturers' instructions and shall be compacted at completion of each

day's work.

Depending on their use the interlocking blocks shall be of the following thickness:

- Laydown areas for medium to heavy loads 100 mm
- Parking areas and laydown areas for light traffic 80 mm
- Walkways and foot paths 60 mm.

The thickness of blocks and the concrete quality shall be approved by the Employer/Engineer.

The respective sub-base may be adjusted according to the manufacturer's recommendations.

12.5.9 Site Surfacing

Chippings for site surfacing shall consist of a 75 mm thickness of 25 mm uniform gauge crushed and washed gravel as approved by the Employer/Engineer.

12.5.10 Kerbs

Kerbs, channels, edgings and quadrants shall be cast generally to BS -'140 but to the dimensions shown on the drawings where these differ from preferred dimensions list in BS 340. They shall be cast to the required radius for all curves not less than 12 meters. Paving slabs will be to BS -'68.

Raised kerbs shall be laid with a 6 mm gap and pointed with 1 to 3 polymer modified cement mortar above road level only. Concrete bedding and backing to kerbs shall be cast in-situ to the dimensions shown on the drawings.

Flush kerbs shall be similarly laid and jointed or may be cast in-situ. The outside comer of the kerbs shall be chambered.

In the case of precast kerbs one joint in ten shall be left unpainted and 6 mm compressible insert provided, and a construction joint formed in the haunching at this point for expansion. Similarly expansion joints are to be formed in in-situ kerbs at 4.0 in intervals.

Marginal strips and kerbs shall be protected against covering or splashing with bitumen or cement. Kerbs and manhole frames shall be primed before bituminous macadam is laid.

All raised kerbs shall be painted alternately black and white in the plant area and at junctions.

12.5.11 Traffic Signs

Traffic signs shall be reflectorised and unless specifically stated to the contrary shall comply with the latest revision or replacements of:

(a) BS 873;

(b) The "Traffic Signs Regulations and Directions" published by

H.M.S.0;

(c) The "Traffic Signs Manual" published by H.M.S.O.

(d) Relevant authorities of Kenya and Traffic Police requirements.

The signs and their individual elements shall be capable of withstanding the minimum wind pressure referred to in the design requirements.

The CONTRACTOR shall design the signs, based on typical details provided by the Employer/Engineer.

Number, type and position of the signs shall be as agreed with the Employer/Engineer.

All signs shall be fabricated from sheet aluminium to BS 1470. Mounting posts shall be of circular

hollow steel section structural steel, Grade 43 to BS 4360.

Post caps, also of Grade 43C steel to BS 4360, shall be continuously fillet welded DM to the post heads to prevent the ingress of water.

Single post signs will generally be cast directly into a concrete base but signs having two or more posts shall have suitable base plates for mounding flat down to a previously constructed concrete base. The base plates shall be continuously fillet welded to the posts, shall be suitably stiffened if necessary, and shall be pre-drilled to accommodate holding down bolts.

Where there is a possibility of aluminium and steel coming into contact with each other at fixing points a suitable non-degradable inert packing shall be provided to prevent such contact.

All steelwork shall be hot-dip galvanized to BS 729 and shop painted in a salt and dust free covered area, the finishing colour coats being according to the Local Traffic Authority requirements.

12.5.12 Carriageway Markings

The material for markings shall be hot applied 'Spray-plastic' complying with the requirements of BS

3262, as manufactured by Prismo Universal Limited, or similar approved for use in the tropics.

Carriageway markings shall only be applied to surfaces which are clean and dry. Where owing to the action of traffic or otherwise, the pavement has become polished before the application of road markings, at the direction of the Employer/Engineer a tack coat compatible with the marking material shall be applied in accordance with the manufacturer's instructions. Markings shall be free from raggedness at their edges and shall be uniform and free from streaks.

"Ballotini" is to be incorporated at 18% to 22% by weight of total mix and also to be applied to the surface of the markings at the rate of 400 to 500 g/m².

The laid thickness of the markings shall be 1.5 ± 0.5 mm measured in accordance with Appendix H of BS 262.

The CONTRACTOR shall state the maximum safe heating temperature, the temperature range of the apparatus and the method of laying shall be used.

12.5.13 Guard Rails

Guard rails shall be used also to protect pipes and structures located at traffic areas and shall be designed to withstand impact forces in accordance to the traffic type and speed.

Railings shall be of galvanized steel which shall be epoxy-painted in addition. Plastic guide posts with glass reflector elements shall be used where required.

12.5.14 Concrete Paving Slabs

Areas to be paved with concrete paving slabs shall be excavated and replaced with 300 mm depth of compacted material at the exact levels and falls required for the finished work. If parts of the base are found to be unstable the CONTRACTOR shall excavate further to a firm bed and fill with layers of fine crushed rock or aggregate, thoroughly compacted. The upper surface of the base shall reflect the exact profile, fall or contour of the final paving as irregularities shall not be compensated for by varying the depth of sand bedding.

Samples of the paving slabs shall be submitted to the Employer/Engineer for his approval. No orders shall be placed with the manufacturers until the Employer/Engineer's approval has been given. The paving slabs shall be laid in accordance with the manufacturer's instructions.

12.5.15 Temporary Traffic Signs & Carriageway Markings

For road diversions the signs and markings shall generally follow the specification for permanent works.

Posts and foundations shall be designed to facilitate re-use but also shall be robust.

Warning lights, heavy duty bollards, etc., shall be provided.

All diversion works and the location, quantity and specification for all signs, lights, bollards etc., shall be approved by the local Authorities and the Traffic Police Department.

12.6 Quality Control and Testing

12.6.1 Tests for Sub-Grade

The sub-grade compaction test shall be modified AASHO compaction test as described in BS l377: Test 13', and shall be carried out in a mould 10 cm internal diameter and 12.5 cm internal height. The mould shall be filled in five equal layers, each layer being given 25 blows of a 4.5 kg hammer failing freely for 45 cm.

Except when otherwise specified, the CBR specimens shall be soaked for 96 hours or such other period of soaking as may be determined by the Employer/Engineer to correspond with the moisture content pertaining under the most unfavourable conditions to which the material may be subjected. Laboratory tests shall be done using surcharge weights as required by the Employer/Engineer.

If due to the high proportion of granular material retained on the BS 19 mm sieve, or for other reason, the Employer/Engineer may select to measure sub-grade compaction by the vibrating hammer method of using a CBR mould as in BS l377: Test 14. The compaction requirements measured by this means shall be taken as that stipulated for the compaction test plus 5%.

In-situ dry density tests on each layer of compacted material shall be carried out at an average of not less than 2 per 100 m length of carriageway. In-situ CBR tests shall be carried out as directed by the Employer/Engineer.

Where any test fails, removal of unsuitable material and/or re-compaction will be carried out over an extent as required by the Employer/Engineer. Retesting will then be required.

Classification tests shall be carried out as necessary to ensure that true comparisons can be made between in-situ densities, laboratory compaction densities and field trial densities, i.e., that variations in the properties of materials being used in the test are not affecting results. Each in-situ dry density result shall be the mean of the in-situ dry density result of three close test holes approximately 0.5 m apart.

12.6.2 Tests on Sub-Base and Road Base

Before any section of the road works is commenced and during its construction, the CONTRACTOR shall carry out on the Employer/Engineers instructions tests and control tests to determine the degree of compaction in the sub-grade, sub-base and base. No section of the work shall be covered until it has been approved by the Employer/Engineer.

The Employer/Engineer may make use among others any of the following tests:

- density/moisture tests
- compaction tests
- CBR in-situ test
- CBR remoulded test

The laboratory tests shall be carried out in accordance with BS 1377. The specified requirements shall be achieved in each successive layer.

Checking that the specified requirements have been attained in lower layers after higher layers have been placed will not be accepted, except where existing road surfaces have been removed.

Any departure from the method of constructing in layers will not be permitted.

The results of control tests shall be furnished daily to the

Employer/Engineer.

The CONTRACTOR shall be responsible for the cost and execution of all density tests, moisture tests and CBR tests necessary in establishing the compaction procedure and subsequent control tests required by the Employer/Engineer.

12.6.3 Frequency of Testing

In-situ dry density tests on each layer of compacted material shall be carried out at an average of not less than 2 per 100 in length or carriageway. In-situ CBR tests shall be carried out as directed by the Employer/Engineer.

Classification tests shall be carried out as necessary to ensure that true comparisons can be made between in-situ densities, laboratory compaction densities and field trial densities, i.e. that variations in the properties of materials being used in the tests are not affecting results.

The compaction procedure and plant shall be proved by trials at the commencement of the Works for approval by the Employer/Engineer. Compaction trials shall be carried out at varying moisture contents. The weights, types and numbers of passes of compaction plant shall also be varied to determine the optimum compactive efforts.

No traffic shall be permitted on the completed base in excess on the minimum required to place the overlying construction.

12.6.4 Testing of Bitumen Macadam

Unless otherwise specified the sampling and testing of bitumen macadam shall be carried out in accordance with the requirements of BS 598. (ASTM 2172 for bitumen content).

Frequent testing of the mix and of the compacted macadam shall be carried out to ensure that the design requirements will be achieved. Aggregate gradings shall be checked frequently to ensure that they comply with those used in determining the mixes. The bitumen metering equipment, the bitumen temperature and the temperature of the aggregate at the exit from the dryer shall be regularly tested.

Samples for analysis shall be taken from the final mix as it leaves the mixer and from around the augers of and/or behind the paver. Marshall cylindrical test specimens shall be made from the mix and tested. Cored samples shall be taken after placing and shall be tested in accordance with ASTM D 1188. The entire operation of mixing and compacting bitumen macadam shall be performed under close control. Frequent testing of the mix and of the compacted pavement will be required as the work proceeds to ensure that the design requirements will be maintained. The Employer/Engineer may check the aggregate radings in the various stock-piles to ensure that they comply with those used in determining the mixes. The Employer/Engineer may test the bitumen metering equipment, the bitumen temperature and the temperature of the aggregate at the exit from the dryer.

The Employer/Engineer may take samples for analysis from the final mixture both as it leaves the mixer and after it is laid. In particular, Marshall cylindrical test specimens shall be made from the mix and shall be tested to ensure the continuing suitability of the job mix in relation to the design criteria specified herein.

The preparation and testing of Marshall cylindrical specimens shall be carried out as specified herein.

Specified gravity of the mixed material shall be measured by the ASTM D2041 Standard test and cored samples taken from the compacted pavement to measure in-situ density.

The frequency of testing shall be as directed by the Employer/Engineer. In general, routine testing of the mix, which shall include at least, Marshall type tests. bitumen extraction, and grading tests, shall be carried out at least 4 times a day during full production or at the rate of one sample for every 100 tons produced whichever is the more frequent.

Cores shall be cut and tested at the rate of 1 per 500 m^2. As soon as possible after cutting, core holes shall be painted on their sides with a thin coating of hot bitumen and refilled with bitumen macadam of the appropriate mix. Compaction shall be carried out with a Marshall hammer or other approved means.

If tests show that the specified requirements are not achieved, the whole process of mixing and laying bitumen macadam shall be stopped and shall not recommence until corrections have been made to the methods adopted for mixing and laying that will ensure that the minimum requirements are achieved.

12.6.5 Sampling Testing Of Materials Used In the Construction Of

Roads

Samples shall be taken in accordance with the relevant British Standard where applicable. Materials subsequently supplied shall at least equal the approved sample in all respects. No source of supply shall be changed without prior written approval from the Employer/Engineer. Any samples not approved or materials failing to comply with the approved samples shall immediately be removed from the site of the Works.

The CONTRACTOR shall submit to the Employer/Engineer copies of all orders for materials to be incorporated in the Permanent Works if required to do so.

All materials to be used in the permanent Works shall be subject to inspection and tests as the work proceeds.

The CONTRACTOR will be responsible for carrying out all tests required under the Contract or as instructed by the Employer/Engineer from time to time and will provide the necessary laboratory facilities, apparatus, equipment, skilled laboratory staff and labour required for this purpose. The Employer/Engineer and his staff shall have access at all reasonable times to the laboratories, laboratory staff and equipment required for the testing of the Works. The results of control tests shall be furnished to the

Employer/Engineer.

SECTION VI PART F

TECHNICAL REQUIREMENTS

CORROSION PROTECTION AND PAINTING

1.0 SCOPE

The intent of this Part of the requirements is to define surface preparation, protective coatings and paint systems to be applied on vessels, equipment, piping and structures.

This Part of the requirements shall be used as a basis for the preparation of painting schedules, engineering drawings and requisitions of materials and labour and for demanding site space for the surface preparation and execution of the painting works.

This Part of the requirements covers the general requirements for painting work of the project. This part of the requirements further outlines the type of paint, surface preparation, touch up for prime coat(s), number of prime and finish coats, dry film thicknesses for any item requiring painting in the project.

The CONTRACTOR shall furnish all labour, materials and equipment, including paints and thinners of the best quality and made available also to every subcontractor. The paints shall be supplied by a paint manufacturer with international experience and internationally available products. Only experienced personnel shall apply paints.

The proposed methods shall be in accordance with the best engineering practice and to the approval of the Employer/Engineer.

1.1 System Description

This part of Employer's requirements covers the requirements for painting, surface preparation, as well as the application of protective coatings for structural steel, equipment, piping, tanks, etc. for the entire plant.

After the Contract has been awarded, the CONTRACTOR shall submit a painting and coating schedule along with a quality assurance program for the Employer/Engineer's review.

1.2 Codes & Standards

Latest editions of the following Standards shall guide this part of Employer's requirements:

- This coating requirements
- ISO 8501-1 / ISO 8503
- ASTM D 2200
- SSPC (Steel Structures' Painting Council)
- Standards
- DIN 55928
- BS 4479
- DIN 2403
- ISO 12944

1.3 Quality Control and Inspection

Quality control and inspection by the EMPLOYER will not release the

CONTRACTOR from his responsibility for the correct performance of the work.

For quality control and inspection the following instruments and standards shall be provided in satisfactory working conditions:

- ISO 8501-1 (Pictorial Reference)
- Keane Tator /Rugotest No. 3 or ISO comparator (ISO 8503)
- Material thermometer
- Surface temperature gauge
- Sling psychrometer
- Non-destructive dry film thickness gauge
- Wet-film thickness gauge
- Non-destructive pinhole detector (for tank linings and immersed surfaces)

The CONTRACTOR shall bear full responsibility for the application of coatings, applied by him on surfaces, primed or painted by others. Covers shall be used where required to protect building structures, equipment, insulation and lagging. When surfaces have been stained or otherwise damaged by the painting and/or surface preparation work, the CONTRACTOR is responsible to thoroughly clean and/or repair these surfaces. Parts which cannot be coated and which are very sensitive to atmospheric exposure must be efficiently packed for storage. The inside of equipment and machinery shall be cleaned thoroughly at works, and before transportation all holes and access openings shall be efficiently sealed in order to prevent infiltration of dirt and humidity.

Treated and machined parts not to be painted shall receive a provisional corrosion protection.

Unless otherwise specifically indicated in the particular requirements, surfaces, such as stainless steel, brass, copper or any other non-ferrous items, finished hardware, etc. shall not be painted.

Note: Structural bolts shall be galvanized, and painted as specified under painting systems for carbon steel surfaces.

1.4 Guarantees

The guarantee period for the complete painting and corrosion protection shall amount to five (5) years after the EMPLOYER's final inspection and acceptance. Necessary minor maintenance/touch-up only shall be conducted by the EMPLOYER during the warranty period.

For defining a possible failure of corrosion protection the standards of the European scale for degree of rusting of anticorrosive paints shall be used. A standard of Re 3 after a five (5) years' period is accepted. If the degree of corrosion is above this standard the CONTRACTOR shall be responsible for repairing and/or repainting those areas that failed.

2.0 DESIGN CRITERIA

2.1 Protective Coatings and Paint Systems

Type and number of protective coatings for any item which requires corrosion protection on this project shall be in accordance with these coating requirements.

The intention of the coating requirements is to protect all parts which require corrosion protection with a prime coat which should be applied at supplier's works. Only touch-up of bolts, welds and damaged areas will be required for field priming of these items.

For parts which are not likely to be damaged during transportation, the EMPLOYER may give the approval to apply the full number of coats for these parts in the shop.

2.2 Conditions for Painting

In general, coatings shall not be applied when the temperature of the steel is below + 5°C.

Surface temperature must be at least + 3°C above the dew point to ensure that condensation does not occur on the surface. In order to prevent condensation on the steel surface, the relative humidity must be checked continuously.

In hot climates coating materials should not be applied if the steel temperature is above + 50°C.

No coating should be executed during sand storms and rain. Care must be taken:

- To guard against the influence of the marine atmosphere e.g. by applying the coating by a spraying process using a flame for drying the surface and immediate coat application.
- not to paint outdoor parts prior to rain,
- to attain the specified dry film thickness in hot weather,
- to let prime coats exposed to excessive humidity, rain etc. dry and then remove the damaged coats, and then prepare the surface anew and prime again,
- To apply an additional top coat on any sheltered and/or unventilated horizontal surface on which dew may collect.

If more stringent, the coating supplier's recommendations shall supersede the above. Special exceptions for applications at higher or lower temperatures are possible if approved by coating supplier.

2.3 Safety Precautions

All necessary precautions shall be taken by the CONTRACTOR to protect personnel and property from hazards due to falls, injuries, toxic fumes, fires, explosion or other harm.

All painting and corrosion protection work, including the inside of buildings and vessels, shall be performed under strict safety conditions.

The CONTRACTOR shall be responsible for adequate ventilation, protection from open flames, sparks and excessive heat, by taking into consideration the high temperatures prevailing especially during summer. The areas where this work is performed shall be clearly marked with warning signboards.

The CONTRACTOR is responsible to ensure that all work to be done and all equipment used is in accordance with the local authority regulations. The CONTRACTOR shall also follow the safety regulations of the relevant local or plant safety department.

2.4 Surface Preparation

The life of a coating system depends primarily on surface preparation. Therefore, the CONTRACTOR should precisely follow the degree of specified surface preparation in this part of the requirements.

Any contaminants must be removed from the surface to assure good wetting of it by the primer and its good adherence. (No loose paint, dirt, grease, rust, scale, weld slag, spatter must be left; oil, grease, soil, cement, salts, acids, corrosive chemicals must be removed by solvents, emulsions or cleaning compounds leaving no detrimental residues; newly formed rust must be removed in the specified manner; sharp edges must be rounded off, especially if linings are to be applied; machined surfaces must be protected against further contamination; no blast cleaned surfaces are to be left uncoated overnight, and all cleaned metallic surfaces shall be coated as soon as possible; workshop protected steelwork must be cleaned of contaminants and damage to shop primed components during transport shall be rectified by blast cleaning, restoring the specified grade of surface preparation and protected by touch up; wood surfaces shall be sanded clean, all nail holes shall be puttied and sanded before priming.)

The surface preparation has to meet all requirements of the standards stated above and of the manufacturer and applicant of the coatings who are guaranteeing the quality of the coatings.

2.4.1 Steel

The surface preparation of this part of the requirements shall be governed by ISO 8501-1. Reference to other International specifications on surface preparation is made below:

Surface Preparation Grades			
ISO 8501-1	DIN 55928 / 01-70	SSPC-VIS 1 ASTM- D 2200	NACE TM
Sa 1 - Light blast cleaning	Sa 1	SP 7	No 4
Sa 2 - Thorough blast cleaning	Sa 2	SP 6	No 3
Sa 2½ - Very thorough blast cleaning	Sa 2½	SP 10	No 2
Sa 3 - Blast cleaning to pure metal	Sa 3	SP 5	No 1

The abrasives used for blast cleaning shall be grit, shot, graded flit or silica sand (where allowed) and shall be such that they will produce an average anchor pattern of 25-50 μm.

After blast cleaning all accumulated blasting material, dust etc. must be removed, leaving a surface which is clean, dry and free of mill scale, rust, grease and other contaminants.

The blasted steel shall be primed as specified in the requirements immediately after blasting and cleaning to avoid rusting.

Before field touch-up, all surfaces to be touched-up, such as boltings, weldings and unprimed plates shall be cleaned from all rust, scale, welding contaminants, grease, oil and other foreign matters. Damaged primer shall be removed from welded or defective areas until sound primer is encountered.

Surfaces that have been coated, but are not meeting the standards of this part of the requirements, shall be re-blasted and coated at the CONTRACTOR's expenses.

2.4.2 Galvanized surfaces

Galvanized surfaces shall be cleaned by emulsifier and fresh water to remove oil. After that the surface shall be etched or roughened in accordance with the coating manufacturer's recommendation.

2.5 Coating Material and Application

The CONTRACTOR shall use only coating materials that meet the requirement of this part of the requirements.

Unless otherwise accepted, all field coats of a system must be products of one manufacturer.

2.5.1 Preparation & application of coating materials

Preparation and application of coating materials shall meet all requirements of the standards listed in paragraph 1.2 as well as the specific requirements as stipulated in the relevant paragraphs of chapter 3.

Care shall be taken:

- not to use livered, gelled or otherwise deteriorated paints or coating materials,
- to use the oldest coating of each kind first,
- not to open the paint containers until required for use,
- to mix all paints before and agitate thoroughly during use, to keep the ingredients in suspension
- not to transfer a paint or a primer from the container before all settled ingredients have been suspended,
- to mix open containers and/or to add thinners in a well-ventilated area only and in a way ensuring complete dispersion and suspension of all ingredients

- to mix two component primers and coatings strictly according to the data sheets of the manufacturer,
- not to add thinners to primers or paints unless necessary for proper application according to the manufacturer's data sheets, and to add only compatible thinners,
- to apply primer coatings by brush or airless or flame spray or a combination of these methods, as approved by the coating manufacturer,
- to paint all doors, windows, stairways, handrails (where painted), bottles, flanges and equipment supports by brush,

- not to use spray guns outdoors in windy weather or near unprotected
- surfaces of a contrasting colour,
- under no circumstances to use paint spray guns in areas where spray may be carried onto exposed electrical equipment,
- to do all cold spray painting using standard equipment in accordance with accepted industrial standards and methods
- to remove at the CONTRACTOR's expense, paint misplaced on items that are not to be painted, leaving the surface clean, unstained and undamaged,
- to allow each coat of paint to harden before the next is applied, to keep to a hardening time, as a rule, of 12-14 hours for epoxy paints,
- to follow suppliers' recommendations regarding hardening time for epoxy paints,
- to pay particular attention to full film thickness at edges,
- to keep overspray, skips, runs, sags and drips to a minimum,
- Not to have different coats of the same colours.
- to apply each coat as a continuous film of uniform thickness and free of pores as far as possible,
- to allow the concrete to cure prior to application of the required protective coating,
- To attain the minimum total dry film thickness (measured in microns =
- millionth part of a meter) of the paint systems as required in the
- Following "Paint System Schedules".

2.5.2 Protective coatings & paint systems

A colour scheme shall be established by the CONTRACTOR in co- operation with the Employer/Engineer.

The type and number of protective coats for any item requiring painting during the project shall be in accordance with the attached tables 'Paint System Schedules' and the Employer/Engineer's requirements.

Generally, all parts shall receive the specified prime coat(s) and sealing at the supplier's works to ensure that no corrosion occurs during transport to the site and storage in the corrosive climate at the site. Parts which cannot be damaged during transport shall receive the full number of coats in the workshop.

2.5.3 Galvanizing

Galvanizing work shall conform in all respects to German Standard DIN 55928, B.S. 729, B.S. 3083 and SB.S.C.P. 2008 and shall be performed by the hot dip process, unless specified otherwise.

All details of steel members and assemblies to be hot dip galvanized should be designed to suit the requirements of the process, in accordance with B.S. 4479 and DIN 55928. Care must be taken over:

- vent and drain holes
- careful cleaning of welds
- removal of all defects of the steel surface according to B.S. 4360
- structural steel grit blasted to Sa 2 1/2 or pickled,
- smooth galvanized coating, free from such gross surface imperfections as bare spots, lumps, blisters and inclusions
- minimum weight of average coating, to be (see B.S. 729): on steel sections 5 mm thick and over 900 g/m^2 on steel sections 2.5 mm thick 600 g/m^2
- galvanized contact surfaces of bolts, nuts and washers joined by high tensile friction grip bolts, roughened before assembly to the required slip factor (B.S. 3139, 3294, 4395, 4064), with the roughening confined to the area of the mating faces, to be hot dip galvanized and subsequently centrifuged (B.S. 729),
- nuts shall be tapped up to 0.4 mm oversize after galvanizing and the threads oiled to permit the nuts to be finger turned on the bolt for the full depth of the nut with no lubricant applied to the projecting threads of a galvanized high tensile friction grip bolt after the bolt has been inserted through the steelwork, thus allowing for contact with the mating faces of the steelwork,
- protected slings to be used for off-loading and erection,
- galvanized work stored at the works or on site to be stacked so as to provide adequate ventilation to all surfaces to avoid wet storage staining (white rust),
- restoration of small areas of the galvanized coating by: cleaning the area of any weld slag and thorough wire brushing to give a metallic clean surface followed by the application of two coats of zinc powder rich paint, or the application of a low melting point zinc alloy repair rod or powder to the damaged area, which is heated to 300° C,
- application of two coats of zinc rich paint on the fixed bolt heads, washers and nuts,

- Protection of connections between galvanized surfaces and copper,copper alloy or aluminium surfaces by suitable tape wrappings to the Employer/Engineer's approval.

1.5.4 Sprayed metal coatings

Corrosion protection can also be achieved by spraying aluminium, zinc, tin, copper, lead or other suitable metals onto the surfaces of structures. Composition of coating metals, methods of surface preparation and application of coatings, requirements for thickness and adhesion and subsequent treatment shall conform to B.S. 2569.

The requirements for sprayed, un-fused coatings of metals and metallic compounds applied by combustion gas flame, plasma arc, detonation and similar processes, and the preparation of components, spraying techniques, sealing, finishing and inspection are those of B.S. 4761.

2.5.5 Weathering steels

The requirements of Standards ASTM A 242, ASTM A 588 and DIN 17 100, DIN 55928 must be observed in the use of structural steel which is corrosion inhibited, so called weathering steel.

2.5.6 Pipelines

All pipelines shall be marked according to the medium transported in agreement with a colour code. The marking shall take the form of painting by executing the painted colour rings in suitable size and number.

The referred application method for the coating systems specified is by airless or conventional spray equipment. Where spray equipment is required, the equipment, adjustments and air pressure shall conform to the manufacturer's requirements.

Regarding storage of paint and coating material as well as mixing and application, the CONTRACTOR shall follow the application instructions of the coating manufacturer. The colours of the different coats shall differ sufficiently for control purposes.

The specified different dry-film thicknesses are minimum requirements. Therefore, sufficient wet film thickness per coat shall be applied to obtain the specified dry-film thickness after drying or curing. The CONTRACTOR shall follow the manufacturer's instructions and shall use wet film as well as dry-film thickness gauges.

Drying time between coats shall conform to the manufacturer's recommendations and shall be strictly followed.

A UV protection final coating using a polyurethane based painting is preferred.

3.0 DESIGN /ENGINEERING

3.1 Colour Schedule

After the award of the contract the colour schedule for the plant shall be compiled by the CONTRACTOR and submitted for approval to the EMPLOYER.

All pipe and equipment cladding shall be painted in a colour that blends the pipework into the environment. The colour and pattern shall be as close as possible to the green camouflage used on KenGen geothermal pipelines at Olkaria. The Contractor shall propose suitable colours and patterns for the Employer's approval.

Pipes and valves shall be identified by painted bands of the identification colour for the fluid transported.

All identification colours shall be in accordance with RAL.

Flow direction arrows shall be painted in the vicinity of branching-off connections, at the inlet branch connections downstream of each valve and at points which will be indicated by the EMPLOYER on site.

All equipment and installations shall also be marked with identification numbers.

3.2 Galvanizing

For surfaces where galvanizing is specified, all galvanizing shall be carried out by the hot dip process, and unless otherwise specified shall conform in all respects to BS 729.

The detailed design of members shall be in accordance with BS 4479.

3.3 Painting Systems

The following painting requirements for different systems are valid for the different purposes as quoted in the headlines and/or as detailed in the first paragraph of each requirement. Surfaces of structural steel and other related steel components shall be galvanized where specified. The steel surfaces mentioned in those first paragraphs below are meant to be applicable for surfaces, which are not specified as galvanized.

All steps for surface preparation, prime coating, finish coating have to be carried out at work. External bellows are made of stainless steel. No grease shall be used on bellows. Suitable corrosion protection will be provided. Details shall be verified during execution.

3.4 Carbon Steel Surfaces up to 100°C; Inside Buildings

3.4.1 Definition

- Environment corrosion category according to ISO 12944-2: C3
- Carbon steel surfaces, not insulated, indoors, such as structural steel, cranes, air ducts, pipes, condensers, tanks and vessels' exterior surfaces, valves and fittings.
- Temperatures up to 100°C.

Surface preparation	Blasting according to ISO 8501-1 Grade: SA 2 ½
Prefabrication Primer-optional	Depending on production flow, a weldable organic zinc silicate shop-primer may be used. Dry film thickness 20 µm. Solids
Prime coat	Organic zinc silicate. Dry film thickness 50 µm. Solids by volume min. 58%

3.4.2 At Works

Pre-treatment	Thorough cleaning to remove oil, grease, dirt and any other contaminants. De-rusting of all mechanical damages according to ISO 8501-1 Grade: ST3 Touch-up with organic zinc by volume content of not less than 75%.
Intermediate coat	Epoxy Dry-film thickness 100 µm

3.4.3 At site

Pre-treatment	Thorough cleaning to remove oil, grease, dirt and any other contaminants. De-rusting of all mechanical damages according to ISO 8501-1 Grade: ST3 Touch-up with organic zinc by volume content of not less than 75%.
Intermediate coat	Epoxy Dry-film thickness 100 µm
Finish coat	Polyurethane top coat Dry-film thickness 50 µm as per colour code Solids by vol. min. 60% Total system minimum dry-film thickness 200 µm.

Note:

When airless spray application is not possible, 2 coats of epoxy polyamide cured finish can be applied by roller or brush to achieve specified thickness.

3.5 Carbon Steel Surfaces up to 100°C; Outside Buildings

3.5.1 Definition

- Environment corrosion category according to ISO 12944-2: C4
- Carbon steel surfaces not insulated, outdoors, such as structural steel, jetty structures non-submerged, cranes, air ducts, pipes, condensers, tanks and vessels exterior surfaces, valves and fittings and other surfaces.
- Temperatures up to 100°C

3.5.2 At works

Surface preparation	Blasting according to ISO 8501-1 Grade: SA 2 ½
Prefabrication Primer- optional	Depending on production flow, a weldable organic zinc silicate shop-primer
Prime coat	Dry-film thickness 15 µm. Organic zinc silicate. Dry-film thickness 60 µm. Solids by volume min. 58%

3.5.3 At site

Pre-treatment	Thorough cleaning to remove oil, grease, dirt and any other contaminants. De-rusting of all mechanical damages according to ISO 8501-1 Grade: ST3 Touch-up with organic zinc with solids by volume content of not less than 75%. Dry-film thickness 75-100 µm
Intermediate coat	Epoxy polyamide Dry-film thickness: 175-200 µm
Finish coat	Polyurethane top-coat Dry-film thickness: 50 µm as per colour code. Dry-film thickness for oil pipelines: 60 µm. Solids by vol. min. 44%

Total system minimum dry-film thickness 300 µm.

For oil pipelines: Total system minimum dry-film thickness 325 µm.

Note:

For areas where good colour and gloss retention is required, finish coat should be an aliphatic polyurethane - 50 µm - instead of epoxy; Solids by volume min. 45%.

3.6 Carbon Steel Surfaces up to 200°C

3.6.1 Definition

Carbon steel surfaces not insulated, indoors and outdoors, such as structural steel, pipes, condensers, tanks and vessels exterior surfaces, valves and fittings.

Temperatures 100°C up to 200°C

3.6.2 At works

Surface preparation	Blasting according to ISO 8501-1 Grade: SA 2 ½
Prefabrication Primer- optional	Depending on production flow, a weldable inorganic ethyl zinc silicate shop-primer Dry-film thickness: 15-25 µm
Prime coat	Inorganic ethyl zinc silicate Dry-film thickness: 75 µm
Pre-treatment	Thorough cleaning to remove oil, grease, dirt and any other contaminants. De-rusting of all mechanical damages according to ISO 8501-1 Grade: ST3 Touch-up with inorganic ethyl zinc silicate or
Intermediate coat	Silicone-acrylic Dry-film thickness: 50 µm
Finish coat	Silicone-acrylic Dry-film thickness: 50 µm. Solids by vol.: min. 36%

3.6.3 At site

Total system minimum dry-film thickness 175 µm.

3.7 Carbon Steel Surfaces up to 400 °C

3.7.1 Definition

- Carbon steel surfaces not insulated, indoors and outdoors, such as pipes, valves and fittings.
- Temperatures 200°C up to 400°C
- Temperatures above 400°C will not result in an immediate breakdown but will reduce the long term anti corrosive properties.

3.7.2 At works

Surface preparation	Blasting according to ISO 8501-1 Grade: SA 3
Prefabrication - Primer- optional	Depending on production flow, a weldable inorganic ethyl zinc silicate shop-primer Dry-film thickness: 15-25 µm
Prime coat	Inorganic ethyl zinc silicate. Dry-film thickness: 75 µm
Pre-treatment	Thorough cleaning to remove oil, grease, dirt and any other contaminants. De-rusting of all mechanical damages according to ISO 8501-1 Grade: SA3 Touch-up with inorganic ethyl zinc silicate or silicone zinc primer, to restore original dry- film
Intermediate coat	Silicone-aluminium
Finish coat	Silicone-aluminium Dry-film thickness: 20 µm

3.7.3 At site

Total system minimum dry-film thickness 115 µm.

3.8 Steelwork Underground

3.8.1 Definition

- Water pipelines – outside surface, buried in the soil.
- Temperatures up to 60°C.

Surface preparation	Blasting according to ISO 8501-1 Grade: SA
Finish coat	Two coats of high solid glass flake epoxy coating, volume solids content not less than 91%.

3.8.2 At works & at site

Total system minimum dry-film thickness 600 µm.

3.9 Galvanized Surfaces

3.9.1 Definition

- Galvanized surfaces, requiring paint finish according to the particular
- technical requirements, indoors and outdoors
  Temperature up to 100°C

3.9.2 At site

Pre-treatment	Thorough cleaning to remove oil, grease, dirt and any other contaminants. To obtain min. 25 µm anchor profile sweep blast surface. If sweep blasting is not practicable, the surface should be etched.
Prime coat	Epoxy polyamide Dry-film thickness: 50 µm
Finish coat	Epoxy polyamide Dry-film thickness: 100 µm

Total system minimum dry-film thickness: 150 µm.

Note:

For areas where high gloss finish is required, the finish coat should be aliphatic polyurethane - 50 µm - instead of epoxy.

3.10 Aluminium and Stainless Steel Surfaces

3.10.1 Definition

- Aluminium and stainless steel surfaces, requiring paint finish according to the particular requirements, unless otherwise specified in the particular requirements.
- Temperature up to 100°C

3.10.2 At site

Pre-treatment	Thorough cleaning to remove oil, grease, dirt and any other contaminants. To obtain min. 25 µm anchor profile sweep blast surface. If sweep blasting is not practicable, the surface should be etched.
Prime coat	Epoxy polyamide [1] Dry-film thickness: 50 µm
Finish coat	Epoxy polyamide [1] Dry-film thickness: 50 µm

[1] Free of chlorine and metallic zinc.

Total system minimum dry-film thickness: 100 µm.

Note:

For areas where good colour and gloss retention is required, the finish coat should be aliphatic polyurethane - 50 µm, instead of epoxy.

3.11 Mechanical Equipment

3.11.1 Definition

Equipment - such as pumps, motors, gearboxes, bearings, instrument panels, electrical cubicles, switchboards, control and relay panels, distribution boxes, transformers, turbines, generators.

3.11.2 At works

Surface preparation	Blasting according to ISO 8501-1 Grade: SA 2 ½
Prime coat	Epoxy polyamide primer Dry-film thickness: 50 µm
Intermediate coat	Epoxy polyamide tie coat. Dry-film thickness: 50 µm. Solids by volume: min. 47%

Finish coat	Aliphatic polyurethane Dry-film thickness: 50 µm. Solids by volume: min. 45%

Total system dry-film thickness: 150 µm.

Note:

Equipment supplied with manufacturer's standard can be approved if the quality of the coating system meets the quality of above system.

If this system does not receive approval, a self-priming high build epoxy shall be used as a tie coat.

3.12 Cathodic Protection

3.12.1 Definition

Cathodic protection system shall be provided for:

- submerged structures of screening and pumping section
- seawater intake and outfall structures, if applicable
- Underground metal structures (bottom external surface of tanks, buried steel pipes, etc.).

All piping, tanks and steel structures in the project area shall be equipped with the cathodic Protection System. In order to ensure the uninterrupted and efficient cathodic protection process, it is essential to monitor certain parameters.

3.13 Steel Floors, etc.

3.13.1 Definition

Steel floors, chequered plates, gratings, galleries, stairways, treads, kick steps, etc. shall be galvanized in general unless excluded specifically in the particular requirements. Gratings shall be painted only if specified. All other parts shall be painted after galvanizing as described below.

3.13.2 At works / site

Surface preparation	Blasting according to ISO 8501-1 Grade: SA 2 ½
Prefabrication - Primer- optional	Depending on production flow, a weldable organic zinc silicate shop-primer Dry-film thickness: 15 µm. Solids by volume min. 25%

Prime coat	Organic zinc silicate. Dry-film thickness: 60 µm. Solids
Intermediate coat	Epoxy polyamide Dry-film thickness: 150 -200 µm
Finish coat	Epoxy polyamide Dry-film with no-skid properties Dry-film thickness: 50 -75 µm Solids by
Touch – Up at Site	Thorough cleaning to remove oil, grease, dirt and any other contaminants. De-rusting of all mechanical damage according to ISO 8501-1, Grade: ST 3 Touch-up with self-priming aluminium containing high build epoxy with solids by

Total system minimum dry-film thickness: 300 µm.

3.14 Concrete and Brickwork

3.14.1 Concrete & plaster (floors, walls & ceilings) in the battery rooms, & chemically aggressive environment or atmosphere, requiring special treatment, unless specified differently in particular requirements

Pre-treatment	The surface must be properly cured, free of dust, grease, oil and other contaminants.	
Prime coat	One coat Polyamide-cured epoxy	100 µm
Finish coat	Three coats Epoxy polyamide, each	100 µm
Total (dft)		400 µm

3.14.2 Concrete surfaces outdoor (exposed)

Pre-treatment	The surface must be properly cured, free of dust, grease, oil, curing agent and other contaminants.	
Prime coat	Two coat silane-siloxane primer	
Intermediate coat	One coat of high built epoxy coating	200 µm
	Solids by volume:	100%
Finish coat	One coat of polyurethane coating-	50 µm
	Solids by volume:	min. 50%
Total (dft):		250 µm

3.14.3 Internal concrete surfaces underground (basements, tunnels, trenches, manholes etc.)

Pre-treatment	The surface must be properly cured, free of dust, grease, oil, curing agent and other contaminants.	
Prime coat	Two coat silane-siloxane primer	
Intermediate coat	One coat of high built epoxy coating	200 µm
	Solids by volume:	100%
Finish coat	One coat of high built epoxy coating	100 µm
	Solids by volume:	min. 50%
Total (dft):		300 µm

3.14.4 Plastered walls indoor & outdoor, concrete columns & ceilings indoor

Pre-treatment	The surface must be properly cured, free of dust, grease, oil and other contaminants.	
Prime coat	One coat alkaline resistant acrylate dispersion	50 µm
Finish coat	Two coats vinyl polymeric emulsion	
	with strong anti-fungicidal properties	each 100 µm
Total (dft)		250 µm

3.14.5 Un-plastered above ground concrete ceilings & floors covered by suspended ceiling & raised floor respectively

Pre-treatment	The surface must be properly cured, free of dust, grease, oil and other contaminants.
Coating	Two coats silane-siloxane

3.15 Wood

The following applies to softwood, hardwood with a moisture value of 25 and 20 % respectively used for indoor and outdoor window frames and doors.

At Works / Site

Pre-treatment	Resins must be removed by solvent cleaning Impregnation with an alkyd based containing fungicidal agent	
	Dry-film thickness:	100 µm
Prime coat	One coat of alkyd paint wood primer	
	Dry-film thickness:	40 µm
Finish coat	Alkyd based with colour pigments 2 x 40 µm	
	Dry-film thickness:	80 µm

Total system minimum dry-film thickness: 120 µm.

4.0 INSPECTION AND ACCEPTANCE

The various operations during the execution of painting and of the corrosion protection works shall be performed according to the preceding provisions and are subject to intermediate inspections. These inspections can be carried out in the workshop and on site.

Intermediate inspections are necessary for all painting systems:

- After cleaning, de-rusting or blasting, as well as when repairs become necessary: Degree of cleaning, profile of anchor pattern.
- After applying the priming coats: Random sample measurements of dry film thickness.
- Before the last final coat: measurements of dry film thickness of possibly no longer accessible surfaces, removal of faults in the coating in order to obtain a clean finish.
- Before the last top coat: Holiday and pinholes tests with the pinhole detector, if in normal operation the relevant surface is permanently immersed.
- After the last final coat of all coating systems: Performance of final total dry-film thickness measurements and determination of the quality of the surface.

Where special coats are concerned, it is sometimes necessary to constantly check the course of the weather in order to avoid being below the dew point. Tests and acceptance shall be specially specified as far as special paint and coating systems are concerned. They shall be dealt with accordingly.

All tests shall be announced in time and have to be coordinated so that no interruptions occur in erection work thus avoiding any waiting periods for further painting.

All necessary measuring and testing apparatus shall be maintained in good condition by the CONTRACTOR during the erection time.

All measuring results shall be entered by the CONTRACTOR on corresponding forms and lists and handed over to the EMPLOYER.

If certificates for coating systems with special requirements are necessary, these shall be submitted for acceptance.

5.0 REPAIR PROCEDURE DURING GUARANTEE PERIOD

The entire work of painting and corrosion protection shall be inspected by the EMPLOYER during the guarantee period and before the Final

Acceptance Certificate is issued.

In case of need repair work shall be carried out. All repairs during the guarantee period shall be it touch-up or complete repainting shall be performed strictly in accordance with the Contract Documents' workmanship standards. Changes of requirements during the guarantee period shall be approved by the EMPLOYER.

6.0 RESPONSIBILITIES

The CONTRACTOR shall bear full responsibility for all losses and damages that occur through inadequate painting & corrosion protection and shall carry out repairs or replacements at his cost.

The CONTRACTOR shall bear full responsibility for paint and corrosion protection applied by him on surfaces primed or painted by others.

7.0 SCHEDULE FOR FINAL COAT COLOUR

7.1 General Notes

The Contractor shall generally follow the Employer's colour standards for all plant and equipment. The Contractor shall submit a proposed colour schedule for approval.

All valves, filters, strainers and similar equipment installed in piping shall be painted the same colour as the piping.

Piping shall be painted with identification colour bands and adequate lettering, in the following locations:

- On all pipework, at not more than 10 m intervals (Cross country piping shall be labelled at appropriate intervals for safe operation and maintenance)
- At branches in the pipework, junctions and bends
- At pumps
- At either side of all valves
- Either side of walls, bulk head, partitions

Direction of flow arrows consisting of black arrow on a white background painted on the pipework shall be provided adjacent to each identification colour band.

No special colour requirements apply to surfaces that are not normally visible, e.g. the insides of tanks.

The secondary colour band, where required, shall be one third of the width of the primary band, placed in the centre of the primary band.

Pipe supports shall be:

Outdoors: aluminium

Indoors: mist grey

7.2 Standard Colours

The following standard colours shall be used

Blues	
Light blue	BS 4800 18.E.51
Lilac blue	RAL 4005
Dark blue	BS 4800 20.D.45
Mid blue	BS 4800 18.E.53
Blue green	BS 4800 16.E.56
Cobalt blue	RAL 5007
Sky blue	RAL 5015
Reds	
Crimson	BS 4800 04.D.45
Bright red	BS 4800 04.E.56
Pink	BS 4800 02.D.41
Greens	
Dark green	RAL 6005
Light green	RAL 6019
Emerald green	BS 4800 14.E.53
Blue green	BS 4800 16.E.56
Greys, Black, White, Aluminium	
White	BS 4800 00.E.55
Black	RAL 9011
Pearl grey	BS 4800 00.A.07
Aluminium	RAL 9006
Mist grey	BS 4800 00.A.05
Light grey	RAL 7035
Browns, Yellow	
Beige	RAL 1001
Deep brown	RAL 8015
Yellow	BS 4800 08.E.53

SECTION VI PART G

TECHNICAL REQUIREMENTS

INSPECTING AND TESTING

1.0 GENERAL

This **SECTION VI PART G** contains the technical requirements for Inspection and

Testing (I&T) of material, parts, equipment and workmanship of the plant during manufacture, assembling and erection and upon completion to demonstrate compliance with the specification, codes and standards to ensure overall reliability of plant operation and performance.

The Contractor and its major sub-contractors/vendors shall each have a certified Quality System that meets the requirements of ISO 9000 or equivalent.

The Contractor's overall project quality assurance system shall cover all aspects of the Works, including design, work off-site fabrication and testing, site construction activities, pre-commissioning, start-up, and performance testing, training and handover.

In general the Contractor shall perform factory quality assurance inspections at major equipment suppliers' facilities during fabrication to ensure equipment is being built to specifications in a timely manner.

As a part of, or prior to, such inspections, the Contractor shall review supplier's quality assurance and quality control program and manuals to assure their adequacy for equipment being supplied. During the inspection, the Contractor shall verify that the supplier's quality program is being adhered to.

The whole of the works supplied under this Contract shall be subject to visual, dimensional, material, non-destructive, hydraulic, functional and performance inspection and tests by the Engineer should they so require during manufacture, erection and after completion, at the manufacturers' works and/or on site. The works shall also be subject to inspection and test by independent inspection authorities and/or the approved agencies of insurance inspection companies approved by the Engineer in accordance with the approved Inspection Plan. The inspection and tests shall include but not be limited to the requirements of the part of the specification as listed under "General Technical Requirements for I&T" and "Specific Requirements for I&T (by Systems/Package)" of this Part.

Inspection and Testing of the works shall be limited to a practical content. Inspection and Test plan of the equipment shall be issued and shall be fulfilled by the Contractor. Contractor/Subcontractor shall provide test certificates for the equipment of similar type, rating and design.

Contractor shall prepare ITP in a reasonable manner for Employer/Engineer approval.

Costs related to those inspections and tests shall be borne by the Contractor as specified.

The cost of inspection to be incurred at manufacturer's premises shall be borne by the Contractor. However, any cost to be incurred for Employer/Engineer's travel, lodging will be borne by Employer/Engineer.

The Contractor shall prove that his material and/or equipment complies with the requirements of this part, such proof being the successful completion of tests and inspections witnessed by the Engineer's representative according to the approved Quality Control Plan.

Test results for all type, routine and site tests shall be recorded on appropriate test formats. All site test formats shall be subject to the approval of the Employer/Engineer.

Employer/Engineer reserves the right to demand the Contractor to appoint an independent authority to control/assure the quality requirements of the project during manufacturing or erection at site for any component/item/system.

2.0 SCOPE

This covers the complete Inspection and Testing of the Connection of Wells OW-50A, OW-50B AND OW-50C to Olkaria IAU power plant.

3.0 EXPENSES

No claim for extra compensation and/or extension of time shall be allowed because of time required for testing, inspection and repairing.

All shop and field testing certifications, reporting, and assuring of engineering quality verification and documentation of the Work in accordance with the technical specifications and the Contractor's testing program shall be performed by the Contractor at his expense.

This shall be based on the agreed Inspection and Test schedule issued by the Contractor and agreed between the Employer/Engineer and the Contractor. Traveling expense and accommodation will be borne by the Contractor. Additional inspection will be agreed with the Contractor prior to visiting the shop.

If the approved inspection plan requires any third party test, the Contractor shall arrange on his expense.

The Employer/Engineer reserves the right for inspection visits in addition to the Contractor's testing program to monitor the progress and quality of the works. Any additional visits required will be announced with written notice according to the witness points within the I&T schedule and will be agreed upon with the Contractor prior to visiting the shop. In the event that such additional inspections and tests indicate non-compliance with the terms of the Contract, the Contractor shall, at his own expense, make all necessary repairs and perform additional test(s) required to indicate compliance with the terms of the Contract.

If any item fails to pass the test or if the test cannot be witnessed by the Employer/Engineer upon his arrival at the workshops due to the fault of the Contractor or his subcontractor, and if for such reasons the postponement or repetition of the test is required, the Contractor shall bear all additional costs of the test repetition as well as the additional expenses of the Employer/Engineer.

4.0 CODES AND STANDARDS

Where no specific code or standard is mentioned then the various items of plant, parts, material and equipment shall be tested in accordance with the relevant American, British, Italian, Japanese or German standards. IEC standards are compulsory for the electrical equipment.

4.1 Reference to Codes and Standards

Reference to special codes and standards, where designated either directly or as relevant, is intended to provide a measure of performance, safety, in-shop and on-site testing, and methods of construction and/or installation which must be equaled or exceeded in order to be acceptable for use under this specification.

In all instances the finally accepted applicable code or standard shall be the version last published prior to the date of submission of the tender selected as the basis for this Contract.

Performance tests shall be conducted in accordance with standards as stated in clause 9.7.

4.2 Alternative Standards

Where no appropriate standard is available, tests shall be carried out in accordance with the manufacturer's standard practice.

In such cases the Contractor shall submit in due time to the Engineer data and a suggested procedure forming the basis of the testing to be performed. If aforementioned standards are accepted the Contractor shall provide four additional copies in English of such alternative standards to the Engineer before any test is carried out.

4.3 Derating Standards

The Contractor's attention is drawn to the climatic conditions in the area of

Olkaria and where applicable in the codes and/or standards an appropriate

derating factor shall be applied after the approval of the Engineer.

5.0 REJECTION

If any item fails to comply with the requirements of this specification in any respect whatsoever at any stage of manufacture, works test, erection, site test and commissioning, the Engineer may reject the item, or defective component thereof, whichever he considers necessary. After adjustment or modification as directed by the Engineer, the Contractor shall submit the item for further inspection and/or test. In the event of a defect on any item being of such a nature that the requirements of this specification cannot be fulfilled by adjustment or modification, such item shall be replaced by the Contractor at his own expense to the satisfaction of the Engineer.

The approval of the Engineer will not prejudice the right of the Employer to reject if it does not give complete satisfaction in service.

No extension of time or extra costs shall be considered as a result of material/equipment rejection.

Detail NCR handling procedure shall be submitted during project execution for information only.

6.0 FORMAL REQUIREMENTS FOR I&T

6.1 I&T Program

All equipment provided under this Contract shall undergo workshop and site tests whether mentioned in this specification or not.

The Contractor shall issue a quality assurance program, indicating the kind and extent of inspections and tests to be carried out on plant components. The quality assurance program shall be based on the tests and

inspections specified in the various parts of the specification.

An Inspection Schedule shall be prepared by the Contractor and shall be approved by the Engineer. Inspection plan is detailing the scope and schedule of inspection required ensuring that materials as dispatched meet the Specification requirements.

The Schedule shall include:

1. Relevant International Standards or equivalent National Standard. For each of the following stages of the work, the acceptance criteria shall be stated. For pressure equipment the schedule shall include all witness points, the place of inspection, short description of the test, the manufacturer and the scheduled inspection date (update every month). During witnessing the tests the specifications, standards, drawings, certificates and delivery instructions shall be available for the Employer/Engineer.
2. Stages of inspection shall cover the following:
   a. Tests to review or approve certification of material;
   b. Review and approval of manufacturing procedures; for STG no manufacturing procedures shall be submitted
   c. Witnessing tests or review and approval of certification of operator's qualification to carry out the work required;
   d. Visual and dimensional examination of components;
   e. Pressure tests on casing and vessels.
   f. Non-destructive examination of materials in progress;
   g. Functional tests on sub-assemblies performance tests, type tests on complete units;
   h. Examination of painting, packing and documentation for shipment.

The Engineer will indicate the inspection requirements on the agreed inspection program in accordance with the following paragraphs.

1. Hold point which requires a mandatory inspection by the Engineer. This inspection or test shall be witnessed by the Engineer and further progress in manufacture shall not be made until the plant is approved by the Engineer.
2. Inspection or test of material may be carried out by the Engineer at his discretion. Witness points will need to be agreed in advance
3. Certification of material and functional test shall be approved by the Engineer before dispatch from the works. However, dispatch will not be held back for lack of inspection. For this, Contractor in his monthly report shall inform about next month inspections. Contractor shall also provide notice 15 calendar days in advance. Employer/Engineer shall attend or wave such inspections.

Independently, the requirements of the Third Party Inspection shall be indicated in a similar manner prior to the submission of the inspection plan to the Engineer for his approval and the approved Third Party Inspection requirement shall be included in the inspection program stated above. In case the STG supplier have no requirement of an independent third party inspection of any equipment, all required test of the offered equipment shall be performed in accordance to STG manufacturing procedures and shall not be subject to any third party inspection as stated above.

The Contractor shall issue comprehensive test procedures describing the kind test and the codes/standards

to be followed together with the scheduled date of the intended tests. Relevant pages of all applicable codes and standards shall be attached to the test procedures.

Waiving of any tests shall not release the Contractor of his responsibility to fully meet the requirements of the Contract.

The Contractor shall submit test record forms during the design phase for the Employer/Engineer's approval. Standard forms may be used. However, any additional details requested by Employer/Engineer shall be submitted separately.

In case of standard production items, certified routine test and type test certificates shall be submitted for each item of equipment, where applicable.

6.2 Formal Requirements for Workshop I&T

6.2.1 General

The Employer/Engineer and/or authorized representatives shall be irrevocably entitled to visit the workshops of the Contractor or his subcontractors at any time with prior announcement to inspect the works performed in connection with this project and to monitor the progress of work, scrutinize related documents such as suborders or work orders and to take photos as may be deemed adequate to the judgement of the said persons to document the actual status of work.

6.2.2 Notifications and Witnessing

At his discretion, the Employer/Engineer will participate in all or in a selected number of the specified workshop tests. Hence the actual dates of said workshop tests are to be announced at least 15 calendar days in advance.

If the Engineer does not appear at the place specified by the Contractor and has not notified the Contractor in due time before test of his intention not to attend, then the Contractor shall perform the test and submit a certified copy of the results to the Engineer. This test shall not relieve the Contractor of any of his obligations under the contract. The Contractor or subcontractors as specified under the contract for the performance of the tests shall provide labour, materials, water, air, electric power, fuel, shop, apparatus and all necessary equipment for the performance of the said acceptance tests. If the equipment passes the tests, the Engineer will give the Contractor a certificate testifying to this.

The same applies to the final work's inspections or workshop tests when all test certificates shall be submitted to the Engineer.

A form sheet entitled "Test and Inspection Manual" has to be prepared showing all steps of the test procedure as well as the relevant codes and standards.

For all inspections and tests the Contractor shall provide sufficient skilled staff or service engineers. Irrespective any independent agency on behalf of the Contractor involvement in the test, Contractor's representative who is well versed about the equipment/item and its related correspondences must present for the factory acceptance test.

Whenever workshop inspections or tests are carried out all material certificates as well as all other intermediate test certificates, in accordance with the agreed test schedule, shall be made available to the Employer/ Engineer in legible copy for his information and review. Further the latest issue of the related

drawings, indicating also the status of approval by the Engineer, shall be made available.

In addition to specified standards and the test procedure, the Contractor shall submit procedures for manufacture, calibration, quality control, materials testing, examination and performance testing as they apply from the procurement phase of raw materials to the finished product. Manufacture shall not begin until the procedures and material specifications documentation have been reviewed and approved by the Engineer.

All these test documents have to be submitted to the Employer/Engineer in due time before the tests are performed. Test procedures along with test for workshop tests shall be submitted not later than 45 days prior to the scheduled tests.

No inspection or test shall be valid unless the Contractor is in possession of drawings and/or specification approved by the Engineer of the equipment or materials to be tested. The Contractor shall supply to the Engineer at the time of tests a copy of all drawings as approved by the Engineer.

If any item fails to pass the test or if the test cannot be witnessed by the Engineer and Employer upon his arrival at the workshops due to the fault of the Contractor or his subcontractor, and if for such reasons the postponement or repetition of the test is required, the Contractor shall bear all additional costs of the test repetition as well as the additional expenses of the Engineer and Employer.

6.2.3 Test Reports & Certificates

Protocol sheet (inspection sheet) with subject, attendance, result and comments to be signed by all parties and distributed immediately after the tests were done. The detailed test protocol with certified copies of all tests, data and results itself shall be distributed according to this section to the Employer/Engineer.

Under no circumstances shall equipment be shipped or even packed, prepared for shipment, or dismantled for the purpose of packing for shipment, unless it has been satisfactorily inspected and approved for shipment, or inspection has been waived in writing.

If the Engineer has been duly provided with the documentation, but fails to inform the Contractor regarding his comments of acceptance within 15 (fifteen) working days after receipt of relevant document, the subjected test records shall be deemed to be accepted and certified and the equipment shall be shipped.

6.3 Requirements for Site I&T

6.3.1 General

The Employer/Engineer and/or its authorized representatives are irrevocably

entitled to inspect any equipment under erection or commissioning at site at any time without prior announcement to inspect the works performed in connection with this project and to monitor the progress of work, scrutinize related documents and to take photos as may be deemed adequate to the judgement of the said persons to document the actual status of work.

The equipment to be supplied under the Contract shall be tested at Site during erection, cold function (loop) checks and tests, pre-commissioning, commissioning, optimization, trial run, initial operation, reliability test and performance/acceptance test. These tests shall prove whether the equipment meets the requirements of the Contract and the safety conditions, whether it has been built and/or erected with satisfactory workmanship, whether the equipment is in conformity with the prevailing standards and

regulations as well as with state-of-the-art technology and satisfies the specified operational requirements. All tests shall be carried out by the Contractor's personnel in the presence of the Employer/Engineer.

Where manufacture or finishing is done at Site, tests and inspections shall be conducted as a replacement for an appropriate workshop test.

All tests are to be accompanied by the test records signed by all parties. In case of tests involving also activity of other contractors all remarks and comments shall be placed in the test record signed by all participants.

At least one month before commencement of any site erection work, Contractor shall submit the method statement and quality control procedures for major, and safety procedures equipment or systems such as waste heat recovery boilers, steam turbines, generators, piping, tanks, pump etc. for the Engineer's approval.

The Contractor shall submit the detail Procedure or Method Statement for all site I&T for Engineer's approval. No site I&T shall be allowed until the relevant Procedure or Method Statement have been approved by the Engineer/Employer.

For major equipment and systems it is a strict requirement that a representative of the equipment/system manufacturer shall be present as supervisor and instructor for any site tests and inspections as well as the main steps of commissioning. The Engineer shall decide, based upon the Site I&T Program, for which tests a representative is required. Prior to commencement of respective site installation work, the Contractor shall deliver a list comprising all instruments and other facilities intended to be used for the site tests together with technical details.

6.3.2 Notifications & Witnessing

Test procedures for site tests shall be submitted not later than one month prior to the scheduled tests, including all necessary drawings, excerpts of applicable standards, etc. for Engineer's approval.

At his discretion, the Employer/Engineer will participate in all or in a selected number of the specified site tests. Hence the actual dates of said site tests are to be announced at least 3 days in advance. Minor changes in the factory test schedules may be informed 24 hrs before the test.

To assist the Engineer in his review of the quality of the work being performed, the Contractor's senior field representative shall provide the Engineer with a schedule of the specific areas and items of work that will be performed during each work week. The list shall be presented to the Engineer prior to the start of work on a day to be agreed with the Engineer.

For day to day Engineer inspection approval, which is necessary to proceed with further works, the Contractor shall submit specific field inspection requests 24 hours in advance to the Engineer/Employer.

Erection and commissioning work on major items of the plant must not be continued without the approval given by the inspection report, or by permission in writing. If the Contractor continues with erection without waiting for the Engineer's decision he shall be required to dismantle the respective parts to make them accessible for inspection.

Neither extra cost nor extension of time can be claimed by the Contractor on account of such dismantling.

When additional inspection and testing is required by the Engineer it shall be performed promptly and no

claim for consequent delay or disruption of the work will be considered.

6.3.3 Erection, Construction & Pre-Commissioning I&T

Erection and construction checks/tests shall be announced and carried out after completion of the electromechanical installation (with all cables connected) works.

Erection checks/tests of major installations (Electronic Room, Control Room, etc.) shall be done in one lot. Erection checks/tests of field instrumentation for mechanical/process equipment shall be done system- wise.

These tests shall be carried out to prove the completeness of the construction before releasing the plant or a part thereof for the (hot) commissioning tests.

The construction tests contain the so called cold commissioning tests, i.e. loop tests and calibration tests, impulse line pressure tests, etc., for the instrumentation and control items, cable connection test, insulation test, motor rotation direction test, etc., for electrical systems, radiographic tests, pressure and hydrostatics tests, alignment works, etc. for mechanical systems, tightness tests for the HVAC system, etc. After all tests are done for unit main components or for auxiliaries, all test records shall be compiled by the Contractor and submitted to the Employer/Engineer (one copy each) in a proper bound form with a covering sheet bearing the title: "Construction Completion Certificate" (CCC) for e.g. for the first unit, etc."

6.3.4 Construction Completion Certificate (CCC)

When a system or part of a system is completely erected the Contractor should notify in writing to the Employer/Engineer that an inspection should take place to determine that the concerned system is installed according to the Technical Specifications of the Contract and to the approved drawings.

Such notice shall be in writing and shall be deemed to be a request by the Contractor for Employer to issue a Construction Completion Certificate.

Preconditions as applicable for such an inspection are:

- System completely installed and cleaned including cable tray and ducts.
- All pressure tests have been successfully performed.
- Quality assurance should present welders certificates, x-rays etc.

The Employer/Engineer has the right to reject such an inspection when the concerned system is incomplete or reveals a very large number of Punch Items.

The Employer/Engineer will, within 15 days of the delivery of such notice either agree on the inspection of the system or instruct in writing to the Contractor that the system is incomplete.

After such an inspection the Employer/Engineer has to produce a Punch Item List within 2 weeks after the inspection took place.

Upon completion of specified unfinished portion of the works and correction of all specified deficiencies, the Contractor shall so notify Employer/Engineer in writing. Within 10 calendar days of the date of receiving of such notice either issue a CONSTRUCTION COMPLETION CERTIFICATE or give the Contractor notice of failure to complete the specified unfinished portion of the works or correct the specified

deficiencies. In the latter instance, the foregoing procedure with respect to unfinished portion of the Work and specified deficiencies shall be repeated.

Discovery of minor defects, errors or omissions (Punch Item) in the works which do not prevent the plant and auxiliary installations from the start of the commissioning operation will not be considered cause for postponing issuance of the Construction Completion Certificate. In this latter instance the Certificate would be issued with a list of the Exception items attached, along with a mutually agreed upon schedule for correction and/or resolution of those items.

In accordance with the provisions of the above paragraph, the Contractor may request and Employer will issue Construction Completion Certificate for any portion of the Work in respect of which a separate Construction Completion Date within the Time for Completion applicable to the Work and each Section of the Work.

The issuance of any specific Construction Completion Certificate does not constitute Employer's acceptance of the Work or acknowledgement of the Contractor's satisfactory completion of the works. The issuance of any Construction Completion Certificate shall not relieve the Contractor from any of his obligations under the Contract connected with the Work or any part thereof.

The operation of the plant included in the Work shall be under the supervision and responsibility of the Contractor until the date of issuance of "Preliminary Acceptance Certificate".

Punch Item means incomplete equipment found during an inspection, these items are listed in the Punch Item List, this list has to be worked off and agreement has to be achieved between the Contractor and the Employer/Engineer on possible Exception Items before the relevant Construction Completion Certificate (CCC) will be signed.

Exception Item means a Punch Item, which cannot be worked off in a short period due to long delivery time of missing parts, etc. Each Exception Item must be accepted and confirmed by the Employer/Engineer and must have a definite and confirmed completion date.

After the CCC is signed for a relevant system, the system is released for commissioning to perform the Site test, loop checks, cold function tests and later on the hot function tests.

Special Erection/Erection Milestones strictly requiring a CCC are as follows:

- First Well Master Valve opened:
- Precondition: The Contractor has to produce a certificate, which has to be signed by the Employer/Engineer before First Well Master Valve opening can take place. This certificate should confirm that all necessary tests were successfully performed to secure proper and safe opening of wellhead master valve.
- Start of Blowing Out of Steam Pipes System:
- Precondition: The Contractor has to produce a Blowing Out Procedure which has to be approved by the Employer/Engineer before Blowing Out can commence.
- First Operation (steam venting):
- Precondition: The Contractor has to produce a certificate, which has to be signed by the Employer/Engineer before First operation can take place. This certificate should confirm that all necessary tests were successfully performed to secure proper and safe operation.

7.0 GENERAL TECHNICAL REQUIREMENTS FOR I&T

7.1 Testing Instruments & Equipment

Instruments and apparatus used for both site and workshop inspection and testing shall be of the best quality and subject to the Engineer's approval, and if required by the Engineer shall be calibrated to an agreed standard at a laboratory of national standing to be nominated by the Contractor and approved by the Engineer. Contractor shall provide tools and machinery required for erection and testing as well as for commissioning of the works. If calibrated measurement instrumentation is required for a precise test the Engineer/Employer may ask and Contractor shall prove that all equipment shall carry a valid calibration certificate and the calibration records shall be made available for review to Employer/Engineer. Certified label on test instrument to be provided indicating the date of certification. The Engineer will not approve test instrumentation. For the Performance Test the instrumentation shall be provided in a list and shall carry a valid calibration certificate and the calibration records will be made available for review to Employer/Engineer.

The manufacturer shall prepare a calibration schedule showing equipment type, identification number, location, frequency of checks, method of checking and action to take when results are unsatisfactory.

The cost of carrying out such calibration shall be borne by the Contractor in all cases.

For site inspections the Contractor shall be responsible for and shall include in his delivery all safety measures such as barriers, warning signs etc. required for inspection and testing while erection is in progress and all interruption of work in this connection shall be at his expense.

The Contractor shall provide all tools for commissioning and safety equipment like helmets, gloves, safety shoes and safety goggles as required for Employers commissioning team who would work in parallel with Contractor.

All pressure gauges, flow meters, venturi, orifice plates and other instruments to be used for works performance and hydraulic tests shall be of sufficient accuracy, to the approval of the Engineer and subject to routine calibration against standard instruments. Calibration

Instrumentation shall be in accordance to the applicable standard and will not be subject to Engineer's approval. The used standard for the test classifies the test instrumentation and the relevant test instrumentation shall be used. The test instrumentation shall carry a valid calibration certificate.

7.2 Non-Destructive Material Tests

When any non-destructive examination that is less than 100% in extent reveals a defect:

1. Two additional items of the same kind, by the same welder, or operator shall be given the same type of examinations; and
2. If the items examined as required by (1) above are acceptable, the defective item shall be repaired or replaced and re-examined and all items represented by this additional examination shall be accepted; but
3. If any of the items examined as required by (1) above reveals a defect, two further items of the same kind shall be examined for each defective item found by that examination; and
4. If all the items examined as required by (3) above are acceptable, the defective item(s) shall be repaired or replaced and re-examined and all items represented by this additional examination shall be accepted; but
5. If any of the items examined as required by (3) above reveals a defect, all items represented by the progressive examinations shall be either:
    a. repaired or replaced and re-examined as required; or
    b. fully examined and repaired or replaced as necessary, and re- examined as necessary to meet the requirements of this Specification and the specified design code.

The above requirements shall be applicable to both works and site inspection and tests.

7.2.1 Visual Weld Inspection

Each weld shall be subjected to a stringent visual inspection in accordance with ASME, ISO 5817, ISO 3834 or an equivalent standard. Welds shall be free from undercut, excessive spatter, craters, cracks, porosity and other surface imperfections. Weld reinforcement shall be of regular contour, uniform weld ripple and indicative of good workmanship.

Fillet welds shall be checked for dimensional tolerance and form using an approved fillet weld gauge. It is preferred that fillet welds shall be slightly concave in form and each leg of the weld shall have equal length.

7.2.2 Application of Radiographic Techniques

Radiography shall be carried out in accordance with the requirements and recommendations of the applied standard.

Radiographic inspection at the manufacturer's works shall be accomplished using preferably X-ray equipment. Radioactive isotopes shall not be used without the written consent of the Engineer. Contractor may use X-ray or Gamma ray isotope source selectively. Final acceptance is subject to detailed engineering stage. Radiographic inspection of welds shall be executed according to the standard under consideration of the definitions in the standard. It is the Contractor's responsibility to obtain the necessary permits from the concerned authorities for the import and use of radioactive isotopes.

Contractor may apply for the density range with 2.0 - 4.0 for Gamma-ray, 1.8 - 4.0 for x-ray according to ASME Code Section V. Final acceptance is subject to detailed engineering stage.

Image quality indicators shall be of the ISO or an equivalent type and shall be selected in accordance with the material and range of thickness to be inspected. A radiographic report shall be issued for each weld examined.

The report shall give full details of the procedure used for the examination together with the thickness and type of intensifying screens, film type and specification and source to film distance. The sensitivity of all radiographic films shall be 2% or less, as indicated by the image quality indicator for density grade between 2 and 3.

The Contractor shall take all steps possible to protect personnel, visitors, and authorized representatives from the effects of ionizing radiation. The Contractor shall keep an inventory of all radioactive sources and shall be responsible for ensuring that safe procedures are adopted for the use, handling and storage of such sources.

7.2.3 Ultrasonic Examination

Ultrasonic examination shall be performed in accordance with the AD 2000 MERKBLATT HP5/3 or an equivalent standard.

Ultrasonic equipment shall be of good quality, well-maintained and reliable in operation. Probes shall not exhibit undue wear on the Perspex shoes. Each operator shall be provided with calibration blocks and shall have access to a suitable beam calibration block.

Equipment and probe systems shall be calibrated prior to each test. The pulse echo technique with A-scope presentation shall be used throughout tests.

A report shall be issued for each examination giving full details of the equipment, type, make, probe crystal,

frequency and angle. Defect positions shall be identified and the size and type of defect shall be given.

7.2.4 Magnetic Crack Detection

The examination shall be performed in accordance with the AD 2000 MERKBLATT HP5/3 or an equivalent standard.

Suitable equipment shall be provided by the Contractor which shall develop a minimum of 800 amperes and preferably 1200 amperes. Tests shall be performed by qualified technicians. Probes shall be kept clean by occasional filing and shall not be spaced wider apart than 25 mm per 100 amperes of current used. The dry powder technique may be used; alternatively water- based inks may be used. Paraffin-based magnetic inks are not acceptable.

It is permissible to coat the area to be tested with a thin film of titanium oxide in a methylated spirit in order to obtain the necessary contrast.

Due care shall be taken to ensure that all arc burns are removed from the work piece upon completion of crack detection.

7.2.5 Dye Penetrant Tests

Liquid penetrant test shall be used only on pieces where geometric form does not allow examination by magnetic particle inspection.

Dye penetrants shall be of an approved type and shall be of the water-soluble ink type.

7.3 Prefab Parts

7.3.1 Forgings & Castings

7.3.1.1 General

Forgings and casting shall be examined and inspected for defects and shall be stress relieved, with documentation supporting examination and stress relief submitted to the Engineer for review prior to start of machining or further manufacturing operations. The documentation shall include a temperature/time curve for the stress relieving oven. Defects of all kinds shall be noted by the manufacturer or Contractor and procedure for repair or request for waiver shall be submitted for review by the Engineer who, upon review and/or following shop inspection, will approve, request additional or alternative repair procedures or reject the item for use in the work. Repairs shall be subjected to re-examination and re-documentation submitted as in the initial case. The Contractor shall replace rejected and/or defective items at no additional cost to the Employer. All equipment shall be designed so that no blind unvented cavities exist after fabrication or assembly.

Avoidance of incorrect Use of Materials

Positive steps shall be taken to ensure only approved materials (PMI – Positive Material Identification), including weld metal, have been used during manufacture. In the case of high pressure items such as boiler drums and headers, checks shall be on a 100% basis. Spectrographic or similar equipment should be used for testing with detailed records kept for scrutiny. An approved system of colour coding shall be used to

identify material which has been checked by spectrographic or other means and found to be correct to the Specification. Hard stamping shall not be used.

All castings shall be homogeneous, free of shrinkage, pipes, undersizing, porosity voids, blowholes, cracks. No welding, filling or plugging of defective parts shall be carried out without the sanction of the Engineer and then only with his approval in writing of the method to be used.

7.3.1.2 Cast Iron Castings

Materials of iron castings shall be selected from the range of materials covered by relevant standards and the inspection and quality requirements together with the other provisions of this specification shall be regarded as the minimum acceptable standard.

No weld interlocking, plugging or filling of a defective part shall be performed without the prior approval of the Engineer in writing. Full details of the proposed method of repair shall be submitted for approval.

Any repairs made to castings without prior approval shall result in rejection of the component.

Test blocks shall be integrally cast on all medium and large castings.

The Engineer may require in justified cases that certain castings be checked using radiographic techniques. The Contractor shall provide for this eventuality and shall comply with the Engineer's instructions when issued.

7.3.1.3 Aluminium Bronze Castings

The Contractor shall prepare material purchasing specifications for all important aluminium bronze castings. Each document shall indicate fully the quality and inspection requirements for the component casting covered. Copies of the Specification shall be issued to the Engineer for his use.

The inspection and quality requirements shall include an analysis of each cast, mechanical testing of test bars from each cast, pressure testing, penetrant flow detection and radiographic examination of selected critical areas.

Weldable grades of aluminium bronze may be repaired by welding provided the written approval of the Engineer is first obtained. The Contractor shall submit full details of the proposed weld repair procedure and weld procedure qualification test prior to making any weld repairs.

Weld repairs of a casting defects has to be permitted following criteria which consider the defects extension related to the casting dimensions.

7.3.2 Plates (For Pressure Vessels)

The testing and inspection of plates for pressure vessels shall be executed by a recognized inspecting authority approved by the engineer in accordance with applicable standards.

Upon completion of inspection and tests the Contractor shall forward to the Engineer four copies of all record and test certificates, duly certified by the inspecting authority, covering where applicable the following:

- chemical analysis,
- mechanical properties,
- heat treatment,
- Ultrasonic report.

Radiographic report of plates may be required if other analysis techniques fail and/or quality evidence is not

available.

7.3.3 Rolled Steel Sections

The testing and inspection of rolled steel sections shall comply with applicable national codes and standards.

The Contractor shall provide to the Engineer analyses for all grades of mild steel and high yield stress steel employed on the project.

7.3.4 Pipes & Tubes for Pressure Parts

The inspection and testing of pipes and tubes for pressure parts shall be executed at the rolling mill and approved material shall be appropriately marked before transportation or shipment. The tests shall be performed in accordance with the applicable codes and standards by a recognized inspecting authority approved by the Engineer.

Upon completion of examination the Contractor shall submit to the Engineer four copies of all records and test certificates duly certified by the inspecting authority.

7.3.5 Testing of Insulating Material

The Contractor shall submit to the Engineer a list of the approved materials he proposes to use, their thermal conductivities for the operating temperatures for each application, the thickness and density of each material used and, where two layers of dissimilar materials are used, the interface temperature.

All insulation materials shall be subject to approval and shall be asbestos- free, vermin-proof, non-hygroscopic, chemically inert when wet or dry, and fire resistant.

The Contractor shall supply type test documentation about insulating materials with the main physical and chemical characteristics. Type test ocumentation shall be in accordance to International standards.

7.4 Welds

7.4.1 Procedure Review

7.4.1.1 Weld Procedure Documents

Prior to the commencement of welding the Contractor shall submit to the Engineer for approval the inspection and test procedure applicable to the completed weld to be used in the execution of the relevant items.

Welding shall be executed in accordance to the international defined standard and will not be subject for approval by Employer/Engineer. STG supplier shall name the standard on which the welding will be based for information.

The weld procedure documents in accordance with ISO Codes may be accepted instead of ASME Codes as specified. However, in this case, all relative codes concerning the welding procedure – including weld procedure qualification tests, welder's qualification, pre-warming and heat treatment, non-destructive tests, material specification and material tests etc. – shall be logically in accordance with ISO Codes. A mixture of codes, i.e. some in accordance with ISO Codes and others according to ASME Codes, shall be avoided for all equipment specified to be certified and stamped by an Independent Approval Authority.

The Contractor will submit a list of ISO Codes and Standards to be used by welding procedure.

The weld procedure documents shall be fully detailed and shall be indicated clearly which item it is intended to cover. The weld procedure documents shall be in accordance with ASME Codes.

7.4.1.2 Weld Procedure Qualification Tests

Weld procedure qualification tests shall be carried out in accordance with the requirements of the ASME Boiler and Pressure Vessel Code - Sect. IX. Subject to agreement, the Engineer will accept the results of weld procedure qualification tests previously carried out under the supervision of any internationally recognized inspecting authority, providing that the Contractor confirms that the basic parameters of the procedure have not been changed since approval.

Where necessary, the work shall be heated prior to welding in an approved manner and in accordance with appropriate code and or specification and the temperature shall be maintained throughout the process. A record of metal temperature shall be maintained by means of a suitable recording thermometer.

The Contractor shall inform the Engineer of any proposed changes to the welding procedure before such changes are implemented. If in the opinion of the Engineer a further qualification test is required as a result of such changes, then the Contractor shall perform the required test without additional charge.

The results of all tests shall be made available for examination by the Engineer and copies shall be retained on site.

7.4.2 Welders Qualification

Welders and welding operators shall be qualified for the work and shall hold current welders' qualification certificates in accordance with the appropriate standards of the work.

Welders' tests shall be witnessed and approved by an authorized third party authority before the welder or operator is permitted to work. The decision of the Engineer regarding the acceptability of any test or existing qualification shall be final. Evidence of previous qualification tests shall be accepted solely at the discretion of the Employer/Engineer.

Records showing the date and results of the qualification tests performed by each welder and weld operator together with the identification number assigned to him shall at all times be available for scrutiny by the Engineer. Each qualified welder and weld operator shall be assigned an individual identifying number. This number shall be marked in indelible crayon on all work performed by the welder to whom it is assigned. Any welder or weld operator whose work is the subject of multiple rejections will be required to undergo a re-qualification test on the appropriate weld procedure. At the discretion of the Employer/Engineer any welder or weld operator failing a re-qualification test may be disqualified from further welding on the works.

7.4.3 Pre-weld Inspections

Before the welding is started it shall be checked that the weld preparation is according the procedures and drawings (dimensional check), that the pre- warming temperature is within the required range (if pre-warming is required according the procedure) and the weld material is according the specification. A checklist shall be filled in according the procedure.

Furthermore all tests as specified in the weld procedure have to be performed.

7.4.4 Post-weld Inspections

7.4.4.1 Quality Requirements for Welds

Welds subjected to non-destructive tests shall be entirely free from cracks or crack-like defects, lack of root fusion, lack of sidewall fusion, root burn through, tailed pores. The standard for porosity and slag inclusions will be as indicated in the AD 2000-Merkblatt HP 5/3 or equivalent standard for design and welding.

7.4.4.2 Mandatory Inspection

All transition welds and welds on low alloy materials and high yield steels, shall be subjected to ultrasonic examination in accordance with AD 2000- Merkblatt HP 5/3 or equivalent standard. In addition, all butt welds on these materials shall be subjected to radiographic examination and crack detection.

The number of radiographically tested welds shall not be less than 10% respectively the percentage as specified in the applicable standards, whichever is higher.

100% radiography on all weld of fuel gas pipeline shall be carried out. All butt-welds between similar material shall be subjected to 100% radiographic examination/inspection.

7.4.5 Post-weld Heat Treatment

Regardless of the requirements of the specific code or specifications applicable to the design and/or construction of the plant and associated pipework, it is a mandatory requirement of this Specification that all welds shall be subject to appropriate post weld treatment with the following exceptions:

1. Austenitic stainless steels.
2. Plain carbon steels containing less than 0.25 per cent carbon at thickness up to and including 30 mm.
3. Low allow steels containing ½ per cent molybdenum and 1¼ per cent chromium, ½ per cent molybdenum up to and including thickness of 12.5 mm provided that:
    a. A hardness traverse across the weld zone gives no single result

       > 240 HV 10, and

    b. No fillet weld leg is greater than 8 mm, and

    c. A minimum preheater of 200°C is used for welding.

All welds in plain carbon steels containing between 0.25 and 0.4 per cent carbon are required to be post weld heat treated at a temperature in the range

630 to 670°C.

All post weld heat treatments of materials and components for use at temperatures in excess of 400°C shall be so designed as to guarantee maximum creep properties in the parent materials and weldings.

The soaking times at the selected heat treatment temperatures shall be:

- Plain carbon steels containing less than 0.4% carbon 2.5 minutes per mm of thickness with a minimum time of 30 minutes.
- Low alloy steels containing vanadium, 5 minutes per mm of thickness with a minimum time of 120 minutes.

- Steels containing vanadium and high chromium steels (e.g. 11 to 15%),180 minutes regardless of thickness.

In the event that any post weld treatment is carried out at a temperature in excess of the original tempering temperature of the parent materials a reassessment of the design strength limit stresses for the materials will be required. This may, in the absence of acceptable mechanical test data for the specific condition, require re-determination of the relevant mechanical properties of the materials.

The requirements for post weld heat treatment do not affect or replace in any way the requirements for maintenance of welding preheats or post welding heating for the purposes of diffusing hydrogen from the weldings.

Welding after stress relieving is prohibited.

7.4.6 Weld Repairs

A procedure for all weld repairs shall be submitted by the Contractor to the approval of the Engineer.

All weld repairs shall be made using the same procedure as for the original weld. All tests shall be repeated after the repair has been completed and reports on radiographic and ultrasonic tests shall be marked to indicate that the report refers to a repaired weld.

7.4.7 Special Requirements for Site Welds

7.4.7.1 Welder's Qualification Tests

All welders and welding operators shall be qualified for the work and shall hold current welders' qualifications certified in accordance with the appropriate British, American or German standards.

All welders' tests shall be witnessed and/or approved by the Engineer before the welder or operator is permitted to work. The decision of the Engineer regarding the acceptability of any test or existing qualification shall be final. Evidence of previous qualification tests shall be accepted solely at the discretion of the Engineer.

Records showing the date and results of the qualification tests performed by each welder and weld operator together with the identification number assigned to him shall at all times be available for scrutiny by the Engineer.

The welder qualification test shall be performed on the test coupon in accordance with qualified welding procedure specifications. Welder qualification test using the production weld shall not be permitted. Each qualified welder and weld operator shall be assigned an individual identifying number. This number shall be marked in indelible crayon on all work performed by the welder to whom it is assigned. Any welder or weld operator whose work is subject to multiple rejections will be required to undergo a re-qualification test on the appropriate weld procedure. At the discretion of the Engineer any welder or weld operator failing a re- qualification test may be disqualified from any further welding on the works.

Procedure for welder performance monitoring at site where radiography is performed shall be submitted to the Engineer for approval.

7.4.7.2 Execution of Welds on Site

The Engineer shall be notified in writing at least two days prior to the commencement of any assembly or fabrication work.

Welders and welding shall be protected by suitable equipment from wind, airborne sand and moisture. Work shall not be performed when weather conditions do not permit satisfactory workmanship or adequate inspection. Dependent on the parent material, weld preparation profiles may be prepared by machining, shearing, flame cutting (not for stainless steel) and grinding and shall be performed carefully and accurately. Whenever possible a mechanically guided tool shall be used for flame cutting. All edges shall be left free of slag, burrs, fins, oxides and foreign matter and the finished profile shall conform to the design tolerances for the weld preparation. Before weld execution the profile shall be dry and free of any humidity in the form of condensate, oil etc., and edges of all parts exposed to pressure or heavy loading shall be examined by ultrasonic, liquid penetrant or magnetic particle method. Examination by the magnetic particle method shall be approved. Line-up clamps shall be used and shall not be removed until the root weld has been completed. Where spacer strips or bridging pieces are utilized due care shall be taken when the tack welds are removed. All scars and blemishes shall be ground off prior to submitting the weld for inspection.

Tack welding of weld preparations may be permitted but all tacks must be ground to a feather edge prior to completing the root pass. Electrodes and preheating for tack welds shall be the same as that required for the completion of the weld. Any defective tack weld shall be removed prior to welding the root pass. Tack weld shall be done by qualified welder with qualified welding procedure.

Tack welds on pressure retaining parts and on parts carrying principal stresses shall be examined in the same way as the principal welds.

Where preheating is required by the welding code it shall whenever practical be carried out by electric resistance or induction equipment or by specially shaped gas burners. Preheat and interpass temperatures shall be checked by temperature indicating crayons at a distance of not less than 75 mm from the weld groove. The use of hand held torches for such preheating is not permitted. However “drying” of pipes being made of material, which does not require preheating by the welding code, can be done by torches.

All slag, excess filler metal, and surface irregularities shall be removed between weld interpass runs. Cleaning may be carried out by hand or power tools. Flame gouging is prohibited.

Back chipping may be carried out by arc air gouging providing that the weld groove is ground to a smooth profile, all surface irregularities arising from the arc air process are removed and all surfaces are inspected in accordance with relevant standards.

Welded-on attachments such as lugs, cleats, supports etc. shall be positioned well clear of all pressure retaining welds and welds carrying principal stresses. If it is found essential to bridge or span a principal weld then the attachment shall be designed so as to ensure that no further weld is positioned within 40 mm of the principal weld. Attachments bridging principal welds shall be designed to give a minimum clearance of 25 mm over principal welds.

All transition welds between dissimilar materials shall be made under controlled conditions at the manufacturers' works. Site welding of structural high yield steel will not be permitted without the prior consent of the Engineer.

All tube butt welds shall have 100% penetration with a maximum of 3 mm excess penetration in the root run.

Unless otherwise specified, welds subject to radiographic, ultrasonic or other forms of non-destructive test shall be dressed to a smooth contour. Care shall be taken to blend weld and parent metal without under-flushing. Branch and attachment welds shall be finished to a smooth contour and the toes of the weld shall be dressed smooth. Welds made by submerged arc process or other approved methods may be left unfinished providing the weld ripple does not interfere with the assessment of non-destructive test results.

All weld dressing shall be carried out before final heat treatment.

Post-weld heat treatment shall be performed in accordance with approved standard and shall be carried out using equipment designed specifically for the process. Gas burners or hand held torches shall not be permitted. For work which is heat treated in a furnace, the Contractor shall supply copies of the heat treatment charts. Work which is subjected to heat treatment by means of electrically heated elements shall be monitored by suitable thermocouples connected to a chart recorder. A minimum of two thermocouples shall be used and copies of heat treatment charts shall be made available to the Engineer.

7.4.7.3 Quality Control of Welds and Materials

Prior to the commencement of welding on site the Contractor shall submit to the Engineer for approval the welding procedures to be used in the execution of the relevant sections of the work.

Welders and procedures shall be qualified on actual work material and weld position.

Except where otherwise specified all materials to be welded and welds carried out on site shall be tested in compliance with clause 7.4.3 and 7.4.4 of this Specification.

The Contractor shall supply a minimum of two scintillation counters to the site for use by the radiographic personnel and by the Engineer as required.

The Contractor shall maintain and keep current a record of all pressure equipment welds against the individual welder identifying number on a weld map or register that shall form part of the QA package.

In the event of any prescribed test not meeting the requirements of the agreed standards, the defects in the welds represented by that test shall be rectified and the Engineer or the approved inspecting authority may call for an increase in the number of tests required until such time as a satisfactory quality is achieved.

The Contractor shall take all steps possible to safeguard site personnel, visitors and authorized representatives from the effects of ionizing radiation. The Contractor shall keep an inventory of all radioactive sources supplied to the site and shall be responsible for ensuring that safe procedures are adopted for the use, handling and storage of such sources.

7.4.7.4 Non-destructive Examinations

The non-destructive weld and material examinations on site shall be in compliance with clause 7.2 of this specification.

7.5 Mechanical Component Tests

7.5.1 Dimension & Alignment

The correct alignment of rotating equipment which is to be coupled onsite installation to other rotating parts (e.g. motors, generators, reduction gears etc.) shall be demonstrated by the Contractor to the Engineer. The alignment results will be entered in an appropriate alignment report sheet which is to be countersigned by the Engineer and the Contractor's representative. The alignment shall be demonstrated on site.

Alignment equipment shall be included in the workshop equipment for maintenance purposes.

7.5.2 Hydrostatic & Vacuum Tests

7.5.2.1 Hydrostatic Tests

All cast, forged or fabricated pressure vessels or enclosures and all

completed pipes, valves, drums, headers, boiler heating surfaces, heat exchangers, bends and fittings which are to be subjected to internal pressure or vacuum during operation shall be subjected in the maker's works to tightness and hydraulic tests as specified in the relevant standards. The test pressures shall be maintained for a minimum of 30 minutes or longer at the discretion of the Engineer to permit complete examination by the Engineer. Cast steel components of the steam turbine are not subjected to a hydrostatic test according to manufacturer's standard if in line with the applied manufacturing codes/standards. The said deviation is applicable for steam turbine only but with the exception of prototype, new material or new supplier.

All tightness and hydraulic tests shall be carried out prior to surface coating or painting. Enclosed structures may be subjected to hammer testing.

The manufacturer shall supply labor and appliances for such testing as may be carried out on his premises. Failing facilities at his own works the manufacturer shall make arrangements for carrying out the tests elsewhere.

The testing shall include, but not be limited to, the following equipment:

7.5.2.1.1 Pressure Vessels & Atmospheric Tanks

Pressure vessels shall be tested in accordance with the appropriate design code and are subject to the approval of the Engineer. The pressure vessels shall be tested at 1.5 times the design pressure of the relevant operating system.

All prefabricated tanks operating at atmospheric pressure shall be subjected to a hydrostatic test with the tank filled with water to full cylindrical height. The external surfaces shall be thoroughly chalked and the pressure maintained for a minimum of 24 hours.

All tests on the pressure vessels shall be made to obtain appropriate certificates from the relevant national or International governing bodies.

7.5.2.1.2 Pipework

All pipework shall be tested hydraulically for a minimum of 2 hours and only if necessary air pressure tested in order to check its tightness.

Pipework shall be tested in accordance with the applicable design code, but the test pressure shall not be less than 1.5 (one and one half) times the design pressure of the relevant operating system. In any event a pressure of not less than 4.5 bar shall be used.

7.5.2.1.3 Valves & Fittings

The body of each valve or fitting shall be hydraulically tested in accordance with ASME B16.34 Paragraph 7.1 Shell test or to the equivalent clause in the code that the valve has been manufactured to. In the particular case of safety valves the seats shall be blanked and the hydraulic pressure applied only to that part of the body on the inlet side. Where applicable, a seat tightness test using air or water shall be performed. The tightness test with air shall be performed at a pressure equal to 0.1 times the design pressure of the system, subject to a maximum of 2 bar. Proof of tightness shall be provided by painting with a readily foaming liquid, by immersing or by equivalent methods. When using water for the tightness test, the test pressure shall correspond to the permissible operating pressure of the system as defined by the pressure/temperature function at the lowest operating temperature.

For low pressure valves the above test requirements shall be carried out on a random check basis covering at least 10 % of each type of valve.

Leakage testing of low-pressure valves may be included in the pressure testing of the line system concerned. If the test medium is water the pressure test shall be carried out at 1.1 times the design pressure for a period of 2 hours.

If the test medium is air the pressure test shall be carried out at 0.1 times the permissible operating pressure subject to a maximum of 2 bar. In this case the period is 15 minutes. In the case of pressure tests using air, the valve body, including spindle gland and flange joints, shall be painted with a bubble-producing agent.

Tubular glasses for water gauges and sub-assemblies containing the glasses for water gauges of the through type or reflex glass type shall be tested to not less than one and one half times its design pressure. Fittings which may suffer internal damage e.g. steam traps; bellows-operated instruments etc. as well as pressure gauges shall be tested in accordance with the relevant codes.

7.5.3 Balancing & Vibrations

Each completed rotating unit shall be subject to a dynamic balance test. On multi section shaft pumps, the balancing will be carried out for each separate element.

A check balance test shall be carried out after the item has been subject to any overspeed or performance test. The standards for dynamic balance shall be specified by the manufacturer and agreed by the Engineer. It is preferred that all statements on vibration and balance be related to ISO 10816. The international standard ISO 1940 will also be accepted. However, standards with the more stringent requirements will be adhered to.

A certificate of balance test shall be provided for each rotating assembly. The vibration levels of all pump-

motor shall be checked under uncoupled and loaded status and recorded at the time of commissioning

with a portable vibration meter. The permissible level of vibration shall also be specified for each pump-

motor.

7.5.4 Metal Piping & Vessels

The Contractor shall test all his work in the presence of the Engineer as follows:

- Inspection of materials used on the basis of the field manual to be supplied by the Contractor for verification of pipe marking and information on materials
- Random testing of pipe dimensions
- Random radiographic testing of at least 15% of all welds. If, according to the first random-test results, 5% of the tested welded seams are not perfect, another 10% shall be tested. In the event of further faults being detected, all seams shall be radiographed. These additional tests, the checks of newly welded seams and all repairs shall be at the expense of the Contractor.

The production of welds to be tested shall occur as instructed and in accordance with local construction progress.

Samples for random tests shall be selected so that each welder employed is tested. In the case of pipes up to DN 80, two (2), in the case of pipes from DN 100 to DN 400, three (3), and in the case of pipes of a diameter larger than DN 400, four (4) partial acceptances are to be made per weld.

All welded seams in pipes, headers, manifolds, valves etc., executed on site, shall be tested by means of X-rays, radioactive isotopes and/or ultrasonics. However, testing by radioactive isotopes may only be done with the approval of the Engineer.

Headers and manifolds shall be tested in the same way as pipes of the relevant dimensions.

The following tests shall be provided for the pipe lengths and fittings:

- 100% X-ray and ultrasonic testing of welded seams in accordance with the standard the pipe is purchased to.
- 100% Ultrasonic testing of branch welded seams and pipe bends,
- 100% pressure testing of pipe and fittings by means of water in accordance with the relavant code the pipe and fittings are purchased to. Where not applicable replaced by 100% NDT.

Brine, condensate and steam piping lines shall be hydrostatically tested in accordance with ASME B31.1 (Power Piping Code). Testing shall be carried out as each line is completed, and after all interconnecting piping has been installed up to an isolating valve and all threaded thermo wells and instrument connections have been completed.

Site welds not hydrostatically tested shall be non-destructive tested in accordance with the Code requirements but not less than:

- 100% visual inspection on all welds
- 100% MT (Magnetic Crack Test) on all welds
- 25% RT (Radiographic Test) on butt welds and 100% RT on branch connections, i.e. the weld between the branch pipe and the run pipe).

Expansion joints shall be restrained or otherwise protected during tests and any pressure gauge or other device that would be damaged either by water or the test pressure shall be removed or otherwise protected during the test.

Below the seat of a closed valve, globe valves shall not be subjected to a test pressure greater than one and a half times the primary service pressure rating of the valve. Full pressure may be applied above the seat of the closed valve or if the valve is open.

The test pressure shall be maintained for a sufficient length of time to enable inspection to be made of all joints and connections. Any pipework, valve etc. found defective shall be repaired and the piping re-tested as specified above.

Equipment necessary for conducting tests including pumps, gauges, etc. shall be of the best quality and shall be provided by the Contractor.

1. Instrument Air Piping

Testing shall be carried out as each line is completed and after interconnecting piping has been installed up to an isolating valve and threaded thermowells and instrument connections have been completed.

2. Measuring Impulse Piping

Instrument take-off piping up to the first block valve shall be tested with the piping or equipment to which it is connected. Instrument headlines, between the first block valve and the instruments to which they are connected, shall be pressure or leak tested with the instruments disconnected. Testing may be performed separately or at the same time as the piping or equipment is tested.

3. Underground Services and Drains

Underground lines shall be visually inspected prior to testing. Underground services and drains at atmospheric pressure shall on completion of routing be tested hydrostatically under a head of not less than 3 meters of water. Underground line joints shall be left exposed until completion of field pressure and leak testing.

4. Water Piping

Before being concealed or insulated and before acceptance of the work, water piping shall be subjected to a hydrostatic pressure test.

5. Service Air Piping

Before being concealed and before acceptance of the work air piping shall be subjected to an air pressure test but at not less than 4.5 bar and joints shall be checked for leaks using a soap solution test. Tests shall be made for a period of two hours.

6. Steam and Condensate Piping

Before being concealed or insulated, steam and condensate piping shall be tested for a period of two hours and in no case shall the test pressure be less than 4.5 bar. In

In the case of welds tested at random only, the random tests shall be selected so that each welder employed is tested.

The minimum extent of radiographic tests shall be applied to tanks produced in workshops.

The tests shall be performed in accordance with AD 2000-Merkblatt HP 5/3 or equivalent standard.

The selection of welds to be tested shall consider the range of material dimensions and shall be equally distributed throughout work execution time on site.

Tightness testing of tanks shall be performed by means of a static pressure test of at least twenty-four (24) hours' duration with the tank filled with water to full cylindrical height. A filling program shall be compiled for filling the tanks. During filling, subsidence measurements shall be continuously performed.

Tightness testing of 100% of floor welds using a vacuum device shall be carried out at least once

before and after the static pressure test. The test vacuum shall be at least 500 mbar.

Magnaflux tests of floor welds are foreseen and included in the inherent

Quality Control Plan.

For protection of control valves and accessories during the period of flushing and blowing out of the system, control valves shall be equipped with suitable valve seat inserts.

No restrictions which would interfere with filling, venting, draining or flushing shall be installed until completion of the pressure test and line flushing operations. These include orifice plates, flow nozzles, venturis, rotameter gauges and all other in-line equipment, which may be replaced by spool pieces, or the ends of the pipe blanked off as appropriate. Piping joints (including welded joints) shall be left unpainted and un-insulated until completion of field pressure testing.

Temporary supports shall be used during hydrostatic testing, flushing and solvent cleaning of piping which has not been designed to carry the weight of the piping full of water.

The following piping and equipment shall not be subjected to field pressure testing:

- Rotating machinery, such as pumps, turbines and compressors
- Strainers and filter elements
- Pressure relief devices, such as rupture discs and pressure relief valves
- Any equipment which does not have a specific test pressure at least as great as the piping pressure rating
- Vessels which do not satisfy the pressure requirements at the piping test pressure
- Equipment lined with chemically bonded castable materials, unless approved by the lining material manufacturer
- Piping which is normally open to the atmosphere such as drains, vents, discharge pipes from pressure relief devices, sewers and flare piping etc.
- Locally mounted pressure indicating gauges, where the test pressure would exceed the scale range
- Other designated equipment, if any, subject to the approval of the
- Engineer.

Unless specified otherwise in the above mentioned specifications, piping and equipment shall be field tested in accordance with the following requirements:

- Associated lube and seal oil systems which could be impaired by the presence of water shall be tested with lube oil
- Piping systems shall be flushed until lines are thoroughly cleaned of loose scale and debris
- Gauges used for testing shall be installed as close as possible to the low point of the piping system
- Vents and other connections which can serve as vents shall be open during filling so that air is vented prior to applying test pressure to a system

- A strainer shall be installed in the fill line to minimize the possibility of foreign matter being introduced into the system during the pressure test
- and flushing operation
- Pneumatic testing of piping is acceptable only if specified, and the test Procedure and the test pressure have been approved by the Engineer.
- Pneumatic testing of spiral welded pipe is not permissible. In all cases, the test pressure shall be maintained for a sufficient length of time to enable an inspection to be made of all joints and connections. Any work found defective shall be corrected and the piping re-tested.

7.5.5 Pumps

- Material inspection and tests shall be performed in accordance with European Standard EN 12952, Part 2 or equivalent codes.
- Welded joints: 100% X-ray or ultrasonic inspection shall be carried out on particularly important welding.
- Balance test: First the impeller must be statistically and dynamically balanced and then the rotating assembly as a whole. Dynamic or static balancing of each impeller according to ISO 1940-1 grade Q 6,3 as applicable. Any other standard including HI standard shall be accepted provided it is equal or better than specified.
- Pressure tests shall be performed on all parts exposed to internal pressure.
- Performance tests shall be carried out on all pumps in compliance with ISO 9906 or equivalent with tolerances according to ISO 9906. Hotwell pumps shall be tested in compliance with ISO 9906, Grade 1; all other pumps for design pressure above 25 bar shall be tested to Grade 2. All other pumps shall be tested to Grade 3. The performance test shall be conducted through the full operating range of the pump to closed valve conditions. Curves showing flow rate versus head, efficiency, power absorbed and NPSH shall be provided for each pump. The performance test shall be carried out at pump discharge flows of 0, 25, 50, 75, 100 (rated) and max.
- Furthermore, NPSH test shall be carried out for each pump set for 3 points.

7.5.6 GRE/GRP Piping

GRE/GRP pipe, fittings and joints shall be free from de-laminations, cracks, bubbles, pinholes, pits, blisters, foreign inclusions and resin-starved areas that due to their nature, degree or extent detrimentally affect the strength and serviceability of the pipe. No glass fibre reinforcements shall penetrate the interior surface of the pipe wall.

Joint sealing surfaces shall be free of dents, gouges, de-laminations, or other surface irregularities that will affect the integrity of the joints.

GRE/GRP pipe, fittings and joints shall be as uniform as commercially practicable in colour, capacity,

density and other physical properties.

The Manufacturer shall take adequate measures in the production of the products covered by this specification to assure compliance with the requirements herein. An Inspection and Testing Plan (ITP) should be forwarded to the Contractor for approval in the Pre-Award phase. Plant inspection by the Contractor's qualified personnel or the omission of such inspections shall not relieve the Manufacturer of the responsibility to furnish products complying with the requirements of the minimum manufacturing requirements given herein. Material certification shall be done in accordance with EN 10204 2.2.

Production and Testing Notice - When plant inspection is required by the Employer, the Manufacturer shall provide adequate advance notice of when and where production and testing of ordered products will commence.

The Employers Inspector(s) shall have free access with reasonable advance notice to the Manufacturer's plant areas that are necessary to assure that products comply with all requirements herein.

As a minimum, the following tests shall be performed at the indicated intervals unless otherwise agreed-upon, and shall form a part of the

Manufacturers overall quality control program.

Type of Test	Each Pipe	Once per shift *)	Standard Reference
Visual inspection outside	x		ASTM D2563
Wall thickness	x		ASTM D3567
Diameter spigot end	x		AWWA C950
Length	x		ASTM D3567
Barcol Hardness	x		ASTM D2583
Stiffness		x	ASTM D2412
Loss on ignition		x	ASTM D2584
Axial Tensile Strength		x	ASTM D638

For GRE, the determination of strength properties may be treated as qualification testing, provided the manufacturer declares the winding angle and submits qualification test reports duly authenticated by third party.

Pipes hydrostatic pressure test shall be carried out at a minimum frequency of 10%.

Test methods shall be in accordance with AWWA C950 or Axial Tensile.

Inspection and Testing of reinforced thermosetting resin pipes

Checks shall be made on all raw materials to ensure that they comply with the relevant ASTM Standard.

In addition the following tests shall be carried out on raw materials

(Minimum requirements):

Resin

All deliveries of resin shall be checked for consistency by viscosity and reactivity. Any resins deviating from the manufacturer's published figures shall not be used.

Applicable Documents:

- ASTM D1824 Viscosity of Resin
- ASTM D1544 Gardner Colour Comparison of Resin
- ASTM D1045 Acid Number of Resin
- ASTM E203 Moisture Content of Resin
- Resin visual control: once per each start up production
- Resin viscosity: once per each start up production
- Geltime of resin: once per each start up production
- Monomer content in the resin: once per each start up production

Glass

Glass fibre visual control: once per each start up production

ASTM D2343 Tensile Properties of Glass Fibres

Testing of reinforced thermosetting resin pipes

The following tests shall be carried out on the manufactured pipes at the frequency stated:

- Long term hoop strength (type test for pressure pipes only in accordance with ASTM D2992 Procedure B with the exception that the test results shall be extrapolated to determine the stress which the pipe can withstand for a period of 60 years without failure. The lower 95% confidence limit at 60 years shall also be calculated.
- Hydraulic test 100% of the pipes shall be subjected to an internal hydraulic pressure test at the manufacturer's works prior to delivery. The test shall be applied to a pressure equal to 1.5 times design pressure stated for each classification of pipe. The test pressure shall be applied for a minimum period of 5 minutes without signs of leakage. In addition to the above the first pipe and every thirtieth thereafter of each class and diameter shall be maintained at test pressure for a minimum of 4 hours without signs of leakage. Each pipe and fitting shall be subjected to an internal low pressure air test at the manufacturer's works prior to delivery. The test pressure shall be an overpressure of 0.1 bar and this shall be applied for a minimum period of 5 minutes without signs of leakage or distress. Fittings, which are of mitred construction, shall be manufactured from pipes, which have successfully passed the tests defined above. 10% of flanged fittings up to 1,200 mm shall be hydrotested.

Fittings, which do not have flanges on both ends, cannot hydraulically tested.

- Dimensions

The dimensions and tolerances of all pipes shall be determined in accordance with ASTM D2122, including thickness of lining, coating and structural wall. The wall thickness shall be measured for each pipe and fitting. The total thickness shall not at any point, be less than 87.5% of the nominal wall thickness specified in the manufacturer's data sheets current at the time of purchase, when measured in accordance with ASTM D3567.

- Stiffness
  A minimum of one pipe for every 30 pipes manufactured shall be tested for stiffness in accordance with ASTM D2412 "Method of Test for External Loading Properties of Plastic Pipe by Parallel Plate Loading". A minimum of one pipe of each class and diameter of pipe shall be tested.

- Longitudinal and hoop tensile strength
  The tensile strength properties of a minimum of one pipe for every

  100 pipes manufactured shall be measured in accordance with ASTM D638. A minimum of one pipe of each class and diameter of pipe shall be tested.

- Cure

Curing, to be tested by the Barcol Hardness test determined in accordance with ASTM D2583 standard: 100% of the produced pieces. Minimum acceptable hardness is 90% of the value recommended by the resin manufacturer of the particular resin used, when non-reinforced. The sample pipe shall also withstand a commercial acetone test on the internal portion of the laminate.

- Loss on ignition

A minimum of one pipe for every 30 pipes manufactured shall be tested in accordance with ASTM D2584 "Standard Method of Test for Ignition Loss of Cured Reinforced Resins".

- Joint tests
  A minimum of two pipes in every 100 pipes manufactured shall be jointed and tested in accordance with the requirements of section 7.2 of ASTM D3262 except that the positive test pressure shall be as in "Hydraulic Test" above and that the deflection during the mis-aligned joint tests shall be 1.5°. This test may be carried out together with the hydraulic test as described above.

- Visual inspection
  Each pipe and fitting shall be subjected to a complete visual inspection before shipment in accordance with ASTM D2563.

- Vacuum test

Vacuum test of pipe shall be carried out for each diameter once at beginning of production. The vacuum to be applied shall be equivalent to the condition which occurs during full vacuum and to the design vacuum of the system. The corresponding deaerated vacuum for this test shall be proved by the pipe manufacturer.

- Failure of tests on completed pipes

In the event of a specimen not fulfilling the minimum requirements for strain corrosion resistance, all pipes of that class and diameter which have been manufactured shall be rejected and shall be replaced entirely at the Contractor's expense.

Any pipe or fitting which fails any of the quality control tests, which are to be carried out on each and every pipe, or fitting shall be rejected.

In the event of any pipe failing any of the remaining tests outlined above that pipe shall be rejected and the relevant test shall be carried out on a further ten pipes of that class and diameter. Five of these pipes shall have been sequentially produced immediately prior to the failed pipe and five immediately following. If any one of these ten pipes fails than the manufacture of pipes of that class and diameter shall cease and discussions shall be held between the Contractor and the Engineer to establish the significance of the failures.

The suitability of the manufactured pipes for the proposed installation conditions shall be determined in the light of the test failures and the Engineer reserves the right to reject all the pipes of that class and diameter. In the event of any pipes being rejected the pipes shall be replaced entirely at the Contractor's expense.

Visual Acceptance

Visual Characteristics	Definition	Allowable Limits
Delamination	Separation in the laminate	None
Blisters	Light (straw coloured areas resulting from too hot a cure)	None to exceed 13 mm in diameter
Haystacks	Accumulation glass resin and sand on exterior surface	None greater than 30 mm diameter
Torn Edges End Delaminations and End Gouges	Tears and rips the edges of cuts	None which will affect the integrity of the joints

Ground Area	Area around lay-up which has been abraded but lay-up doesn't cover or has not been coated with resin	Not Permitted

Testing of Fittings

GRE/GRP fittings such as bends, tees, junctions and reducers shall be equal or superior in performance to the pipe of the same diameter and pressure. All fittings shall have a smooth internal surface with similar wall construction.

Standard tensile resistant fittings shall be filament wound on a collapsible mould (25 - 400 mm Diameter) or mitred (450 - 2500 mm Diameter).

The tolerance on the Manufacturer's declared length of fitting shall be ± 10 mm taken from the point of intersection to the end of the fitting or ± 10 mm on a straight fittings.

All fittings shall be fabricated in the factory to ensure Quality Control (Under no circumstance shall fabrication of fittings be allowed on site by Contractor). Complex fittings arrangements may be preassembled by the pipe Manufacturer in the factory such that field joints are kept to a minimum.

7.5.7 Painting, Coating & Wrapping

The protective coating is to be inspected visually while being applied. After the priming, coating and wrapping operations have been completed, the surfaces shall be tested with an approved electrical holiday detector. Any missed spots in the coating shall be corrected by overwrapping.

The electrical equipment used to test the wrapping in the workshop on site shall be portable low amperage, adjustable voltage holiday detector subject to the Engineers approval. The holiday detector shall be fitted with a coil spring electrode for the larger coated pipe areas, and a suitable brush type electrode for the smaller coated bolt and other surfaces. The holiday detector shall be equipped with audible means to indicate any holidays or imperfections and visual indication of test voltage at all times.

The operating voltage of the detector shall be within the range of 5000 to 20,000 volts. Due to variables such as relative humidity and temperature, the detector shall be adjusted twice daily, once just before starting work in the morning, and again just before starting work in the afternoon.

The operating voltage of the detector shall be determined by the following procedure:

1. Select a coated and wrapped portion with a sound double wrap cover

2. Deliberately puncture the coating with a sharp pointed tool

3. Move the detector electrode back and forth over the puncture and reduce the voltage until the detector does not indicate the known defect.

4. Place a strip of dry tape over the known defect, move the detector electrode back and forth over the strip and slowly increase the voltage until the detector starts to indicate the known defect under the tape strip.

After the voltage has been properly adjusted the electrode shall be passed over the coated and wrapped

surfaces once only, at the rate of approximately 10 to 15 metres per minute.

All GRE/GRP flanges and blind flanges up to 2000 mm diameter shall be machine filament wound.

For GRE/GRP fittings, the deviation from the stated value of the angle of change of direction of a bend, tee, junction etc. shall not exceed ± 1 degree.

All repairs shall be in accordance with the tape manufacturer's instructions except that the repair coating shall extend 75 mm beyond each side of the edge of the existing sound covering.

For measuring the dry film thickness, a non-destructive dry film thickness gauge must be used.

Results of the measurements shall be entered on the inspection report. The required minimum dry film thickness shall be checked for each coating system. In specific cases it is necessary to measure the wet film thickness per coat, for example the primary coats.

After coating work is completed, a general final check of the coating application shall be made. In certain cases (e.g. tar epoxy linings) the finished coating system shall be inspected for pinholes in the paint film by commercial high voltage spark testers. The Defects Notification Period will usually commence from the Take-Over Date.

To provide proof of warranty, various test patches shall be applied in the presence of the Engineer, the Contractor and the paint supplier. The test patches shall be identified and recorded.

Should any defect arise during the Defects Notification Period that is not reflected in the test patches, the reason will be assumed to be inadequate workmanship of application. Should the defect be reproduced similarly in the test patches and the total coated surface, the reason will normally be assumed to be inadequate quality of coating material.

7.6 Electrical Component Tests

Electrical equipment and material which is not covered by the tests specified elsewhere in this document shall be inspected and tested in accordance with standards listed hereafter, in accordance with the latest valid approved edition.

7.6.1 Rotating Electrical Equipment

7.6.1.1 General

The rotating electrical equipment shall be tested in accordance with the following standards:

IEC 60034, IEEE 115, IEEE C50, NEMA SM, ISO 1680 and ISO 10816.

7.6.1.2 Motors

Each motor shall be factory tested and shall undergo a test at site.

For each type of MV motors type tests to be performed on one motor and routine tests on the other motors.

Type test certificates of identical MV or LV motors will be accepted. The following tests shall be

performed under full responsibility of the Contractor.

Workshop Tests:

- Measurement of winding and insulation resistances
- No-load and current measurement
- Open circuit secondary induced voltage test at stand still (wound rotor)
- High voltage test
- Over-speed test (120% for 2 minutes)
- Locked rotor current and torque measurement (type test)
- Temperature rise measurement (type test)
- Power factor and efficiency measurement (type test)
- Measurement of noise level (type test)

7.6.2 Power Transformers

7.6.2.1 General

The Power Transformer shall be tested accordance with IEC 60076. The mounted equipment e.g. tap-changers, CT's/ VT's, bushings, pumps, fans etc. shall be tested in accordance with the appropriate IEC.

7.6.2.2 Type Tests (one of each Power Transformer type)

- Type tests as per IEC 60076-1 section 10.1.2 a) and b)
- Special tests as per IEC section 10.1.3 a) to i)
- Vacuum deflection test on transformer tank
- One transformer tank will be subject to the vacuum equivalent to up to 1 mbar of absolute pressure for 24 hours, in order to check the mechanical withstand capability of the tank. During this test no damages or fractures shall occur. This test may be combined with other tests or made during the manufacture of the unit. Max. Admissible permanent deflection after pressure balance is 1 mm.
- Overpressure test of transformer tank
- One transformer tank shall be subjected to an overpressure of 0.35 bar above the atmospheric pressure. After the overpressure test there shall be no permanent deflection of the stiffeners and the permanent deflection of the panels between stiffeners shall not exceed 1 mm. The test may be combined with the routine oil leakage test.

- Overpressure test of pressure relief devices
- All pressure relief devices mounted on the transformer tank shall be subjected to a functional test. The devices shall operate before reaching an overpressure of 0.35 bar above the atmospheric pressure.
- Pressure test of radiators

- Oil leakage test
- All tanks shall be tested for oil tightness by being completely filled with oil of viscosity not greater than the one specified by IEC 60296 at ambient temperature and subject to overpressure of 0.35 bar above the atmospheric pressure for not less than 24 hours. No oil leakages are admissible.

7.6.2.3 Routine Tests (each Power Transformer)

- Routine tests as per IEC 60076-1 section 10.1.1 a) to e)
- Insulation resistance
- Separate source voltage withstand test
- Induced over voltage test & PD test
- Frequency response analysis
- Gas in oil analysis
- Pressure relief device, Buchholtz relay, oil, winding meters, oil level indicator, dry cool breather, dissolved gas analyser test/check

Transformer Fault withstand (fault versus time) curve (TCC) for all transformers shall be submitted by the Contractor together with the protective device to demonstrate proper protection of the transformer.

Over-excitation curves shall be provided by the manufacturers for Step-Up

Transformers and auxiliary transformers, connected to the Generator bus. Separate type and routine tests shall be carried out for all accessories like bushings, bushings CTs, tap changers, fans, control panels, etc.

7.6.2.4 Control Cubicles, Kiosks & Terminal Boxes

- Checks on functioning of contactors, overloads isolators and general operation of control circuits for cooling gear
- Checks on operation of circuits for thermometers, thermal images, pressure relief valves, oil and gas operated relays, flow detectors, heaters, lights and power output sockets
- Checks on wiring arrangements and terminal boards
- Checks on weather sealing of doors, cable glands and other external features
- Visual and dimensional checks

7.6.3 Generator Circuit Breaker

Generator circuit breakers shall be tested as per IEC 62271. The following type and routine tests shall be carried out:

Type (design) tests:

- Rated continuous current carrying test
- Rated dielectric test
- Short circuit current rating

- Rated transient recovery voltage
- Standard duty cycle test

- Rated interrupting time test
- Short circuit current with delayed current zero
- Load current switching test
- Out of phase switching test
- Excitation current switching test
- EMC test as per IEC 62271-1

Routine (production) tests

- Gas/air receiver test
- Pressure, leakage test
- Nameplate check
- Resistor, heater and check test
- Control and secondary wiring check test
- Clearance and mechanical adjustment check
- Mechanical operation tests
- Timing tests
- Store energy system test
- Electrical, resistance of current path test
- Power frequency on major insulation components, control and secondary wiring

7.6.4 Insulators & Bushings

The insulators and bushings shall be tested in accordance with the following rules and regulations:

IEC 60383 Insulators for overhead lines with a nominal voltage above

1000 V

IEC 60507 Artificial pollution tests on high voltage insulators to be used on AC systems

IEC 60137 Insulating bushings for AC voltages above 1000 V

7.6.5 Current & Voltage Transformers

The current and voltage transformers shall be tested in accordance with IEC 61869.

7.6.6 HV cables

7.6.6.1 General

The 220 kV XLPE-Insulated Single-Core Underground Cables and Accessories shall be tested as per latest IEC 62067 including all subsequent amendments and relative standard. The Employer/Engineer shall witness the required Type and Sample tests.

The approval of the Employer/Engineer or the passing of any such inspection or test will not however, prejudice the right of the Employer/Engineer to reject the 220 kV XLPE-Insulated Single-Core Cables and accessories if it does not comply with the Specification.

Defects discovered during the type/routine/sample tests shall entitle the Employer/Engineer to reject the cables/accessories fabricated for this Project.

The Tenderer/Contractor shall fabricate without additional cost the cable lengths and accessories necessary for the tests, over and above those required to complete the Work at Site.

For the definitions of the Type Tests, Sample Tests, Routine Tests and Tests after installation, reference shall generally be made to the relevant IEC Standards.

HV cables and accessories shall be workshop tested as per IEC 62067 with the following tests as a minimum:

7.6.6.2 Type tests on cable systems: according clause 12

- Electrical type test according Clause 12.4
  - Check of insulation thickness acc. to Clause 12.4.1
  - Bending test on the cables acc. to Clause 12.4.4 followed by installation of accessories and a partial discharge test acc. to Clause 12.4.5
  - Tan d measurement acc. to Clause 12.4.6
  - Heating cycle voltage test acc. Clause 12.4.7
    - Partial discharge test acc. to Clause 12.4.5 (at ambient and at high temperature)
  - Switching impulse voltage test acc. to Clause 12.4.8
    - Lightning impulse voltage test followed by a power frequency voltage test acc. to Clause 12.4.9
  - Test of outer protection for joints
    - Examination of cable system with cable and accessories after completion of tests acc. to Clause 12.4.10.
  - Tesitivity of semi-conducting screen acc. to Clause 12.4.11
- Non electrical type tests according to Clause 12.5
  - Check of dimensions acc. to Clause 12.5.1
  - Tests for determining the mechanical properties of insulation acc. To Clause 12.5.2
- Tests for determining the mechanical properties of oversheats acc. to Clause 12.5.3
- Aging tests acc. to Clause 12.5.4
- Pressure test at high temperature on oversheets acc. to Clause 12.5.6
- Other test on oversheets according to the type used.
- Hot set test for XLPE insulation acc. to Clause 12.5.10
- Measurement of carbon black of black PE oversheats acc. to Clause
- 12.5.12

- Water penetration test acc. to Clause 12.5.14.

Also following additional type tests shall be carried by the Contractor at their own cost prior to the first shipment of all offered cable if no type test certificates of identical cables are available:

- Fire Resistant according to IEC 60331, BS 6387
- Flame Retardant according to IEC 60332
- Low Smoke Test according to IEC 61034
- Halogen Content Test according IEC 60754
- Water Tree Test of XLPE Insulation (accelerated)
- Test voltage = 3 x Uo
- Test frequency = 500 Hz
- Core environment = 40^0C water
- Duration of test = 4 month
- Test after 4 months: Dielectric stress withstand >14kV/mm

Cables and accessories shall have passed type approval tests in accordance with IEC Specifications and details of the cable designs offered shall be given in the appropriate place in the Technical Schedules. Type test reports shall include cable design details and design drawings of each jointing accessory included in the type test.

The Bidder/Contractor shall submit certified copies of type test certificates covering the proposed Cables.

7.6.6.3 Routine tests:

- Partial discharge test
- voltage tests according
- electrical test on oversheath

7.6.6.4 Type Tests of Accessories

All accessories shall be tested as per IEC 62067 and all subsequent amendments and relative standards considering Test of Outer protection for buried joints (if applicable).

7.6.6.5 Routine Tests, Insulation Joints

The insulation flange shall be designed to withstand tests voltages as specified in the Technical Data Sheets and shall be tested accordingly.

7.6.6.6 Routine Tests, Bonding/Earthing Leads

The Bonding/Earthing Leads shall be designed to withstand tests voltages and currents as specified in the Technical Data Sheets and shall be tested accordingly.

7.6.7 MV cables

MV cables shall be workshop tested as per IEC 60502-2 with the following tests as a minimum:

Type tests:

- electrical type tests acc. to: IEC 60502 - 2 Clause 18.
- non electrical type tests acc. to: IEC 60502 - 2 Clause 19

Also following additional type tests shall be carried by the Employer at their own cost prior to the first shipment of all offered cable if no type test certificates of identical cables are available:

- Fire Resistant according to IEC 60331, BS 6387
- Flame Retardant according to IEC 60332
- Low Smoke Test according to IEC 61034
- Halogen Content Test according IEC 60754
- Water Tree Test of XLPE Insulation (accelerated):
- Test voltage = 3 x Uo
- Test frequency = 500 Hz
- Core environment = 40^{0}C water
- Duration of test = 4 month
- Test after 4 months: Dielectric stress withstand >14kV/mm

Moreover, test certificates shall be provided, proving that each cable type to be used has successfully passed type tests as required by the applicable standards during the last 12 months before award of contract. Otherwise, these tests have to be repeated on sample sections.

7.6.8 High Voltage Fuses

The high voltage fuses shall be tested in accordance with the following rules and regulations:

IEC 60282 High voltage fuses

IEC 60644 Specification for for high voltage fuse links for motor circuit applications.

7.6.9 Installation Material

The materials for installation shall be tested in accordance with the latest edition of the following rules and regulations;

IEC 60130 Connectors for frequencies below 3 MHz

IEC 62326 Printed circuit boards

IEC 60335 Low voltage electrical installations IEC 60364 Electrical installations of buildings IEC 60423 Conduits for electrical purposes

7.6.10 Materials for Earthing & Lightning Protection

IEEE 80 Guide for safety in AC Substation Grounding

IEEE 142 Recommended Practice for Grounding of Industrial and Commercial Power Systems

IEEE 81 Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface potentials for Ground system

IEEE 665 Guide for generating station grounding (as guidance because the standard were canceled without substitution)

IEC 60364 Electrical Installation of Buildings (e.g. Protection against Electric Shock; Earthing Arrangements, Protective Conductors and Protective Bonding Conductors)

NFPA 780 Installation of Lightning Protection Systems

IEC 62305 Protection against lightning

7.6.11 Surge Protection Equipment

The surge protection equipment shall be tested in accordance with IEC 60099.

7.6.12 Switchgear for Voltages above 1 kV

7.6.12.1 General

The AC switchgear for voltages above 1 kV shall be tested in accordance with the following rules and regulations:

IEC 62271 High voltage switchgear and controlgear

7.6.12.2 Workshop Tests

At least the following tests shall be performed in the manufacturer's workshop on the individual apparatus and on the complete installation, respectively, all in accordance with IEC-Standards:

- Visual inspection
- Power frequency HV tests
- Dielectric tests of the auxiliary circuits
- Measurement of the main contacts resistance with dc
- Temperature rise test on circuit breakers (type test certificate)

- Test of mechanical endurance (type test certificate)
- Measurement of the contact opening period (type test certificate)
- Functional tests of the control circuits
- Check of the operational sequence
- Measurement of the instrument transformer's angle and ratio errors

  (according to IEC 61869)
- Check of the denominations.

- Test of protection class (IP code) (type test certificate)
- Internal arc classification test (type test certificate)

Note: All switchgear shall be type tested according IEC 62271-1 and IEC 62271-200 including internal arc classification. Related type test reports shall be provided with the Bid.

7.6.13 Low voltage Switchgear

7.6.13.1 General

The low voltage switchgear shall be tested in accordance with the following rules and regulations: IEC 60947 Low voltage switchgear and control gear

IEC 60439 Low voltage switchgear and control gear assemblies.

7.6.13.2 Workshop Test

In addition to the type tests for which certificates shall be submitted, at least the following tests shall be performed in the manufacturer's workshop on the individual apparatus and on the complete installation, respectively, all in accordance with IEC Standards:

- Visual inspection
- Power frequency HV tests at main circuit
- Dielectric tests of the auxiliary and control circuits
- Functional test of the control circuits
- Check of the operational sequence

7.6.14 Batteries & Charging Equipment

7.6.14.1 General

The batteries and charging equipment respectively shall be tested in accordance

with the following rules and regulations:

IEC 60086 Primary cells and batteries

IEC 60119 Recommendations for polycrystalline semiconductor rectifier stacks and equipment

IEC 60146 Semiconductor convertors

IEC 60478 Stabilized power supplies, DC output

IEC 60896 Stationary lead acid batteries

IEC 61204 Low voltage power supply devices DC output

7.6.14.2 Workshop Test

Chargers and batteries shall be tested together in the factory or at site. All factory tests to be repeated at site.

Chargers

- Visual inspection (to be repeated on site)
- Functional tests (to be repeated on site)
- Heat run (type test)
- Output voltage stability measured for 25% load steps
- Ripple voltage measurement without connected battery
- Ripple measurement (voltage and current) with connected battery
- Insulation test (to be repeated on site).

Batteries

- Visual inspection (to be repeated on site)
- Insulation test (to be repeated on site)
- Charge test and discharge tests (testing at site is acceptable)

Fuse Box

- Visual inspection (to be repeated on site)

- Functional tests (on site)
- Insulation test (on site).

7.6.15 Inverters and DC/DC converters

The inverters shall be tested in accordance with the following rules and regulations:

IEC 60146 Semiconductor converters

IEC 61204 Low voltage power supply devices DC output

At least the following tests shall be carried out at manufacturer's workshop:

- Visual inspection (to be repeated on site)
- Functional tests (to be repeated on site)
- Heat run (type test)
- Insulation test (to be repeated on site).

7.6.16 Site Tests on Electrical Equipment

7.6.16.1 General

The following tests or measurements must be made during and after erection but before any item of equipment is put on trial operation:

- Design and visual checks
- Screwed connections for correct assembly
- Terminals and terminal connections for correct assembly
- Checking of earthing connections and testing of earthing resistances
- Measurement of insulation values (didactic tests)
- Verification of earthing conditions
- Fire-proof partitioning
- Marking, inscription, provision of designation plates
- Rotating-field measurement
- Voltage checks
- Polarity checks in the case of DC voltages

- Fuses, overcurrent trips, short circuit trips, time settings, relay settings
- Oil levels
- Status indication, alarm and trip signals
- Checks on wiring and cabling for conformity with the constructional circuit drawings and plans
- High voltage tests
- Current and voltage transformer circuits
- Functional test of all protection relays including winding and oil temperature monitoring as well as Buchholz protection etc.
- Interface with the DCS and SCADA.

The tests shall be carried out according to relevant standards.

The Contractor shall submit for each test of all equipment a method statement, with relevant diagrams explaining the procedure of the tests and test criteria supported by relevant standards and test methods.

All major equipment shall have a separate test package.

All high voltage tests shall be carried out at 50 Hz. Equipment for which DC tests are proposed shall be justified and approved by Employer/Engineer. HV tests of switchgears shall be carried out with the relevant circuit breakers in open and closed positions.

Unless otherwise agreed, all erection and civil works related to the equipment shall be completed before starting any site tests.

All switchgears shall be verified by primary injection in addition to secondary injection.

7.6.16.2 Motors

Tests at Site (with motor coupled):

- Measurement of insulation resistance
- Measurement of shaft current
- Measurement of motor vibrations
- At motors rated 47 kW or higher, in addition:
- Oscillographic measurement of starting current (if not performed during workshop testing)
- Measurement of starting period.

7.6.16.3 Switchgear for Voltages above 1 kV

The complete installation shall be tested at site as follows:

- Dielectric test
- Visual inspection
- Contact resistance/torque test of bus bar joints
- CT's, VT's ratio, magnetisation characteristic and burden measurement
- HV test
- Mechanical functioning test
- Test of the functional sequence
- Testing of all interlocks
- Testing of all protection relays and circuits by primary/secondary injection and functional tests of the arc protection
- Testing of high speed transfer systems
- Testing of all alarms (local and remote).

7.6.16.4 LV switchgear (AC and DC)

The complete switchgear and the individual apparatus shall be tested on site as follows:

- Visual inspection
- Dielectric test
- Contact resistance/torque test of bus bar joints
- CT's, VT's ratio, magnetisation characteristic and burden measurement
- Testing of all interlocks
- Setting and testing of all protection relays and circuits by primary/

  secondary injection. Test kit of adequate rating to be provided
- Testing of automatic change over devices
- Testing of all alarms (local and remote)

- Functional test
- Test of the functional sequence.

Setting and functional test of protection devices (primary injection method).

However, test plugs and socket facilities for secondary injection tests shall also be made available. Tests kits of adequate ratings shall be made available for the tests.

7.6.16.5 Batteries and charger

Chargers

- Visual inspection
- Functional tests
- Output voltage stability measured for 25% load steps
- Ripple voltage measurement without connected battery
- Ripple measurement (voltage and current) with connected battery
- Insulation test

Batteries

- Visual inspection
- Insulation test.

Fuse Box

- Visual inspection
- Functional tests
- Insulation test.

7.6.16.6 Inverters & DC/DC converters

Following test shall be carried out:

- Visual inspection
- Functional tests
- Insulation test.

7.6.16.7 Earthing and lightning protection

The complete earthing and lightning protection systems shall be tested as follows:

- The earthing system as a whole shall be tested and verified before putting any major equipment into operation

- Visual inspection of exposed elements

- Measurement of the earth electrode potential U_E by the voltmeter/ ammeter method, test current 100 - 300 A or an equivalent, approved method if above will be proved to be not feasible.

- Measurement of the touch potential U_B.

- Measurement of step potential.

7.6.16.8 Control and monitoring equipment

During the erection period and before the associated plant item is put into operation all control and monitoring equipment shall be tested. These tests shall include calibration and functional tests in addition to on-line commissioning for the following:

- calibration tests of all analogue measuring loops including all remote indications and recorders and the input signals used for closed loop control

- wiring test of all control cabling in the field, relay room and control rooms combined with the function tests

- testing of all control modules in the control room

- functional testing of remote control of drives, circuit breakers, solenoid valves, actuators, etc.

- testing of remote and logic control devices especially all sequence logic equipment using simulated inputs

- testing of all interlocks to ensure safe operation

- testing of the alarm annunciation and event recorder system in connection with all field and control room devices using simulated inputs

- testing of all closed loop controls.

The Contractor shall submit a comprehensive description of each test to the

Employer/Employer's Representative for approval. This shall include the type and classification of all test equipment and shall be submitted at least two months before the proposed date on which each test is to be carried out unless otherwise specified.

Certificates and test reports shall be issued for each test made to Employer/

Employer's representative for approval. Group certificates are acceptable for the tests of cabling and similar items.

7.7 Instrumentation and Control Equipment Tests

7.7.1 General

Instrumentation and control equipment shall be tested at the manufacturers' workshops before dispatch to site. Certificates or test reports shall be issued for all tested equipment and systems.

The Contractor shall submit a comprehensive description (test program) of each test. This shall also include the type and classification of all test equipment and shall be submitted at least one month before the proposed date on which each test is to be carried out.

Where temperature or humidity limits are specified by the manufacturer, tests shall be carried out on each type of equipment to demonstrate that the equipment is capable of operating correctly within these limits.

Additional requirements regarding inspection and testing are included in **Part F** of the Specification.

7.7.2 Calibration tests

The Contractor shall carry out calibration tests of the following instruments and equipment in accordance with the applicable standards:

- local indicators over the full range
- analogue transmitters over the full range of the transmitter
- binary transmitters over the full range of the transmitter, including preliminary setting.
- remote indicators over the full range of the indicator
- one of each type of thermocouple or resistance thermometers
- superheated steam thermocouples
- analysers and probe sampling equipment over the full measuring range by use of test gas or test liquid

Contractor shall provide typical calibration data for each different type of transmitter. This shall include the following:

- Five points calibration data within the range or minimum transmitter signal and maximum transmitter signal to ensure the transmitters work linear.
- Minimum transmitter signal below which it can be assumed that the transmitter has failed.
- Maximum transmitter signal above which it can be assumed that the transmitter has failed.
- Maximum zero drift after one year.

7.7.3 Orifices, Nozzles, Thermowells

Test of materials shall be carried out for all orifices, nozzles, thermowells etc. corresponding to the tests for the piping system in which they are fitted. The actual dimensions of all orifices, nozzles, venturi nozzles have to be certified by the Contractor.

7.7.4 Control Valves

Control valves shall be tested according to Clause 7.5.

Mechanical functional tests on the control valves shall be performed with the actuator mounted (open to closed position and vice versa). Actuators shall be subject to mechanical and electrical function tests.

7.7.5 DCS

Apart from the usual post-manufacture quality control tests on final products, FAT shall be carried out in the workshop prior to shipment.

The FAT of the DCS in the manufacturer's workshop shall be done in one lot with all cubicles including also all equipment of the Human-Machine Interface, if not otherwise agreed.

Data regarding response times and resolution shall be tested and proven during the FAT prior to shipment.

The minimum scope of Workshop Tests shall comprise the following. Further details shall be part of the approved FAT test procedure.

a.) Conditions

- The approved documentation of DCS hardware and software and the approved FAT test procedure is available before beginning with the tests
- DCS hardware is set up and interconnected/linked
- Firmware and user specific application software is loaded.
- I/O modules software is downloaded and all modules are initialized.
- A process-emulating computer is connected.

b.) Tests

- A representative number of each kind of input circuitries shall be tested
- A representative number of closed loop controls shall be tested.
- A representative number of open-loop controls shall be tested with simulation of stepping criteria and interlocks.

- A representative number of functional group controls shall be tested
- The Plant main start-up/shut-down sequence shall be tested with simulation of stepping criteria and interlocks
- Display/annunciation/printing/logging functions are to be continuously tested during the FAT.
- All protection criteria are to be tested one by one
  - Redundancy test for all redundant processors, power supply, I/Os and LAN equipment.
  - Testing power lost for individual equipment.
  - Testing and checking system alarm during failure.
  - Tally hardware quantity and type against requested ones.
  - Checking system load and spare allocated per spec.
  - Visual inspection for automation system panel.
  - Testing LAN communication.

7.7.6 Control Desks, Panels, Boards, Cubicles (As Applicable)

Control desks, panels, boards, cubicles etc. to be installed locally shall be pre-assembled and wiring operational and functional tests shall be performed in the Contractors workshops.

- Check of the following for cubicles:
  - Cubicle colour
  - Cubicle shock absorber
  - Cubicle fire detector
  - Cubicle panel alignment
  - Cubicle panel plate name
  - Inspection certification report cubicle installation
- Check of the following for control desks
  - model
  - size
  - colour
  - quantity

- service
- edges
- drawers
- locks
- structure

7.7.7 Site

During the erection period and before the associated plant item is put into operation all instrumentation and control equipment shall be tested by the Contractor in close collaboration with the contractors of the other contracts wherever any interconnection exists.

These tests shall include but not be limited to:

- calibration tests of local indicators
- calibration tests of remote indicating circuits and recorders
- calibration tests of measuring circuits for closed-loop control
- wiring tests of all control cabling in the field, electronics room, control room etc.
- redundancy test for all I/Os automation system interface modules and power supply
- testing time synchronization
- testing LAN components
- testing speed of serial data line
- testing engineering work station
- testing of main closed-loop controls for polarity and function
- functional testing of all final control elements
- testing of remote and logic control equipment by actuating all plant mounted binary transmitters. Inputs to the remote and logic control system which cannot be actuated at the primary element shall be simulated
- functional testing of remote controls of drives, circuit breakers, solenoid valves, actuators, etc.
- testing of interlocks and protection inputs to ensure the safe operation

- testing of the alarm annunciations and fault printing by simulation of all inputs.
- Check of the following:
  - Cubicle colour, damages
  - Cubicle shock absorber
  - Cubicle fire detector
  - Cubicle panel alignment
  - Cubicle panel plate name
  - Inspection certification report cubicle installation
  - Inspection certification report for cubicle erection
  - Inspection report for cable laying
  - Inspection report for field junction box
  - Certification for equipment ready for operation

Instrumentation testing and calibration facilities shall be supplied by the

Contractor. The Contractor shall submit a comprehensive description of each test. This shall also include the type and classification of all test equipment and shall be submitted at least one month before the proposed date on which each test is to be carried out.

Certificates shall be issued for each test carried out.

7.8 Civil Works Tests

7.8.1 General Requirements

7.8.1.1 General

The Contractor shall submit all test certificates of materials for approval by the Engineer and shall arrange for tests of all materials to be carried out in laboratories on site or elsewhere, or in Contractor's shop as and when directed by the Engineer. The cost of all test equipment, samples, tests and transport for tests shall be borne by the Contractor (to be included in the lump sum for this Contract) and the tests shall be performed by efficient and well-qualified staff.

The Contractor must carry out all requisite tests on material samples in order to verify their compliance with the specifications. The testing operations shall be performed in accordance with the relevant codes or standards and under the supervision of the Engineer.

The test samples of materials which have been approved by the Engineer shall be kept in a safe place and protected against damage or deterioration until completion of the works.

Where in the specifications materials are specified to be approved by the Engineer, samples shall be

submitted for approval at the earliest possible date and strictly before any purchasing or delivery to the site is made. The individual tests and inspection for the materials, supply and execution shall be carried out in compliance with the requirements of the individual technical specifications. In the case of rejection, further samples of the rejected materials shall be submitted to the Engineer until they are approved or the material replaced with one more suitable. The Engineer may reject any material which in his opinion is not in accordance with the approved standard. All samples shall be submitted free of charge to the Engineer.

The characteristics as determined in the samples which are approved shall indicate the standard to be maintained in the materials used in the execution of the works.

7.8.2 Quality Control Procedure

7.8.2.1Civil Works Quality Plan

The Contractor shall submit for approval of the Engineer a Civil Works Quality Plan with the whole Quality Control Procedure.

7.8.2.2 Nominated Person

The Contractor shall appoint a management representative to be responsible for all quality control matters. His other functions shall be limited to permit sufficient attention to be given to quality control. He shall have the necessary authority to execute such responsibility to the satisfaction of the Engineer. The Engineer will appoint a representative from amongst his site staff, to coordinate quality control matters.

7.8.2.3 Review Procedure

The quality system shall be subject to periodic joint reviews by the Contractor and the Engineer to ensure:

1. The essential requirements described above are being met.
2. That the Engineer can order and has adequate notice to attend each inspection and testing, and if he declines then is notified of the results as soon as practicable, but without disrupting the Contractor's schedule.
3. Reveal defects, irregularities and shortcomings.
4. Suggest improvements.
5. Verify corrective action procedures are effective.

7.8.2.4 Laboratories

The testing laboratories shall be as follows:

1. A Third Party Independent Laboratory (TPIL) for testing of concrete works and earthworks. For testing of these works, sampling, handling, transport to the laboratory, reporting and analysing of the test results shall be by TPIL. The TPIL shall be to the approval of the Engineer. The reporting and analysing of the test results shall be directly to the Engineer. The costs of all the tests and activities performed by TPIL shall be borne by the Contractor.
2. Laboratory (ies) by the Contractor (LC) for testing of all other works according to the specification. This (these) laboratory (ies) may be used by the Contractor for further testing, such as his own quality control or retesting in areas of previous failure. The Contractor may instead use the TPIL.

For the LC the Contractor shall provide all equipment, labour, staff and facilities necessary to carry out the necessary tests.

For testing of these works, sampling, handling, transport to the laboratory, reporting and analysing of the test results shall be by the Contractor. The costs of all above mentioned tests, equipment, labour, staff and acilities shall be borne by the Contractor.

7.8.2.5 Notifying & Informing the Engineer

The Contractor shall notify and inform the Engineer as follows:

a. Formally of the commencement, interruption or recommencement of any new area of working, wherever possible 24 hours in advance.
b. In advance of any inspection, calibration sampling or testing to enable attendance by the Engineer.
c. Of the results of tests not attended by the Engineer as soon as practical after testing.
d. By formal submission of results (weekly).
e. By formal summary and analysis of results whether weekly or monthly as instructed in advance or monthly in default.

Notifications as described by b) and c) above may be verbal, to a schedule arranged at the joint review or by handwritten notes informally submitted subject to the approval of the Engineer. However, should the Engineer consider such notifications inadequate as to accuracy, comprehensiveness or warning then such approval shall be withdrawn and such notifications shall be formally in writing with at least 24 hours advance notice of testing and no considerations shall be given to any disruption to the works thus caused. The information as per items a) through e) above shall be submitted in 3-fold.

7.8.2.6 Engineer to Instruct

The Engineer may select the sampling point at no cost. The Engineer may instruct tests at no cost provided either the overall frequency governed by the specification is not exceeded and the notification given to the Contractor is equal to that currently being provided by the Contractor for his normal testing in formality and warning, or the Engineer has due cause to suspect a change in the quality, such concern having been advised to the Contractor.

The Engineer may instruct sampling, testing or both which satisfy only some or none of the above criteria.

7.8.2.7 Engineer to Inspect & Test

The Engineer shall have the right to carry out independent inspections and testing either using his own resources or those of a third party. Should the Engineer require the results to determine the conformance with the specification then he shall notify and inform the Contractor at least to the same degree as the minimum of the following three options of the Contractor informing the Engineer:

a) Specified; as described above.

b) Agreed; as part of the quality system review as described above.

c) Actual.

(It is to be noted that should the Contractor repeatedly fail to notify or inform the Engineer of inspections,

sampling or testing (if any) then the Engineer may carry out independent checks without informing the Contractor and reject parts of the works should the results of such inspection or testing fail).

As far as is practicable the Engineer shall have free access to the site, fabrication areas and suppliers work at all times without notice. Should he discover unsatisfactory work then he will invite a formal joint inspection. Either after such an inspection or if the Contractor declines the invitation the Engineer shall issue instructions with regard to the faults and their reparation.

7.8.2.8 Approval process

All items to be incorporated in the permanent works require approval by the Employer/Engineer. Normally approval is to be a staged process. Stages are to be applicable to the item in question but shall comprise some or all of the following:

a) Supplier or source.

b) The material or product.

c) A mixture or combination of materials or products.

d) Repeats within tolerance.

The Contractor shall supply, as far as is practical, the following information:

a) On supplier or source a review of previous performance in supplying to similar specifications, evidence that he can legally supply to Kenya, capacity of plant, other ongoing commitments, details of main items of plant and key personnel, independent references (if any and preferably unsolicited), test reports on similar products (again preferably independent), a signed statement that the source will be open to inspection at all times before and during the time of supply and for major suppliers a statement that they have read this contract and their financial conditions of supply are allied thereto (i.e. if their material or product is found to be faulty and thus not liable for payment under the main Contract then the Contractor will not be left with a bill or debt that will inhibit his commitment to undertake his other obligations under this Contract).

b) On materials or product a copy of drawings, design calculations, supplementary specifications, previous test results, inspection, taking samples and tests according to the specification. All necessary and sufficient information to demonstrate conformance with this specification.

c) On mixes and combinations as b) above.

d) On repeats a selection or schedule of tests to monitor deviation from the results obtained under b) and c) above plus spot checks and/or independent checks to do likewise.

7.8.2.9 Rejection

Should any materials, items or complete parts of the works fail to comply with the requirements of this specification when tested in accordance with this section the Engineer may reject such materials or items, or condemn complete parts of the works, and demand of the Contractor such replacement or modification as may be necessary to ensure their compliance.

Should modification or adjustment be deemed a satisfactory alternative to demolition and/or removal, the Contractor shall submit full details in writing such modifications to the Engineer for approval, and should

such approval be forthcoming carry them out without delay.

If however, he is required to demolish and/or remove any such items or materials this shall be carried out quickly and with as little disruption to the works as possible.

No claims of any sort whatsoever will be entertained arising from the rejection of any part of the works through failure to meet this specification, and repairs, demolitions, removals, additional testing etc.

shall be entirely at the expense of the Contractor, nor shall any official extension of the be granted for such a reason.

7.8.2.10 Transport, Handling & Storage

If for any reason materials or other items are received or made on site before approval of them has been granted, these shall be transported, handled and stored separately or labelled in such a way in order to, wherever possible, prevent them being incorporated into the works or, should such prevention not be possible, to accurately define the part(s) of the works in which such materials or items were used.

Approvals previously granted for any materials etc. shall be withdrawn if they are not properly transported, handled or stored and otherwise protected against weather or contaminants which may adversely affect their properties. The Contractor has the option of removing such materials or having them retested for approval.

8.0 SPECIFIC REQUIREMENTS FOR I&T (BY SYSTEMS/PACKAGE)

This clause specifies the minimum tests that are specific to the individual systems. It applies in addition to the general requirements (clause 7), i.e. all components have to be tested according the requirements as described under clause 7, regardless if these tests are not explicitly mentioned in clause 8.

However, Contractor shall submit an individual inspection and test plan for each equipment/item/system as applicable for Employer/Engineer (Employer/Engineer) approval. Employer/Engineer reserves the right to demand for any additional test technically required to prove the design/performance of the respective system/item/component apart from the tests given in the test plan submitted by the Contractor.

8.1 Workshop I&T

Plant items shall be tested with the motor/sub-system specifically purchased for the respective item. Where this is not possible because of non- availability of parts or by technical reasons, Contractor shall explain the arrangement used for the tests well in advance for Employer/Engineer's scrutiny providing also technical justification that his solution/substitution fulfils the testing requirements.

8.2 Site I&T

8.2.1Steam turbine units and auxiliaries

Functional Tests:

The Steamfield shall provide a stable steam supply for the following steam turbine tests:

- Steam to Set

- Cold start of turbine/generator and loading up to nominal load (max. allowable load change rate), automatic control of turbine drain and leak off steam system, estimation of starting time

- Generator protection, turbine protection and turbine trip criteria by DCS
- Hot start of the turbine/generator and loading up to nominal load (max. allowable load change rate)
- Operation of turbine/generator at min. load for 1 hour, all controls in auto mode
- Operation of turbine/generator at nominal load for 8 hours, all controls in auto mode
- Automatic function test of turbine stop valves during operation of turbine

  (periodical on-line valve freedom test)
- Automatic load reduction initiated by selected criteria
- Load rejection to idle run at min. and nominal turbine load
- Automatic shutdown of turbine/generator from nominal load to turning gear operation (max. allowable load change rate, system disconnection by reverse power)
- Operation at maximum continuous load within the generator stability curves
- Over-speed test
- Vacuum Tests for the Condenser. The performance of the air extraction equipment shall be proven in a vacuum build-up test where the start-up vacuum with and without gland steam sealing shall be attained within the specified times. The air tightness of the condensing section of the ST and condenser shall be tested under full load service of the ST and at closed suction valve to the air extraction equipment. The resulting loss of vacuum must lie within the specified limits
- Backup ejector (LRVP out of service) test
- Performance test

8.2.2 Steam Systems

- The following tests shall be performed on site during/after the erection and assembly of the system:
- Hydrostatic test
- Functional check of valves
- Characteristics/setpoint check of valves and safety valves
- Cleanliness check of the piping, especially at low points
- Verification of effectiveness of steam blow-out (target bar steam cleanliness test)

8.2.3 Separators

The following tests shall be performed on site during/after the erection and assembly of the system

- Functional check of valves

- Characteristics/setpoint check of valves and safety valves
- Cleanliness check of the piping, especially at low points
- EDV system operation

8.2.4 Brine and Condensate Reinjection Systems

The following tests shall be performed on site during/after the erection and assembly of the system:

- Hydrostatic test
- Functional check of all valves
- Characteristics/setpoint check of valves and safety valves
- Cleanliness check of the pipin g, especially at low points
- Verification of effectiveness of flushing
- Trip of hotwell pump at nominal load

8.2.5 Analysing Equipment

All analysing equipment shall undergo a functional test on site and demonstrate that it is properly calibrated.

8.2.6 Cranes, Hoists & Lifts

8.2.6.1 General

All items of lifting equipment shall be tested to the relevant standard and electric overhead cranes with the associated structural members.

All cranes and hoists shall be assembled at the manufacturers' works and functional tests without load shall be executed to the satisfaction of the Engineer.

The Contractor shall supply to the Engineer all necessary test certificates for individual parts of the installation, such as ropes, carrying cables, carrying chains, pistons, cylinders, hoses, electrical equipment etc. for all cranes, hoists and lifts. Calculations shall be provided for evidence of sufficient drive capacity and strength of the main parts including the drive machinery.

The Contractor shall erect the cranes and their supports and shall load the cranes to the requirements specified in BS 466 or equivalent standards. Deflections of the main girders shall be taken before, during and after proof loading. The Contractor shall demonstrate each of the operations of the cranes using the control devices provided for this purpose. Cross traverse limit switches shall be checked and tested. High voltage tests and insulation values shall be taken upon completion of all tests.

The Contractor will be responsible for providing test weights and materials and dispose of the same after load test.

The Contractor demonstrates to the satisfaction of the Engineer that all the crane motions work correctly and reliably; that all limit switches operate correctly.

The Contractor will be responsible for providing test weights and materials and for disposal of the same after the load test.

Work Performance Tests and Component Tests

Items including hooks, ropes, shackles shall be tested in accordance with the requirements of:

Hooks: BS EN 1677-5 & 3017

Ropes: BS EN 12385

Shackles: ISO 2415

Hydraulic Tests

Gearboxes and hydraulic equipment shall be tested to ensure that it is oil-tight and without defects of workmanship

Gearboxes not subject to pressure shall be tested to 0.1 for 30 minutes. Pressures parts gearboxes and

hydraulic equipment shall be tested to

1.5 times the design pressure.

All hydraulic tests shall be carried out before painting or coating is applied.

Preliminary Function Tests

The Contractor shall demonstrate to the satisfaction of the Engineer or this representative that all the crane motions work correctly and reliably and that all limit switches operate correctly.

Deflection Test on Bridge Girders

Each bridge girder is to be checked for deflection by loading to the equivalent overload capacity with the two ends on simple supports.

Brake Test

Performance of the brakes shall be proven as follows:

- Check of overload trip
- To suspend 125% of the nominal load without drift
- To stop the nominal load within 10 mm of vertical travel when lowering at maximum rated speed
- Deflection of girder and hooks at nominal load

- To lower nominal load without exceeding the hoist motor synchronous speeds
- To lower empty hook at maximum rated speed

During trial operation, the crane shall be tested under operational conditions and with the specified speeds under loads for lifting, lowering inching, braking and transporting. The actual deflection shall be measured and compared with the allowable ones stated in the applicable standards.

A complete inspection and overhaul shall be performed at the expense and in the presence of the Employer's personnel by the Contractor to return the cranes and hoists to the condition of new equipment if, they have been used by the Contractor on Site for erection purposes, prior to being taken over by the Employer.

Overload Tests

Main and Auxiliary hoists shall be tested to lift a minimum test load of

125% at the mid-span of the bridge girders.

The test load will be lifted and moved through the various motions of the crane sufficiently to test all the different gearings, the switchgear and controls.

The above tests may be witnessed by or repeated in the presence of the

Inspection Authority in order to obtain the required Fitness Certificates. All settings shall be recorded by the Contractor and confirmed by the Engineer.

8.2.7 Electrical equipment

Refer to Part C for further inspection and testing requirements.

8.2.8 I&C systems

Refer to Parts D for further inspection and testing requirements.

8.2.9 Civil works

Refer to Parts E for further inspection and testing requirements.

9.0 TESTS ON COMPLETION

9.1Completion Checks and Operation Procedure

The Contractor shall be responsible for the safe and efficient setting to work of the whole of the plant and equipment. The methods adopted shall be to the satisfaction of the Engineer on site and shall be in accordance with any safety and permit regulations in force by the Employer on the site.

The condition for allowing any plant or equipment to be operated is the successful test on completion documented by a duly completed and countersigned erection checklist.

The Contractor shall give sufficient detail in the commissioning program to satisfy the Engineer that the sequence and duration of the proposed setting to work activities are logical and realistic. Details of the Contractor's commissioning staff necessary to achieve the program shall be given.

At least three months before commencing the commissioning of any plant or equipment, the Contractor shall submit for approval fully comprehensive schedules of pre-commissioning checks applicable to each item of the plant and equipment provided. The schedules shall then be used during commissioning as a guide to the methods to be followed and to record the actual activities carried out with the appropriate date.

Each activity on the schedules, when completed to the satisfaction of the Engineer, shall be signed and dated by the Contractor and countersigned by the Engineer.

The Contractor shall also submit for approval schedules of commissioning procedures that he proposes to follow when bringing groups of plant items into service during the commissioning period. These schedules shall detail the tests necessary to ensure the complete and satisfactory commissioning of each section of plant and shall detail operational limitations. The schedules shall be used during commissioning, which shall only commence when the relevant check schedules have been completed.

The schedules shall be updated regularly by the Contractor and a revised copy submitted to the Engineer for approval.

Each activity on the commissioning procedure schedules, when completed to the satisfaction of the Engineer, shall be signed and dated by the Contractor and shall be countersigned by the Engineer.

The commissioning procedures shall ensure that the commissioning of any item of the works does not interrupt the normal operation of any previously commissioned item or any item to be commissioned jointly with equipment of other sections.

When the commissioning of any item or equipment of the section is complete and before the trial operation period is commenced, the Contractor shall carry out such preliminary tests as are necessary to establish that the plant is functioning correctly and efficiently, and shall make any adjustments required.

All test equipment, tools, materials, consumables, labour and spare parts required during commissioning shall be provided by the Contractor. Also the Contractor shall maintain adequate stock of consumables and spare parts at site to fulfil his contractual obligations during Defects Notification Period.

The Tests may be witnessed by or repeated in the presence of the inspection authority in order to obtain the required fitness certificates.

The Contractor shall supply all test equipment, lubricants and other material. The Contractor shall be responsible for providing test weights and materials and their disposal after the load test.

9.1.2 Materials

During the pre-commissioning and commissioning periods and for tests on completion, the Employer will provide the required steam for testing free of charge to the Contractor.

Provided that the permanent auxiliary power supply system for the plant auxiliaries is completed and energized, all subsequent electricity consumed for pre-commissioning, commissioning and tests on completion will be free of any charge to the Contractor.

The Contractor shall provide all other necessary material, apparatus and stores including any necessary spare parts.

9.1.3 Commissioning Management Structure

For Commissioning activities a Commissioning Management Team shall be formed. The Commissioning Management Team will include Engineering and Operations personnel representing the Employer as well as Technical personnel and Supervisors from the Contractor.

The charter of this team will be to safely coordinate the interfaces between

Commissioning activities with a view to:

a) Ensuring safety of personnel

b) Ensuring safety of plant

c) Minimising commissioning time

d) Coordinate commissioning with the GPP

The Contractor shall coordinate this team.

9.1.4 Commissioning Workshop

A minimum of 3 months prior to the commencement of any commissioning activity on-site there shall be a workshop held to discuss and agree on procedures and timing for Tests on Completion. The workshop shall be attended by the Contractor's commissioning manager and his commissioning engineers, by the Employer, and by a GPP representative.

The workshop will include a review of:

a) Commissioning procedures,

b) Work Permit and HSE systems and procedures,

c) Scheduling, timing and cooperation amongst the various interested parties.

At least two 2 weeks prior to the workshop, the Contractor shall submit to the Employer the following documents, in draft form, for review. The workshop shall not commence until these documents have been modified to include any Employer's comments:

a) A detailed Gantt chart showing the timing of Tests on Completion activities on a system by system basis

b) Checklists and ITP's for Tests on Completion.

c) Commissioning procedures for each plant item and sub-system detailing proposed methods for all tests and inspections necessary to establish that the plant is functioning correctly and efficiently, and that all operational limitations are established.

d) Detailed procedures for acceptance and performance tests

e) Details on conformity to site safety rules

9.1.5 Staffing

During pre-commissioning the Contractor shall provide all necessary supervisory and operating staff. The only involvement of the Employer's staff will be in accordance with the training and instruction as defined elsewhere in this specification.

During the commissioning phase the Employer's operating staff will operate the relevant parts of the Work under the guidance of the Contractor's operating staff. During this phase, the operation and safety of the relevant part of the Work shall be the sole responsibility of the Contractor. Notwithstanding the provisions of the Conditions of Contract, that part shall not be deemed to have been taken-over by virtue of such operation by the Employer's operating staff.

The Contractor shall have satisfied himself as to the capability of the Employer's operators to carry out such operations as he may direct and shall remain responsible for the successful performance of such operations.

Throughout the whole of Commissioning Period the Contractor shall provide suitably qualified and experienced operating staff, who shall instruct the Employer's staff in the correct operating procedures.

The Contractor shall provide a team of suitably qualified and experienced engineers and technicians to pre-commission and commission the overall plant. The Contractor shall also ensure that a suitably qualified commissioning engineer from the respective major equipment manufacturer's own service organization shall visit the site to check the erection or installation of each significant plant item, and to supervise the commissioning of the plant item, until the basic functioning of the item has been demonstrated to the Engineer's satisfaction.

Competent Engineers shall be provided to overall supervise the mechanical, electrical, control & instrumentation, commissioning activities. The appointment of these Contractor's engineers shall be subject to the approval of the Engineer.

Subsequent to the issue of the Preliminary Acceptance Certificate for any part of the Work the Employer shall assume full responsibility for the operation thereof, but the Contractor shall retain on site a competent engineer to advise on all aspects of operation and to analyse performance. The competent engineer shall remain on site until the last unit is commissioned. Should the Employer require to extend the time of stay of this engineer, this service shall be provided to him for up to a further six months.

At all times the Contractor shall ensure that his staff and any sub- contractor's or seconded staff observe all prescribed safety rules and permit systems.

9.2 Reporting

9.2.1 Incident Reports

From the date of commencement of the Tests on completion and until the expiration of the Defects Notification Period, all incidents shall be reported under an approved incident reporting system. Each unit or plant trip shall be logged in the DCS system. An incident is defined as any failure or interruption such as an unscheduled trip or inadvertent operator or maintenance action causing a trip, occurring in any portion of the plant covered by this Contract. Incident reports shall be submitted within 36 hours from time of occurrence.

All settings and changes in the set point list shall be recorded in the commissioning documentation added into the O&M Manual and shall become part of the final product manual of the Plant.

Control Systems Reports shall be submitted within 36 hours from time of change, or maintenance activity, or incident. Reports shall be sufficiently extensive to allow the Engineer to perceive the exact details of the

occurrence and as a minimum shall include the part no. of the item and the reference drawing sheet no. and details of software where necessary. When extensive reports are not possible within 36 hours of the occurrence then a brief report shall be submitted firstly, followed in due course by a second subsequent report to provide the necessary elaboration. At the discretion of the Engineer meetings shall be held throughout the Contract to discuss and agree on any action arising from Control System Reports.

9.3 Pre-commissioning Tests

Procedures for all the calibrations, tests and pre-commissioning activities shall be submitted to the Employer for review and comments before implementation. The Contractor shall submit written notification of such activities prior to implementation.

The Contractor shall conduct all necessary pre-commissioning works of Plant equipment to ensure a safe, reliable and successful commissioning of the Plant. The Contractor shall prepare a comprehensive pre-commissioning procedures and checklist and submit to the Employer for review and acceptance.

The pre-commissioning works shall include but not limited to the following:

a) check each pipe or sector for correct installation of controls, instrumentation, valves, drains and vents against piping & instrumentation diagrams;

b) stroke all valves fully. Check, limit switches and positioners, where applicable;

c) check and adjust protective device and interlock settings;

d) check correct reliable functioning and calibration of all automatic controls, instrumentation, supervisory equipment and manual controls;

e) lubrication verification (both quantity and grade of lubricant);

f) check all bolting is correctly tightened;

g) flushing and cleaning of all pipes with temporary strainers;

h) check correct alignment of rotating equipment;

i) check correct setting/elevation of static equipment;

j) check all electrical equipment and connections prior to energization; and

k) installation of temporary pipe lines, and blinds

l) Hydrostatic pressure testing

9.3.1 Cleaning of Steam Piping (Steam Purge)

The Contractor shall clean the Steamfield piping by carrying out a steam purge, and other cleaning techniques as appropriate. The steam purge shall completed in accordance with an appropriate standard (such as NEMA SM 23) or approved equivalent.

Steamfield piping will be progressively blown out in stages starting with the

2 phase systems and separators. The steam blow shall be undertaken to obtain clean steam sufficient to

satisfy the steam cleanliness requirements of the Olkaria IAU power plant. Target bars shall be used to test the cleanliness of the steam.

9.3.1.1 Steam Purge Procedure

The Steam Purge shall be carried out in accordance with the approved

Testing Procedure, but as a minimum requirement shall include the following:

a) The steam purge cycle shall comprise high speed steam flow and thermal shocks by repeatedly providing high and low temperature states. Steam purging shall be carried out during normal working hours and pipes shall be allowed to cool during the night.

b) The steam purge cycle shall be not less than three consecutive days.

c) Pipe cleanliness tests shall be done immediately after satisfactory completion of the steam purge cycle. A polished copper target test piece shall be placed in the temporary discharge piping to check for the number, size and distribution of indentations in the test piece.

The test target shall be 25 mm in width and extend the full length of the discharge pipe. Triangular test targets may be used. The duration of each pipe cleanliness test shall be not less than 2 minutes.

Pipe cleanliness tests shall continue until three consecutive test pieces have each satisfied the following criteria:

1. Indentations shall be less than 0.5 mm in diameter.

2. The number of indentations shall be less than one dent per 25 cm^2 of exposed test piece surface.

The minimum purging steam velocity shall be not less than the maximum operating velocity such that the steam forces applied to any foreign matter in the pipeline are greater than the maximum operating forces.

The Contractor shall state in the approved Testing Procedures the requisite purging velocities for the relevant pipe sizes.

The Contractor shall prepare a detailed procedure for all steam blowing, included the methodology for determining disturbance factors, and submit to the Employer for its approval before commencing steam blowing.

The procedure shall include details of all equipment used for the steam blow (including temporary steam blow pipework), the employer will conduct random internal inspections to confirm acceptable cleanliness.

No uncleaned upstream pipework shall be connected to previously cleaned downstream pipework.

9.3.2 Other Lines

All compressed air piping and tubing shall be blown clear. Main headers shall be blown to atmosphere individually with the air receiver installed. Pipe and tubing to individual instruments, actuators and controllers shall be blown clear by disconnecting air lines at each device.

9.3.3 Functional Tests

Following all pre-commissioning checks and tests, the Contractor shall perform functional tests on the Plant equipment or system. The functional tests shall demonstrate the proper start-up and operation of the equipment or system, under various operating conditions and prove that the equipment or system operates safely and reliably according to the design specifications, including safe shutdown during trip situation. Functional tests shall also be performed to replicate the pre-disassembly functional tests, for comparative purposes.

9.4 Commissioning Tests

Commissioning tests shall be carried out to demonstrate that the plant can perform, under the steady state and transient operating conditions required by the Specification.

These commissioning tests shall demonstrate both the technical suitability of the plant and its control equipment, and the methods recommended by the Contractor for the handling the operation of the plant.

The commissioning tests shall include tests to show that:

a) The plant may be started up and shut-down, in an economical and well- controlled manner, using the methods described in the Contractor's draft instruction manuals, without the use of any special or unusual skills on the part of the operators and without imposing any stress or loading on any plant item beyond that for which it is designed.

b) The plant may be shut-down satisfactorily under emergency conditions using the methods described in the Contractor's draft instruction manuals.

c) The plant may be run stable at any load within its design range, under automatic control.

d) The plant is capable of stable and continuous operation at rated and minimum output with the steamfield in operation under automatic control once on stream.

Commissioning Tests shall be conducted in 2 stages:

1. Standalone steamfield commissioning to confirm safe and reliable operation. This will include venting steam and demonstrating satisfactory pressure control and commissioning of the reinjection system.

2. Commissioning Tests in conjunction with power station commissioning.

Specific Steam field testing will include:

a. Full load test. Operate the Steamfield at Guarantee Case conditions for 8 hours, monitoring the steam flows and pressures and stability of the system

b. Part load tests. Demonstrate stable operation at 25%, 50%, 75% of Guarantee Case conditions, monitoring the steam flows and pressures and stability of the system

c. Load increase, ramping rate test

d. Load rejection test (from 25%, 50%, 75%, 100%, 110% or maximum continuous overload if greater than 110% to house load), including re-synchronization (of the Plant).

e. Load rejection test (from 100% load to 0% load)

f. Steam flow and pressure tests at all Design Cases

g. Demonstrate stable operation while operating with excess steam venting of at least 5% of steam flow

h. Demonstrate stable operation while operating with zero steam venting (Vent station zero flow)

i. Noise level tests

9.5 Optimization

After the first synchronisation of the GPP the Contractor shall start with the

optimization of the steamfield, including the optimization of the closed loop controls, the verification and finalization of the open loop controls, live tests of certain protections, load run backs, automatic changeover of stand-by equipment, change-over of wells without affecting the operation of the unit/s, finalization and adaptation of the printed protocols, operator station screen representations, etc.

This task shall be done under the sole responsibility of the Contractor respecting however, the agreed project time schedule and in accordance with the Engineer's approval.

9.6 Trial Operation

After the unit optimization is completed, the Contractor shall confirm the successful completion in writing and the unit shall perform a 24 hours continuous Full Load Run operation under nominal conditions.

9.6.1 Initial Operation Tests

After completion of the trial run, the Contractor may apply for the initial operation tests. The trial run will be initiated by the end of the commissioning of the plant. During the commissioning of the steamfield all required tests on equipment shall be executed. If the commissioning is finished the steamfield may start with the reliability and trial run. Commissioning clearance certificates shall be approved by Employer/Engineer. The Initial Operation shall be done after the unit/plant optimization and before the Reliability Tests, respectively during the Plant Integration tests.

The Initial Operation is a demonstration of the steamfield operational behaviour under standard, extreme and special conditions. The initial operation program shall be prepared by the Contractor and approved by the Employer/Engineer. At least the following tests as well as tests, which may be required by the grid authority, shall be included.

- Startup times and conditions
- Changeover to standby under different conditions
- Operation in min/max conditions
- Trip/runback conditions
- Critical functional tests
- Operation in abnormal conditions
- Load variations

During the tests the characteristic values shall be continuously logged. For transient operating conditions the curves shall be recorded by the DCS with high resolution. The log sheets and curve prints shall be attached to the report with explanation of the events. The report shall be sent to the Employer/Engineer in the agreed amount of copies.

The Employer, upon successful completion of these tests, shall issue an initial operation test certificate.

9.6.2 Reliability Test

After the Contractor has notified the Engineer and received the Engineer's agreement that the plant is ready for service the plant will be required to operate in commercial service under working conditions within the limits of output specified and either continuously or intermittently, as may be more convenient for the Employer, without failure or interruption of any kind resulting from defect of plant supplied under this Contract, for a period of thirty (30) days.

Operation of the plant during the Reliability Test Period will be the responsibility of the Contractor, but the Employer will provide operating staff to assist during this period that will work under his guidance. The Contractor may request permission to carry out any minor adjustments which may be necessary, provided that such adjustments do not result in reduced output or efficiency.

If any failure or interruption occurs in any portion of the plant covered by this Contract due to, or arising from, faulty design, materials or workmanship (but not otherwise) sufficient to prevent full use of the plant, the reliability test period of thirty (30) days shall re-commence after the Contractor has remedied the cause of defect.

During the Plant Reliability Run Period thirty (30) days not more than four (4) unplanned interruptions will be tolerated if each single outage duration

12 hours is not exceeded and in total the aggregate outage duration of 48 hours is not exceeded.

The effective outage duration will be added to the 30 days Reliability Run period.

I.e. the Reliability Run will continue after remedy of the defect causes and will be extended by the total effective outage time (max. 2 days) in order to maintain the 30 days duration.

If any interruption of the unit/equipment or the entire plant occurs at any time which exceeds twelve (12) hours or if the interruptions exceed four (4) in number, then the Reliability Test Run shall be restarted from Day 0. Minor defects, such as instrument faults or equipment faults requiring the operation of standby plant, shall not constitute a failure of the reliability test, provided that the overall plant continues to operate satisfactorily and that the faults are rectified and are not persistent.

The onus of proving that any defect is due to causes other than faulty design, materials or workmanship shall lie with the Contractor.

9.7 Performance Tests

The Contractor shall complete the following performance tests as a minimum requirement:

a) Geothermal steam flow and pressure at the interface point (steam main) between this Contract and Lot 2.

The Contractor shall demonstrate that the Steamfield can deliver the steam flow and pressure defined in this Specification for all Design Cases at the main steam interface point with Lot 2 contract.

Steam flow shall be measured at the venturi flow meter downstream of the interface point (steam main), compliant with ASME PTC 6 and ASME PTC 19.5.

Steam pressure shall be measured using existing pressure transmitters and a test quality pressure gauge, calibrated before and after by a dead weight tester.

b) Steam Quality (dryness) at the interface point (steam main) between this

Contract and Lot 2

The Contractor shall demonstrate the steam quality at the main steam interface point with Lot 2 contract complies with this specification for all flows and pressures.

c) Steam Quality (chemical constituents)

The Contractor shall demonstrate that the chemistry at the main steam interface point with Lot 2 contract complies with this specification for all flows and pressures

d) Steam Pressure Stability

The Contractor shall demonstrate that the Steamfield complies with this specification for steam pressure stability.

9.7.1 Performance Test Conditions

The Contractor may shut down the Steamfield prior to the performance tests for cleaning and minor adjustments.

The Contractor shall calibrate all instruments used to demonstrate compliance with this specification within 30 days prior to the tests commencing. An accurate measurement of the site barometric pressure shall be made at the start of the performance tests.

The Contractor shall use the GPP venturi steam flow meter to measure steam flow. The installed differential pressure transmitter shall be used in addition to a mercury manometer. The correction curves for the venture will be made available to the Contractor to allow the measured values to be corrected. A full set of calculations shall be provided to the Employer.

The performance tests shall use geothermal fluid from the wells provided by the Employer. The Contractor shall operate and setup the geothermal wells

to the satisfaction of the Engineer and the Employer's local operating staff.

Conditions shall be held steady during the tests, as safe operation permits.

Each test shall be for at least 4 (four) hours from the time that the plant reaches stable operation as determined by the Engineer. Manual measurements of the tests shall be conducted every 15 minutes, and SCADA readings shall be recorded at the instrument scan time, but not longer than at

10 seconds intervals.

The Contractor shall adjust any readings based on instrument correction factors, and then average the readings over the test period. The Engineer may reject any readings that are significantly different from the normal range.

The Contractor shall perform calculations to demonstrate that the measured values comply with this specification.

Where stable operation cannot be maintained for the duration of the test, the test shall be repeated.

9.7.2 Allowable Tolerance

The allowable tolerance for geothermal steam flow and pressure is 1.5% of the guaranteed values. This allows for the cumulative effect of all errors in instrumentation and instrument reading.

9.7.3 Procedure

Performance tests shall be carried out on Steamfield by the Contractor to determine the Steamfield performance as well as the performance of main plant components which shall be separately tested. The tests will be so arranged as to prove the performance guarantees given in the relevant schedules in the various parts.

In the event of any of the performance guarantees not being achieved the respective equipment or plant shall be made available to the Contractor for him to make good by modifying or replacing defective parts of his supply. To enable the Engineer to identify the individual item(s) of plant which is (are) causing the overall plant performance to fail to meet the guaranteed figure(s), the Contractor shall perform acceptance tests as required by the Engineer for any item of plant the Engineer suspects. Facilities shall therefore be provided on the plant for the installation of the Contractor's test instrumentation at the appropriate locations of the components and equipment to enable such acceptance tests to be performed. Such acceptance tests shall be carried out in accordance with the relevant standards which shall be subject to approval by the Engineer.

The Contractor shall submit for approval with his tender suitable correction formulae to enable the guaranteed figures to be adjusted should the average conditions during the test differ from those specified in the performance guarantee schedule. If the correction curves are submitted with the Proposal and are agreed by Employer/Engineer and thus will be part of the Contract Documents no further approval is necessary. If the curves may have to be modified at a later stage, than these curves are subject to the approval by Employer/Engineer.

The Contractor shall submit for approval to the Engineer three (3) months prior to completion of assembly and/or mechanical completion the detailed procedure for conducting the performance and acceptance tests. The procedure shall include the following for each test or group of tests:

1. The sequence of the tests to be conducted.

2. The time duration of each test at each load.

3. The number of test runs at each load.

4. A list of instruments that will be used for each test. The list shall define which instruments are (a) special test instruments, (b) certified, (c) to be calibrated before and after each test, (d) check instruments, (e) station supply instruments. A schematic diagram showing all test points cross- referenced to the instrument list shall be included.

5. All formulae, calculations, conversion factors, curves, correction curves etc., to be used in the conducting of the tests and the calculation of the test results.

6. Sample test reports or data sheets and all specific result sheet forms that will be used for the test.

7. Written procedure and description of conducting the test.

As soon as practicable after the satisfactory completion of the reliability tests, performance tests executed at site shall be carried out. The performance test is limited to that test being described and agreed in the performance test procedure in order to determine that the plant is in accordance with the Specification and Guarantees.

Prior to the tests under this clause the Contractor shall submit with the detailed procedure covering the testing to be undertaken and the methods to be employed. The detail areas of responsibility and items, which specifically require preparation and agreement before the tests, can be carried out.

All test instrumentation shall be supplied by the Contractor and shall be retained by him upon the satisfactory conclusion of all such tests at site unless otherwise specified in this contract.

All costs associated with the supply, calibration and installation of the test instrumentation shall be included in the Contract Price.

All test instruments shall be supplied with up-to-date calibration certificates issued by an independent testing laboratory.

The difference between the certification date and the actual Performance Test start date shall not be greater than 3 months. Where the installed plant instrumentation is used for the tests, calibration checks shall be conducted immediately prior to the tests and shall be witnessed by the Engineer.

The calibrations of all instruments required for guarantee measurements are to be re-checked within 1 month after the performance test. If significant errors are found the Engineer may call for the performance test to be repeated after such errors have been corrected. The Contractor may provide additional check instruments, with certified calibrations, as a back-up to the permanent instrumentation.

9.7.4 Test instrumentation

The method of measuring all quantities and qualities and the measurement tolerances shall be in accordance with the appropriate IEC, EN or other national standards that must be approved by the Engineer.

The definitive conditions required for establishing whether the guarantees are met shall be measured by precision test equipment to be installed by the Contractor in addition to the permanent measuring equipment supplied under the contract.

Where permanent measuring equipment has been installed to the requisite standard suitable for test purposes, this may at the discretion of the Engineer, be acceptable for acceptance and performance test measurements in conjunction with test differential pressure measuring equipment for the flow measurements.

The design of the components and equipment shall provide for the installation and use of the test equipment so as not to interfere with the plant loading or delay the guaranteed completion dates.

The precision test equipment used for the acceptance and performance tests shall be calibrated against standard instruments before the tests, and if required by the Engineer also after the tests. Calibration

records shall be available for inspection by the Engineer.

Pressure gauges shall be calibrated against a certified dead weight tester.

The error of the pressure gauges shall not exceed 0.25% of their range at any indicated value.

Mercury columns and pressure gauges shall where possible be connected in such a way that no allowance for head of water has to be made. When the geodetic head in connecting piping contributes to the indicated pressure reading, a correction shall be applied.

For the measurements of temperature, thermocouples, mercury-in-steel or glass thermometers shall be used.

Thermocouples shall be calibrated at fixed points on the international temperature scale using primary or secondary points. During the performance tests the milivolt output of test thermocouples shall be measured using high quality null-balance potentiometers with the cold junction of the thermocouple immersed in a mixture of melting ice and water.

Mercury-in-steel or glass thermometers shall be calibrated in a temperature controlled bath. The bath shall be continuously stirred and the temperature measured by an NPL calibrated thermometer or equivalent. The error for temperature measuring devices shall not exceed those given in the approved standards.

In cases where flow measurement is necessary for the acceptance tests, the measuring element and its installation must conform to the requirements of the relevant EN, ASME or British Standards. Calibration of flowmeters before installation shall be confined to a visual inspection of the orifice plate coupled to a check on dimensions and sharpness of the orifice. Readings shall also be taken of the pipe bore diameter at several representative points upstream of the orifice plate over a distance of not less than two pipe diameters immediately adjacent to the orifice plate.

The flow shall be calculated on the basis of the constants given in the relevant standards, taking into account all corrections such as viscosity, pipe roughness, lack of edge sharpness etc.

The total tolerance of the flow measurement shall be the root of the sum of the squares of all tolerances.

If the differential pressure is measured by instruments operating according to the force-balance principle, the standard accuracy class of these instruments shall be at least 0.5%. The calibration of the flow measuring instruments shall be in accordance with the following:

- The differential pressure transmitter shall be calibrated by applying a differential pressure to the process connections of the instrument
- The value of this differential pressure shall be measured by a mercury or water or other suitable liquid column depending on the range
- The transmitter output shall be measured by a standard device during calibration of the transducer. The device used to indicate or totalise the measured flow shall be calibrated separately against a standard test instrument.

Steam and water purity shall be determined by means of a conductivity meter calibrated against a known resistance connected across the measuring cell and temperature compensating cell terminals. The resistance used shall have a tolerance not exceeding 1%. Water samples shall be analysed by means of a flame photometer to determine the relationship between conductivity and total dissolved solids. The photometric analysis shall also determine the Na content and other dissolved solids content of the sample.

In cases where the electrical power consumption of an item of plant or the electrical power output is required to be measured, a high quality integrating watt-hour meter with an accuracy of class 0.5 shall be used.

It will be sufficient to produce maker's test certificates for the integrating watt-hour meter, but should the measured value be disputed by either party a further calibration shall be performed.

All services required by the instruments, e.g. air and electricity supplies, shall be adjusted to the values required by the instrument manufacturer's specification prior to the commencement of the acceptance and performance test and shall be kept at these values for the duration of the test.

During the design stage of the equipment the Contractor shall give details of measurements to be made to substantiate that the performance of the equipment meets the requirements of the specification, and in particular shall submit for approval a schedule of performance test instrumentation necessary to demonstrate the guarantees in the performance schedules in the various sections.

The test instrumentation schedule shall quote an appropriate test tolerance for each parameter, including the calorific value of the fuel, and an overall test tolerance for each guarantee value.

After commissioning and during the trial operation period, the Contractor shall test the main closed-loop control systems to demonstrate that the quality of control is within the guarantee limits specified in the corresponding section of this specification. The Contractor shall submit a comprehensive description of each test. This shall include the type and classification of all test equipment. In general such tests shall consist of step changes of a desired value with all important parameters being measured on high speed, multi trace recording devices, preferably of the UV type.

If these tests indicate that any part of the control and monitoring equipment does not perform in a satisfactory manner or is not able to meet the stated figures for overshoot or provide stable control, the Contractor shall improve the control equipment by suitable engineering measures, making full use of all theoretical and equipment engineering possibilities such as load- dependent parameter variation, feed forward of disturbance variable, improved optimization and modification of characteristic curves for control valves and actuators.

9.7.5 Environmental Tests

During the acceptance and performance tests the Contractor shall demonstrate to the satisfaction of the Engineer that the plant emission levels (noise, exhaust gas and waste water) do not exceed the acceptable levels specified in individual sections and as required by the local environmental requirements.

9.7.6 Records and Reports

During each performance and guarantee test run the relevant measuring values will be taken jointly by the Engineer and the Contractor.

After completion of a test run the data sheets will be jointly initialled and three

(3) copies distributed to each of the parties.

The Contractor has to compile the readings and results of sample analyses in a report presenting the results in graphs and tables and showing all necessary calculations and interpretation of the test results with respect to guarantee figures and performance particulars as given.

For each of the specified acceptance and performance tests the Contractor shall evaluate the test figures

and within one month of the completion of the relevant test shall submit to the Engineer for review four copies of the test report containing a complete analysis of the test results.

The Performance Test results will be evaluated in accordance to the Performance Test Procedures and is not subject to Engineers approval. All Parties involved will jointly sign the test results.

9.7.7 Performance Worse Than Guaranteed

After the measured or "as-run" test results have been corrected to the specified conditions, the corrected test results will be directly compared with the plant operation guarantee data provided elsewhere in this specification, to determine whether the contractual requirements have been met.

No "tolerance", "adjustment" or "correction" on the test results will be permitted, for instrumentation error or inaccuracy, the method of testing, or any other cause.

9.8 Warranty

The Contractor warrants during Defects Notification Period that all plant

furnished and work performed under the Contract shall be free from defects in title, design, materials, and workmanship and shall conform in all respects to Technical Specifications and the terms of the Contract, and shall be new and of good quality, if no quality is specified. Employer shall also be entitled to, at no additional cost, the benefits of extended warranties for periods exceeding the Defects Notification Period which are received by Contractor from any of its Subcontractors.

Upon receipt by Contractor of written notice from Employer of any such defect or nonconformity in any such plant, the works or work during the Defects Notification Period, the defect or nonconformity except for normal wear and tear, shall be redesigned, repaired, or replaced by Contractor at a time acceptable to Employer. Contractor shall perform such tests as Employer may require verifying that such redesign, repairs, and replacements comply with the requirements of the Contract. All costs incidental to such redesign, repairs, replacement, and testing, including the removal, replacement, and reinstallation of equipment and materials necessary to gain access, shall be borne by Contractor. Contractor warrants such redesigned, repaired, or replaced works against defective design, materials, and workmanship for a period of 12 months from the date of such repair or replacement of works. Should Contractor fail to promptly make the necessary redesign, repairs, replacement, and tests, Employer may perform or cause to be performed the same at Contractor's expense. Contractor and its surety or sureties, if any, shall be liable for the satisfaction and full performance of the warranties as set forth therein.

The foregoing warrants are exclusive and in lieu of all other warranties whether written, oral or implied. There is no implied Warranty of Merchantability or Implied Warranty of Fitness for purpose.

SECTION VI PART H

PROPOSED WORK PLAN

The bidders to prepare a works program that fits in a contract of Twelve (12) months of practical completion of works. A bidder that does not provide for this program of works will be disqualified.

SECTION VII – STEAMFIELD SPECIFIC REQUIREMENTS

STEAMFIELD SPECIFIC REQUIREMENTS

1. INTRODUCTION

1.1 Project Background

The Olkaria geothermal field is located in Hells Gate National Park in the Kenya Rift Valley about 120 km by road, north of Nairobi and about 35km west of Naivasha town. The geothermal field supports 4 main power plants namely Olkaria I (45MW), Olkaria II (105MW), Olkaria IAU (140MW), Olkaria IV (140MW) and Olkaria V (172MW). The field further supports 15 wellhead generating units with a combined production of 81MW. One more plant is currently under construction namely Olkaria IAU Unit 6 (83MW).

Olkaria IAU 140MW which has been in operation for the last 7 years now requires make-up steam to ensure that the plant receives sufficient steam to enable it to operate at full capacity. Kenya Electricity Generating Company (KenGen) PLC has drilled and tested 3 production wells on well pad OW-50 close to the Olkaria IAU power plant and has identified the wells as suitable candidates for providing make-up steam for the Olkaria IAU power plant. KenGen has since carried out detailed Steamfield design and now intends to procure a contractor to procure materials and install a pipeline to transport the steam from the 3 wells to the power plant and a separator station to process two phase geothermal fluid from well pad OW-50 and a brine line to dispose the brine from well pad OW-50 into a selected reinjection well and one other back up reinjection well. The location map and site plan drawings are provided in the Annexes.

The contract for installation of the separator station and pipelines will be a supply and install contract. The contractor that will be procured will implement the design developed by the employer under the supervision of the employer.

1.2 Project Description

The objectives of the project is to install a fully functional steam field system to process two phase geothermal fluid from the 3 production wells on well pad OW-50, separate the steam fraction and deliver it to a tie in point where the new pipeline will be connected to an existing pipeline and to install and connect a brine line to the selected reinjection wells OW-6 and a backup line to well pad OW-38 reinjection system.

1.3 Project Objectives

The Employer has the following stated objectives for the Contract Works:

Health, Safety and Environmental

a) Health, Safety, and Environmental: Comply with the Employer's policies
b) Achieve zero harm outcome during the project.
c) Through design of new components, improve Health and safety outcomes for future operation and maintenance tasks

d) Comply with the Kenya Wildlife Service's requirements for the construction and operation of a geothermal Steamfield in the Hell's Gate National Park

Plant Performance

a) Use reliable, simple, well-proven technology to achieve safe, reliable operation and maintenance
b) Select equipment that is suitable for silica scaling in the geothermal environment, and size components to provide flexibility for future reservoir changes
c) Achieve: a start reliability of 99%, an availability of 95%, and a forced outage factor of <1%.
d) Facilitate operation of the GPP over the full range of output

Operation & Maintenance

a) Plant that is maintainable
b) Provide Steamfield operating information
c) Provide comprehensive, coherent documentation on the plant to improve maintainability and fault finding

Knowledge Transfer

a) Provide and facilitate knowledge transfer from the Contractor's construction team to KenGen's staff

1.4 Steamfield Description

The 3 production wells on wellpad OW-50 are located on the southern Eastern part of the Olkaria East geothermal field. The production wells on this wellpad are at a slightly higher elevation compared to power plant and also compared to the selected reinjection wells and therefore the two-phase piping will be horizontal going into a separator that will be on wellpad OW-50. The steam line and brine line will both run down hill upto tie in point into Olkaria IAU power plant steam system and wellpad OW-38 brine line system respectively. The project area already has other geothermal wells and pipelines serving existing power plants.

In this project, the fluids from the 3 production wells on well pad OW-50 will feed into one separator vessel. Separation will be done at 12.5g bar g separation pressure to ensure that the separator pressure is high enough to minimize the risk of silica deposition, due to the chemistry of the geothermal resource exploited for this project.

The reinjection wells chosen for the project can utilize gravity flow from the separators to the reinjection well. Pipe lines have been designed for channel flow with fill of 50% or less to allow for enthalpy changes which could increase the brine flow rate. Loop seals on brine line shall be used for level control in the channel flow. Pipelines should follow design pipe routes as far as practical to minimize impacts on the environment.

All pipelines have been designed to be able to be fully drained, with low point drains and high point vents. Pipeline drains for steam lines can be discharged through CDP's into local soakage ponds. Drains for two phase lines and reinjection line low points shall be collected into ponds suitable for 120% of the maximum fluid volume to be drained. Provision for these ponds to be emptied with a portable pump shall be provided. Emergency dump ponds have been provided at the reinjection well pad for emergency dumping of brine should the well be unable to inject.

The project area is inside a wildlife park and animal migration paths shall be maintained for animal movements. Pipe crossings for animals shall be the same as existing types for easy recognition.

1.5 Steamfield Concept Design

Connection of wells on wellpad OW-50

The 3 Production Wells - OW-50A, OW-50B and OW-50C will be connected to one separator vessel. The 2 phase pipelines from the production wells will run horizontally and be directed to the separator via a collector header pipe. Isolation and working valves will be installed at the pipeline. Rupture discs will be installed as a way of protecting the system against over-pressure. Separated brine from the separator station will flow through pressurized piping under the influence of gravity only, to the designated reinjection wells.

The separator station consisting of one separator will be located on the wellpad and therefore Some minimum earth works will be required to level the separator site to create a level ground for installing the separator. The brine will leave the separator vessel and flow downhill to reinjections wells OW-R6 and OW-38 wellpad reinjection system. A flash tank and emergency dumping valves will be provided at well pad for dumping of two-phase in case of malfunction of separator and the reinjection well OW-R6 to dump the brine should the reinjection wells malfunction.

From the separator station, the steam line will run downhill all through passing through wellpad OW-R6 then cross one gorge just after wellpad OW-38 then connected to the line from SN3 in Olkaria II field to Olkaria IAU power plant near well OW-32.

1.6 Equipment Locations & Pipe Routes

All practical steps shall be taken to eliminate low points in the 2 phase, brine reinjection and steam lines. If low points cannot be avoided, then provision shall be made for the collection and proper disposal of drained brine or condensate.

Pipes shall not block roads or access ways. Road crossings shall be below the road through a culvert. Vertical loops shall not be used unless there are clear advantages to the Employer or an underpass is impractical. Vertical loops shall be subject to the approval of the Employer.

2. SCOPE OF WORK FOR THE CONTRACTOR

The Contractor shall procure the materials required for the works, carry out any Factory Acceptance Tests (FAT), Ship the goods, insurance, custom clearance and transportation to site. The contractor will then construct, install, works inspection and certification by any third parties required for the Works to be operated in Kenya, performance testing, warranty and commission the Works, including all matters and things required to provide a fully functioning steamfield. This shall include all Civil, Structural, Electrical, Mechanical, Process, and Control and Instrumentation Works as specified in the design documents

2.1 Project Implementation

1. The contractor shall carry out any additional site surveys required to carry out installations

2. The contractor shall facilitate any statutory requirements for pressure equipment, pressure piping, and pressure vessels in Kenya
3. The contractor shall adhere to quality systems, manufacturing inspection, construction monitoring and documentation review
4. The contractor shall obtain any consents, licenses, permits, local certification that may be required from a contractor

2.2 Steamfield Equipment Installation

a) Production well pads

1. Prepare access passage to well pad OW-50, to separators location on the wellpad OW-50and along the steam and brine pipelines for ease of access and construction works
2. Install security fencing, lighting and local services as required
3. Install the two phase pipework, with valves, bends, drains, vents, insulation and supports to the separator vessel
4. Install Drain Piping, Atmospheric Flash Tank, and drain pond
5. Install Access platforms & stairs as per design
6. Install startup flash tanks at the respective wellpads
7. Install Electrical, instrumentation, controls and actuators, electrical and control panels, and communication as per design

b) Two Phase Pipelines

1. Two phase pipelines, with valves, drains, vents, instrumentation, insulation and supports to supply two phase fluid from the wellheads to the separator inlets for wellpad OW-50
2. Wildlife crossings as shown in the design to comply with the Hell's Gate National Park requirements
3. Low point drain ponds, facilities to pump out of low point drain ponds, and roads to access ponds

c) Separator station

1. Two phase pipework on cluster, valves, drains, vents, instrumentation,
2. Two separators including foundations, all piping, level indicator bridles, valves, instruments, Emergency Dump Valves (EDV) and associated valves and pipework
3. Drain Piping, Atmospheric Flash Tank, and Brine Pond
4. Electrical, instrumentation, controls and actuators, electrical and control panels, communications
5. Access platforms & stairs
6. Access roads

d) Steam Pipelines

1. Steam pipelines from the two separators to the tie in point to existing pipeline near well OW-32 wellpad.
2. Steam pipeline, with valves, instruments, vents, drains, insulation and supports to deliver steam from the separators to the tie-in

3. Wildlife crossings to comply with the Hell's Gate National Park requirements

e) Brine Pipelines

1. Brine pipelines from the two separator to reinjection wells and ponds at OW-R6 and all through to OW-38 well pad reinjection system.
2. Brine pipeline, with valves, instruments, vents, drains, insulation and supports to deliver brine from the separators to the reinjection wells
3. Wildlife crossings to comply with the Hell's Gate National Park requirements
4. Low point drain ponds, facilities to pump out of low point drain ponds, and roads to access ponds
5. Electrical, instrumentation, controls and actuators, electrical and control panels, communications
6. Access platforms & stairs
7. Access roads
8. Pressure Protection
9. Pressure protection system including bursting disks
10. Access ladders and platforms as required to safely operate and maintain the plant

2.3 Mechanical Works

1. Install all pipes, valves, valve actuators, fittings, jointing materials
2. Install all pipe supports, holding down bolts, grouting
3. Insulation of aluminium cladding, painted to match existing green patterned cladding used in Olkaria steamfield
4. Spare parts and special tools required for the maintenance of the Works
5. Further requirements for the mechanical Works are specified as well in detailed design

2.4 Electrical works

1. The works includes all 415V and 230V AC distributions system, ancillary plant, control panels, motorized actuators, cabling, and all design documentation, installation, testing and commissioning of the installation.
2. Lighting for well pads, clusters, vent station, and operation areas
3. Lightning Protection
4. Earthing of all equipment (electrical, mechanical, structural and civil)

2.5 Control System works

1. Sensors and Transmitters
2. Communications systems
3. Control valves
4. Earthing

2.6 Civil & Structural Works

1. Temporary Works required for construction, including sedimentation and storm water control, laydown areas, security fencing for construction Works, and site facilities
2. Site earthworks including construction and access roads, excavations, drainage, bridges and under road culverts for pipe crossings, animal crossings for migratory routes, ground cover and silt control for rehabilitation, making good, landscaping, fencing, fluid storage ponds
3. Upgrade or provide storm water drainage around all well pads, and clusters
4. Provide brine drains for all well pads and clusters
5. Access roads to production and reinjection well pads, and separator clusters
6. Access roads for the operation and maintenance of the pipelines, including access to all ponds, Condensate Drain Points, and all items that require operation and/or maintenance access.
7. Concrete works including foundations for vessels, structures, and pipelines, embedded items, foundations and structure for rock mufflers
8. Access platforms, ladders, stairways for operations and maintenance
9. Security fencing around production and reinjection wellpads and separator clusters, and ponds

2.7 Inspection, Testing and Commissioning

1. Inspection and testing during manufacture and installation
2. Record, document and report on all inspection and testing
3. Pre commissioning of mechanical, electrical and control systems
4. Commissioning of the Steamfield
5. Trial Operation including performance testing to demonstrate performance guarantees
6. Provision of all labour, materials, consumables, and equipment for testing and commissioning

3. PREPARATION OF DESIGN DRAWINGS

The full construction drawings will be provided by the employer. The Contractor shall implement the design works done by the employer. Details of equipment to be installed such as instrumentation, valves, actuators, pipelines, and other items to be provided by the manufacturer from who the contractor will procure. The Contractor shall provide additional equipment if deemed necessary for the operation of the Steamfield.

4. PERFORMANCE OBLIGATIONS

The Contractor shall construct the pipelines as per the design provided by the employer. The contractor shall be responsible for all the quality of the construction materials and the quality of the works to ensure that they meet the standards defined in the design drawings and in the tender document. It is expected that the contractor shall employ international best practices in the construction of the Steamfield

5. ADDITIONAL STEAMFIELD INFORMATION

The wells that shall be connected in this project are as follows:

1. OW-50A
2. OW-50B
3. OW-50C

TECHNICAL SPECIFICATIONS FOR MATERIALS, EQUIPMENT AND WORKS

1.0 PIPING SPECIFICATIONS

Project: Connection of wells OW-50A, OW-50B and OW-50C to Olkaria IAU Power plant.
Service: *Two phase production wells (900 class)*
Pressure limit: 115 barg
Corrosion Allowance: 3.0mm
Design code: ASME B31.1
General Material: CARBON STEEL A53Gr.B

Item	Size	Description	Material Specification	Note
PIPE	½"-14"	SEAMLESS CARBON STEEL SCH 80	A 53Gr. B or A106 or API 5l Gr. B	
PIPE NIPPLES	½"-2"	SEAMLESS CARBON STEEL PBE, TBE, TOE SCH 80 (CUT FROM PIPE)	A 53Gr. B or A106 or API 5l Gr. B	
FITTINGS -WELDOLET(MSS SP 97) - ELBOLET (MSS SP 97) -SOCKOLET (MSS SP 97) - COUPLING -UNION (MSS SP -83)	½" -2"	FORGED CARBON STEEL CLASS 3000 BUTT WELDED TO ASME B16.11 CONNECTIONS TO BE CARBON STEEL, SOCKET WELD UNLESS OTHERWISE STATED.	ASTM A105	1,3
-PLUG SQ OR HEX HEAD -CAP SQ OR HEX HEAD -REDUCING BUSHING HEX HEAD -THREADOLET (MSS SP -97)	1/2" -2"	FORGED CARBON CLASS 3000, SCREWED NPT TO ASME B 1.20.1	ASTM A105	

-ELBOLET (MSS SP -97) -UNION (MSS SP - 83)				
-90⁰ ELBOW -45⁰ ELBOW -TEE -REDUCING TEE -CONCENTRIC TEE -ECCENTRIC TEE -CAP	½" -14"	CARBON STEEL, BUTT WELD TO ASME B 16.9	ASTM A234 Gr. WPB	1,3
FLANGES	½" – 1 1/2"	WELD NECK OR SOCKET WELD OR SOCKET WELD FORGED CARBON STEEL CLASS 900 WITH RAISED FACINGS, ASME B16.5	ASTM A105	2
	2" -14"	WELD NECK FORGED CARBON STEEL, CLASS 900 RTJ TO Gr. II ASME B16.5 GROOVE TO SUIT RING DETAIL	ASTM A105	2
	½" – 1 ½"	BLIND FLANGE, FORGED CARBON STEEL CLASS 900 WITH RAISED FACINGS TO ASME B16.5	ASTM A 105	
	2" – 14"	BLIND FLANGE, FORGED CARBON STEEL CLASS 900 RTJ TO ASME B16.5	ASTM A 105	
BOLTS		STUD BOLT, CARBON STEEL TO ASME B 18.2.1 UNC THREAD TO ASME B1.1	ASTM A 193 B-7	
NUTS		HEAVY HEX NUT, CARBON STEEL TO ASME B 18.2.2 UNC THREAD TO B1.1	ASTM A 194 – 2H	
GASKETS	½" – 1 ½"	316SS, 0.175" THICK METALLIC WINDING 0.125" THICK CENTRE RING, GRAPHITE FILLER, FLEXTALLIC STYLE CGI WITH 316SS INNER RING.		
	2" – 14"	SOFT IRON OCTAGONAL RING TO SUIT CLASS 900 ASME B16.5 RTJ FLANGE		

NOTE

1. FOR PIPELINE BRANCH FITTINGS REFER TO TABLE ON DRAWING TBD.
2. BORE OF FLANGE TO MATCH ID OF PIPE.
3. WELDING ENDS TO MATCH PIPE SCHEDULE OF CONNECTED PIPES.
4. LSAW PIPE TO BE 100% RADIOGRAPH TESTED WITH E = 1.0

ABBREVIATIONS

LR LONG RADIUS WITH A RADIUS OF 1.5 X DIAMETER OF THE COMPONENT

PBE PLAIN BOTH ENDS

RF RAISED FACE

TBE THREADED BOTH ENDS

TOE THREADED ONE END

WN WELD NECK

Project: Connection of wells OW-50A, OW-50C and OW-50C to Olkaria IAU Power plant.

Service: *Two phase production wells and Reinjection line (600 class)*

Pressure limit: 79 barg

Corrosion Allowance: 3.0mm
Design code: ASME B31.1
General Material: CARBON STEEL

Item	Size	Description	Material Specification	Note
PIPE	½"-14"	SEAMLESS CARBON STEEL SCH 80	A 53Gr. B or A106 or API 5l Gr. B	
PIPE NIPPLES	½"-2"	SEAMLESS CARBON STEEL PBE, TBE, TOE SCH 80 (CUT FROM PIPE)	A 53Gr. B or A106 or API 5l Gr. B	
FITTINGS -WELDOLET(MSS SP 97) - ELBOLET (MSS SP 97) -SOCKOLET (MSS SP 97) - COUPLING -UNION (MSS SP -83)	½" -2"	FORGED CARBON STEEL CLASS 3000 BUTT WELDED TO ASME B16.11 CONNECTIONS TO BE CARBON STEEL, SOCKET WELD UNLESS OTHERWISE STATED.	ASTM A105	1,3
-PLUG SQ OR HEX HEAD -CAP SQ OR HEX HEAD -REDUCING BUSHING HEX HEAD -THREADOLET (MSS SP -97) -ELBOLET (MSS SP -97) -UNION (MSS SP - 83)	1/2" -2"	FORGED CARBON CLASS 3000, SCREWED NPT TO ASME B 1.20.1	ASTM A105	
-90º ELBOW -45º ELBOW -TEE -REDUCING TEE -CONCENTRIC TEE -ECCENTRIC TEE -CAP	½" -14"	CARBON STEEL, BUTT WELD TO ASME B 16.9	ASTM A234 Gr. WPB	1,3
FLANGES	½" – 1 1/2"	WELD NECK OR SOCKET WELD OR SOCKET WELD FORGED CARBON STEEL CLASS 600 WITH RAISED FACINGS, ASME B16.5	ASTM A105	2
	2" -14"	WELD NECK FORGED CARBON STEEL, CLASS 600 RTJ TO Gr. II ASME B16.5 GROOVE TO SUIT RING DETAIL	ASTM A105	2
	½" – 1 ½"	BLIND FLANGE, FORGED CARBON STEEL CLASS 600 WITH RAISED FACINGS TO ASME B16.5	ASTM A 105	
	2" – 14"	BLIND FLANGE, FORGED CARBON STEEL CLASS 600 RTJ TO ASME B16.5	ASTM A 105	
BOLTS		STUD BOLT, CARBON STEEL TO ASME B 18.2.1 UNC THREAD TO ASME B1.1	ASTM A 193 B-7	
NUTS		HEAVY HEX NUT, CARBON STEEL TO ASME B 18.2.2 UNC THREAD TO B1.1	ASTM A 194 – 2H	
GASKETS	½" – 1 ½"	316SS, 0.175" THICK METALLIC WINDING 0.125" THICK CENTRE RING, GRAPHITE FILLER, FLEXTALLIC STYLE CGI WITH 316SS INNER RING.		
	2" – 14"	SOFT IRON OCTAGONAL RING TO SUIT CLASS 600 ASME B16.5 RTJ FLANGE		

Project: Connection of wells OW-50A, OW-50C and OW-50C to Olkaria IAU Power plant.
Service: *Two phase production wells, two phase header and Steam line (300 class)*
Pressure limit: *42 barg*
Corrosion Allowance: 3.0mm
Design code: ASME B31.1
General Material: CARBON STEEL

Item	Size	Description	Material Specification	Note
PIPE	½"-14"	SEAMLESS CARBON STEEL SCH 40	A 53Gr. B or A106 or API 5l Gr. B	
	20"	LSAW CARBON STEEL SCH 40	A 53Gr. B or A106 or API 5l Gr. B	
PIPE NIPPLES	½"-2"	SEAMLESS CARBON STEEL PBE, TBE, TOE SCH 40 (CUT FROM PIPE)	A 53Gr. B or A106 or API 5l Gr. B	
FITTINGS -WELDOLET(MSS SP 97) - ELBOLET (MSS SP 97) -SOCKOLET (MSS SP 97) - COUPLING -UNION (MSS SP -83)	½" -2"	FORGED CARBON STEEL CLASS 3000 BUTT WELDED TO ASME B16.11 CONNECTIONS TO BE CARBON STEEL, SOCKET WELD UNLESS OTHERWISE STATED.	ASTM A105	1,3
-PLUG SQ OR HEX HEAD -CAP SQ OR HEX HEAD -REDUCING BUSHING HEX HEAD -THREADOLET (MSS SP -97) -ELBOLET (MSS SP -97) -UNION (MSS SP - 83)	1/2" -2"	FORGED CARBON CLASS 3000, SCREWED NPT TO ASME B 1.20.1	ASTM A105	
-90º ELBOW -45º ELBOW -TEE -REDUCING TEE -CONCENTRIC TEE -ECCENTRIC TEE -CAP	½" -14"	CARBON STEEL, BUTT WELD TO ASME B 16.9	ASTM A234 Gr. WPB	1,3
FLANGES	½" – 1 1/2"	WELD NECK OR SOCKET WELD OR SOCKET WELD FORGED CARBON STEEL CLASS 300 WITH RAISED FACINGS, ASME B16.5	ASTM A105	2
	2" - 20"	WELD NECK FORGED CARBON STEEL, CLASS 300 RAISED FACING TO Gr. II ASME B16.5	ASTM A105	2
	½" – 1 ½"	BLIND FLANGE, FORGED CARBON STEEL CLASS 300 WITH RAISED FACINGS TO ASME B16.5	ASTM A 105	
	2" – 20"	BLIND FLANGE, FORGED CARBON STEEL CLASS 300 WITH RAISED FACINGS TO ASME B16.5	ASTM A 105	
BOLTS		STUD BOLT, CARBON STEEL TO ASME B 18.2.1 UNC THREAD TO ASME B1.1	ASTM A 193 B-7	
NUTS		HEAVY HEX NUT, CARBON STEEL TO ASME B 18.2.2 UNC THREAD TO B1.1	ASTM A 194 – 2H	
GASKETS	½" – 1 ½"	316SS, 0.175" THICK METALLIC WINDING 0.125" THICK CENTRE RING, GRAPHITE FILLER, FLEXTALLIC STYLE CGI WITH 316SS INNER RING.		
	2" – 20"	SOFT IRON OCTAGONAL RING TO SUIT CLASS 600 ASME B16.5 RTJ FLANGE		

2.0 VALVES

Gate valves

VALVES

Valves should meet the following requirements:

- Basic design in accordance with applicable requirements of API 602 specifications.
- Wall thickness should be in accordance with API 602.
- Ends flanged and drilled in accordance with ANSI B16.5

- Face to face dimensions to be in accordance with ANSI B16.10.
- Pressure/temperature rating to be in accordance with ANSI B16.34
- Pressure test to be in accordance with API 598.
- Materials for various parts of the valves should be as follows
    a. Body to be cast carbon steel to ASTM A216 Gr. WCB
    b. Seat to be carbon steel to be ASTM A105
    c. Shaft to be stainless steel ASTM A564 Gr. 630
    d. Gate to be Cast stainless steel to be ASTM A217 Gr, CA15
    e. Bonnet to be cast carbon steel to ASTM A216 Gr. WCB
    f. Basic Design and wall thickness to be in accordance with applicable requirement of API 600 specifications
    g. Ends flanged and drilled in accordance with ANSI B16.5
    h. Pressure test to be in accordance with API 598 standard
    i. The wheel to be manually operated.
    j. The flanges of rating class 300 and below to be raised facing while class 600 and above should be Ring type joint (RTJ).

3.0 SEPARATOR AND FLASH TANKS

3.1 SEPARATORS

1	TYPE	VERTICAL WEBRE TYPE (CYCLONE)
2	GENERAL DIAMETER	1200MM
3	GENERAL HEIGHT	3855MM
4	MATERIAL OF CONSTRUCTION	SA 516 Gr. 70
5	PLATE THICKNESS	16MM
6	TWO PHASE INLET NOZZLE	14" STD
7	TWO PHASE INLET FLANGES	14" CLASS 300
8	BRINE LINE OUTLET NOZZLE	4" STD
9	BRINE LINE OUTLET FLANGES	4" CLASS 300
10	MANHOLE SIZE	DN 600 XS WITH CLASS 300 FLANGE
11	SHOULD HAVE SUPPORT SKIRT OF HEIGHT 2M AND MATERIAL THICKNESS OF 20MM	
12	STEAM OUTLET	14" STD NOZZLE WITH CLASS 300 FLANGE
13	THE SEPARATOR TO BE FABRICATED IN ASME APPROVED FACILITY (WORKSHOP)	
14	PROVIDE FOR THIRD PARTY INSPECTION	
15	SHOULD BE INSULATED BY 55MM CALCIUM SULCATE AND ALUMINIUM CLADIING	

3.2 FLASH TANK

1	TYPE	VERTICAL STEEL TYPE
2	GENERAL DIAMETER	3000MM
3	GENERAL HEIGHT	7500MM
4	MATERIAL OF CONSTRUCTION	SA 516 Gr. 70
5	PLATE THICKNESS	12.7 MM
6	BLOW LINE INLET	28" STD

4.0 STEAM TRAPS

1	TYPE	INVERTED BUCKET
2	SERVICE FLUID	GEOTHERMAL STEAM CONDENSATE
3	CORROSIVE/EROSION	CHLORIDES/H2S
4	RATED PRESSURE	15.3 BAR
5	RATED TEMPERATURE	202 DEGREES CENTIGRADE
6	BODY MATERIAL	FORGED/ CAST STEEL TO ASTM A105/ A216 WCB
7	CAP	FORGED/ CAST STEEL TO ASTM A105/ A216 WCB
8	INTERNALS	316 STAINLESS STEEL
9	BOLT AND NUTS	TO ASTM A193 Gr. B7 & A 194 Gr. 2H
10	CONNECTION SIZE	¾"
11	CONNECTION TYPE	NPTF
12	ORIENTATION	HORIZONTAL
13	ASSOCIATED PIPES AND FITTINGS	2" STAINLESS STEEL PIPE AND FITTINGS, STRAINER AND BYPASS PIPE.

5.0 INSULATION

Insulation should be calcium silicate with specifications according to C 533 – 95.

The cladding material to be 0.8 mm thick Aluminium that will be factory painted with colour that will be agreed with the Employer.

6.0 PIPE SUPPORTS

- Minimum concrete cover to reinforcement shall be 75mm
- All structural concrete shall have a minimum compressive cubic strength of 30Mpa at 28 days,
- Reinforcement shall be deformed bars Grade 460 A type 2 or Grade 460B type 2 conforming to BS 4449 - 1997.
- Pipe columns to be Grade 275Mpa steel, Seamless to ASTM 53, ASTM 106 and API 5L.
- Tolerances for pipe installation of pipe supports;
    - Maximum tolerance on plain location of steel column shall be 25mm in any direction.
    - Maximum tolerance on top elevation of steel column to shall be 25mm.
- Steel pipe columns to be cast directly into concrete foundations clean pipe column of any dirt, oil and grease prior to placing pipe columns shall be shop primed down to a depth of 200mm below the top of concrete prior to casting.

- Contractor to paint welds and interface between steel pipe column and concrete after installation of pipe support heads where paint will not seal shrinkage cracks between pipe column and concrete fill cracks with non-shrinkage cement based grout before painting.
- The minimum embedment depths are based on volcanic ash. If during excavation it is found that soil is different, contact the Engineer for revised embedment requirements.
- The contract may choose to fully embed the pipe column in the pipe.

6.0 ELECTRICAL WORKS

The proposed separator station and production wellpad are adjacent to existing well pad OW-26 which is already supplied with 3.3kV main ring circuit and a 3.3kV/415V transformer. The reinjection well OW-R6 will also receive power from well pad OW-26.

Because the separator station and production wellpad are close to well pad OW-26, they will be supplied with the 415V power from existing transformer at well pad OW-26. This will require laying of a 415V underground cable to the separator station and extended to the well pad. To supply reinjection wellpad, a new 3.3kV underground cable will be laid from the main ring circuit at well pad OW-26 to wellpad OW-R6. The power requirements at the production wellpad, separator station and reinjection wellpad will include lighting, powering of instruments such as transmitters and powering of motorized actuators.

7.1 Electrical Scope

The electrical scope will include the following;

- Supply 415V power from the transformer at wellpad OW-26 to the separator station via a suitably sized armored 415V underground aluminium power cable
- Install the 415V distribution board and lighting system at the separator station
- Connect the utility points including transmitters and motorized actuators
- Extend the armored 415V underground aluminium power cable from the separator station to production wellpad OW-50
- Install the 415V distribution board and lighting system at the production wellpad
- Connect the utility points including transmitters and motorized actuators
- Supply and install an underground armored 95mm2 aluminium power cable to connect the existing ring main unit at well OW-13 to the separator station and run along the brine pipeline to wellpad OW-R6.
- Install the 415V distribution board and lighting system at the wellpad OW-R6.
- Connect the utility points including transmitters and motorized actuators

7.2 Details of requirements

Below is a summary of the electrical requirements under this project:

- All the electrical system equipment and materials to be supplied and the installation procedures should comply with international electrical standard.
- Armored cable 95mm2 Aluminium for underground transfer of 3.3kV power from wellpad OW-13 to wellpad OW-R6.
- Armored cable, 60mm2 aluminium for underground transfer of 415 V power from transformer at wellpad OW-26 to wellpad OW-50 via the separator station to be installed.
- 415V distribution boards at wellpad OW-50 and OW-R6 and at the separator station
- Standard earthing system on all the electrical systems
- Standard outdoor lighting system at wellpads OW-R6 and OW-50 and at the separator station.

7.3 Contractors works scope

The contractor will implement the works as described above and as indicated in the single line diagrams attached. The contractor will adhere to acceptable international standards and practices in the installation

of the electrical systems described herein. Specifically, the contractor's scope will be;

- Estimate the quantity of electrical materials and works described above
- Provide a cost in the tender prices
- Procure the materials and implement the installation works as described and in accordance to international standards
- Test and commission the system
- Provide the relevant product documentation as supplied by the manufacturers

8.0 INSTRUMENTATION AND CONTROL

1. Control System Philosophy

The requirement is that the instrumentation and control under this contract shall be independent of any existing system, shall be operated through a local control panel with an operator interface, preferably a touch screen. The control system supplied under this contract shall have an operator interface, local alarm indication and local field instrument measurement together with those specified on individual field instruments.

The control system shall allow for data exchange to and from the field system so that the operator has access to field instruments data and control, measured variables, status, alarms and sequence of events.

2. Operating Logic

The operating logic for the separator station and well controls shall reside in PLCs (Programmable Logic Controllers) associated with the steam field instruments data, with the panel system acting as the SCADA (Supervisory Control and Data Acquisition) interface to the operating logic and measurement information.

3. Control Design

The Contractor shall provide the complete design and supply all equipment, install and commission an integrated control system to provide the complete functional operation of the new production, separation and steam supply process. The control system shall include, but not limited to;

a) Panel mounted programmable logic controller (PLC) based systems to execute all the process protection, emergency shutdown and any tripping logic, alarm generation, and outputs to the controlled devices for the wells and separator station,
b) Strictly local I/O or data communications to actuators mounted in the separator station,
c) Combined AC distribution switchboard and PLC cubicle as required,
d) All instrumentation, including at least the instruments contained on the P&ID's, to allow full monitoring of all parameters required for monitoring/control and auxiliaries,
e) Data communications to actuators or intelligent instrumentation as required,
f) A control system network for data communication between devices, fully redundant and monitored for loss of redundancy,
g) All the necessary hardware (including routers, gateways, switches etc.) to allow communication to the operator interface and
h) Hardwired tripping systems specifically required for protection separate to the PLC. The PLC shall fully monitor the integrity of all hardwired systems.

4. Design

A complete schematic design shall be provided for the PLC cubicle and AC switchboard. The design shall include allocation of AC and DC supplies, terminals, fuses, MCBs, relays, module numbers, rack numbers, slot numbers, channel numbers, module connections and any other related details. The Contractor shall provide a complete electrical design for all of the works provided. This shall include;

a) All schematics and wiring drawings,
b) Connection drawings,
c) General equipment arrangement drawings and plant location drawings,
d) Earthing and lightning drawings,
e) All operational and maintenance manuals,
f) All technical data sheets and
g) Parts list including brand and part number of all hardware.

The drawings shall be a comprehensive set, fully cross referenced and complete with all data on the supplied items and full details on the connection to each item.

5. Field Mounted Panel

The PLCs and the AC/DC Distribution systems and any ancillary equipment shall be mounted in self-contained field mounted panel. The field mounted AC Distribution Panel and the PLC panel shall have;

a) A totally enclosed IPS65 stainless steel free standing panels mounted on a plinth, inclusive of internal lighting, a single phase 230V power point, heat shield, with front opening lockable doors complete with 3 point securing locks,
b) An incoming main breaker and power monitor,
c) A change over switch and provision for connection of an external power supply,
d) An AC distribution system complete with barriers to eliminate any human contact to live parts,
e) A PLC system complete with processor, I/O, terminals, communication cards,
f) A 24VDC battery backup supply via sealed lead acid batteries and applicable charger complete with 24VDC under voltage alarm. Anti-condensation heaters with thermostat control and
g) A drawing sleeve on inside door

6. Conformal Coating

All electronic components shall have an approved conformal coating suitable for the geothermal environment.

7. Spare Capacity

An appropriate level of spare capacity for I/O points, network switch ports, cabling, spare cores, and terminations shall be supplied. As a minimum there shall be;

a) 20% spare installed I/O of each I/O type and 10% spare on each I/O card,
b) 20% additional I/O card capacity including all fuses, terminals and connections,
c) Two unused ports for Ethernet switches and bridges,
d) 40% processor memory capacity,
e) No greater than 60% processor loading at completion,

f) Correctly terminated spare cable cores to terminal blocks and
g) Correctly identified spare cable cores in the as built I/O schedule.

8. Backup Power Supplies

A 24VDC battery backup supply via sealed lead acid batteries and applicable float and boost charger complete with 24VDC under voltage fault alarm and all charger alarms shall be supplied for each PLC processor/ I/O rack assemblies and for each remote I/O rack assembly.

The battery systems shall maintain communication and supply to the field instruments for at least 30 minutes generally under power failure.

The charger shall be sized to recharge flat batteries in 4 hours with normal load resumed.

The Contractor shall provide loading calculations to support the sizing of the charger and batteries.

9. Field Junction Boxes

Where required for connection of multiple field instruments and the like the contractor shall provide local field mounted junction boxes. These shall be IP65 rated and constructed of stainless steel, with a single or double lockable door. All field junction boxes shall be mounted at a height to allow easy maintenance access.

10. Control Architecture Documentation

The Contractor shall produce and submit for review at least the following for the completed design;

a) Control Architecture diagrams showing the total arrangement of the control system,
b) IT, network and communications system diagrams inclusive of data stream identification, and IP addresses and
c) Control Logic Drawings derived from the functional specification.

11. Instrumentation and Control Valves

The Contractor shall supply, install, calibrate, test and commission all field instrumentation and valving and allow for the design and installation within the field control panel of any required interface equipment, power supply and distribution.

12. Test Equipment

The Contractor shall provide the following test equipment for the PLC and instrument system and hand over at the completion of the works;

a) One medium range rugged laptop PC complete with all calibration software including but not limited to Valve link software with 100 tags and drivers for all software adjusted instrumentation,
b) One set of device communicator and
c) Two pieces of USB isolated Hart modems.

13. Dry Commissioning

The above systems and facilities shall be commissioned and in service prior to the commencement of Wet Commissioning: The Contractor shall develop a Dry Commissioning plan.

The dry commissioning shall include:

a) Livening of the control systems via the permanent power system,
b) Establishment of communication system between the PLC's and the operators interface,
c) Point to point proving of the memory locations of the PLC to the operator interface and
d) Provide PLC functional performance tests on site.

14. Wet Commissioning

Wet Commissioning and the associated Tests on Completion shall consist of all tests with the actual fluid control to progressively prove the correct operation, output and efficiency of complete steam reticulation system.

Tests on Completion shall demonstrate fitness prior to the Reliability Run and commercial operation by the Employer. Tests on Completion shall be conducted on all equipment, systems and facilities provided for the Works and shall comprehensively demonstrate correct, reliable and safe operation in accordance with the requirements of the Contract.

Following the pre-requisite commissioning tests the Contractor shall carry out Tests to demonstrate any Guaranteed Performance Levels. Details of the proposed Tests on Completion shall be submitted to the Employer for review and comment, as described in the Design Program.

Tests on Completion shall include;

a) The tests required by the applicable standards,
b) The relevant inspection and tests as specified in the Contract,
c) PLC site acceptance tests (SAT), including appropriate capacity, stability, performance, reliability and availability tests,
d) Communications systems SAT, including capacity, stability, performance, reliability and availability tests,
e) Performance Tests and
f) Such other inspection and tests as may be necessary to demonstrate compliance with the Contract.

9.0 RAPTURE DISCS

a. The rapture disk to be universal Reverse acting type.
b. For two phase (vapour and liquid) service and pure steam service
c. Operating Ratio: 90% of Marked Pressure or 95% of the low side of the applicable performance/rupture tolerance for burst pressures greater than 40 psi or 90% of the low side of the applicable performance/rupture tolerance for burst pressure less than 40 psi
d. Should be manufactured and certified to ASME Section VIII paragraphs UG 125 through UG 137
e. The material of construction should be resistant to corrosive geothermal service fluids.

Holders

The URA rupture disk is designed for use in the "URA-I" or "URA-PT" pre-torque insert-type design

The flat "bite- type" seal makes the assembly leak-tight without the need of any gaskets. The outlet bore has the same cloverleaf shape to provide support to the shear ring for higher pressure disks

The URA-I and URA-PT holders are designed to fit between standard pipe flanges.

10.0 SOFTWARE

The contractor will purchase the following software in readiness to hand over to the Employer. The software should be genuine and authorized by the manufacturer for East Africa.

1. 5 **NODE** licenses for Auto PIPE Nozzle

The software will be accompanied by an appropriate training to enable the staff to start using the licenses. The bidder will provide a proposal on how best to cover the training including the duration and the trainers.

11.0 STAFF TRAINING

The contractor will arrange a training for a period of at least 4 weeks in Steamfield design to be achieved as follows.

- The contractor to procure a well reputed Consulting firm with experience in Steamfield design and supervision especially in Olkaria to offer the training.
- The training to be carried out at the Consultants office so that members of staff can interact with various skilled personnel on different aspects.
- The members of staff to be trained will include
    1. 2No. Civil structural Engineers.
    2. 5No. Mechanical Engineers
- The costs to be incurred by the contractor will include Cost of paying the training firm, facilitation of travels and coordination of the training to success and local transport while in the country of the training.
- KenGen will pay for air tickets and accommodation of staff while in the training.

12.0 STAFF TRAINING

The training will cover the following aspects:

- Overview of Geothermal Reservoir
- Overview of Design of geothermal power plants
- Process design of geothermal Steamfield and power plant.
- Sizing of all Steamfield components which include, pipes, valves, separators, Atmospheric flash tanks, steamtraps, insulation and cladding, rapture disks, Vent stations and their control valves.
- Mass and Heat balance
- Design of Steamfield Process flow diagrams and P&IDs
- Overview of Chemistry in Steamfield flow process
- Steamfield Mechanical design
- Stress analysis in Steamfield design
- Design of pipe supports for Steamfield
- Civil and structural design pipe supports

- Corrosion control
- Testing and commissioning of geothermal Steamfield.

The contractor will prepare a proposal covering all the above aspects of Steamfield design to be considered during evaluation.

13.ASME STANDARDS AND DESIGN BOOK

13.1 ASME STANDARDS

- ASME B31.1 Power Piping Design Code
- ASME B31.3 Process Piping Design Code
- ASME VIII Div 1 Boiler and Pressure Vessel Design Code, Division 1: Rules for Construction of Pressure Vessels.
- ASME VIII Div 2 Boiler and Pressure Vessel Design Code, Division 2: Alternative Rules.
- ASME B16.5 Pipe Flanges and Pipe Fittings
- ASME B16.9 Factory Made Wrought Butt-welding Fittings
- ASME B16.10 Face-to-face and End-to-end Dimensions of Valves
- ASME B16.11 Forged Fittings, Socket-welding and Threaded
- ASME B16.20 Metallic Gaskets for Pipe Flanges - Ring-Joint, Spiral-Wound and Jacketed.
- ASME B16.34 Valves - Flanged, Threaded and Welding End
- ASME B16.36 Orifice Flanges
- ASME B16.47 Large Diameter Steel Flanges (Series A Flanges)
- ASME B18.2.1 Square and Hex Bolts and Screws
- ASME B18.2.2 Square and Hex Nuts
- ASME B36.10M Welded and seamless wrought steel pipe
- ASME B36.19 Stainless Steel Pipe
- ASME B73.1 Horizontal End Suction Centrifugal Pumps for Chemical

13.2 ASTM STANDARDS

- ASTM A36 Specification for Structural Steel
- ASTM A53 Specification for Pipe, Steel, Black and Hot-Dipped, Zinc coated
- Welded and Seamless
- ASTM A106 Specification for Seamless Carbon Steel Pipe for High-
- Temperature Service
- ASTM A193 Alloy Steel & Stainless-Steel Bolting Materials
- ASTM A194 Carbon & Alloy Steel Nuts
- ASTM A283 Specification for Low and Intermediate Tensile Strength
- Carbon Steel Plates
- ASTM A516 Specification for Pressure Vessel Plates, Carbon Steel, for
- Moderate and Low Temperature Service

13.3 ANSI/MSS STANDARDS

- SP-58 –2018 Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation

13.4 STEAMFIELD DESIGN BOOK

- Geothermal Engineering Fundamentals & Applications by Arnold Watson

14.0 FACTORY ACCEPTANCE TESTS

The following factory acceptance tests will be carried out by the Employer

1. PIPES
2. SEPARATOR
3. VALVES

The Employer will take care of Air tickets for 4 No. staff for each FAT trip, accommodations, airport transfers while the Contractor will facilitate visa applications, local transport at the manufacturer's country and factory visits.

15.0 PRELIMINARIES

Preliminaries will comprise but not limited to the following items;

a) Mobilization
b) Standard and equipped site office
c) Performance bond
d) All relevant Insurances as will be agreed by the Employer
e) Seeking for any relevant licenses and approvals from relevant authorities
f) Third party inspections where applicable
g) Compliance to Health and safety requirements
h) Maintenance and operation manuals
i) Storage of materials
j) Electricity and other utilities for construction.
k) Demobilization

16.0 LAPTOPS

The contractor will supply 5 laptops with the following specifications.

PROCESSOR	10th Generation Intel® Xeon® W-0885M vPro™ with Intel® UHD Graphics (2.4 GHz base frequency, up to 5.3 GHz with Intel® Turbo Boost Technology, 16MB cache, 8 cores)	MANDATORY
Chipset	Mobile Intel® WM 490	MANDATORY
Integrated Graphics	Intel® UHD Graphics	MANDATORY

Graphic card	NVIDIA® Quadro® T2000 with Max-Q Design (4 GB GDDR6 dedicated)	MANDATORY
DISPLAY	Next Gen HP Dream Color display 15.6" diagonal UHD IPS HDR 400 eDP1.4 + PSR2 anti-glare BV LED-backlit and ambient light sensor 600 nits 100% DCI-P3 (3840 x 2160)	MANDATORY
OPERATING SYSTEM	Windows 10 Pro for Workstations 64 bit for business	MANDATORY
STORAGE AND DRIVES*	1TB PCIe NV Me TLC M.22280 Solid State Drive **External USB DVD-RW drive**	MANDATORY
DRIVE CONTROLLERS	PCIe Gen 3 x 4 lanes NVMe Solid State Drive	MANDATORY
MEMORY	16 GB DDR4-2667 ECC SDRAM Supports Dual Channel Memory1 Slots are customer accessible / upgradeable	MANDATORY
NETWORKING/COMMUNICATIONS	LAN Integrated Intel® I219-LM GbE, vPro® Integrated Intel® I219-V GbE, non-vPro WLAN Intel® Wi-Fi 6AX201 (2x2) and Bluetooth® 5 combo, vPro® Intel® Wi-Fi 6 AX201 (2x2) and Bluetooth® 5 combo, non- vPro	MANDATORY
AUDIO/MULTIMEDIA	Audio by Bang & Olufsen, dual stereo speakers, World Facing Microphone dual array digital microphone1, functions keys for volume up and down, combo microphone/headphone jack, HD audio	MANDATORY
Camera	720p HD camera; 720p HD IR camera	MANDATORY
KEYBOARDS/POINTING DEVICES/BUTTONS & FUNCTION KEYS	**Keyboard**: Premium Quiet Keyboard, full-size, spill-resistant, backlit, a Programmable Key, with sperate numeric keypad, DuraKey, touchpad with glass surface, multi-touch gestures and taps enabled **Pointing Devices:** Dual point stick; Touchpad with multi-touch gestures enabled, taps enabled as default; Precision Touchpad Default Gestures Support	MANDATORY

SOFTWARE AND SECURITY	Workstation ISV Certifications Performance Advisor Security Management Absolute persistence module Absolute persistence module 6 Device Access Manager Fingerprint Sensor Manageability Integration Kit Gen411 Power On Authentication Security lock slot12 Trusted Platform Module TPM 2.0 Embedded Security Chip with Windows 10 (Common Criteria EAL4+ Certified) (FIPS 140-2 Level 2 Certified) Master Boot, Record security Pre-boot authentication Windows Defender10 Client Security Manager Gen57, 16 BIOSphere Gen6 5 Sure Recover Gen3 Sure Start Gen6 5, 14 Secure Erase 15 HP Sure Sense17, Secure Platform18 Sure Click, Sure Run Gen3 Tamper Lock, Sure View Reflect Smartcard	MANDATORY
POWER & BATTERY	Long Life 8-cell, 94 Wh Li-ion polymer2 Up to 16 hours 15 minutes, 150 W Slim Smart external AC power adapter, 150 W power adapter is configurable with NVIDIA Quadro T1000 and T2000 configurations	MANDATORY
WEIGHTS & DIMENSIONS	Dimensions (w x d x h): 14.06 x 9.55 x 1.02 in; 35.7 x	MANDATORY
PORTS/SLOTS	1 smart card reader 1 SD 4.0 Media Card Reader Left side 61 RJ-45 1 USB 3.1 Gen 1 (charging) 1 USB 3.1 Gen 1 1 headphone/microphone combo Right side6 1 power connector 2 USB Type-C® (Thunderbolt™ 3, pass through support Display Port™ 1.42 , USB 3.1 Gen 2, with BC 1.2) 1 Mini DisplayPort™ 1.4 1 HDMI 2.0b1	MANDATORY

SERVICE AND SUPPORT	3-years and 1-year limited warranties and 90 day	
Fingerprint reader	Fingerprint	MANDATORY
ANTI-THEFT	cable Lock	MANDATORY
Software	Bing search for IE11; Hotkey Support; Noise Cancellation Software; Performance Advisor; Support Assistant; Native Miracast support; Connection Optimizer; Cloud Recovery; ZCentral Remote Boost Software;	
Warranty	a 3-year standard limited warranty	MANDATORY
Environmental	Low halogen	MANDATORY
Wireless technologies	Optional Near Field Communication (NFC)	MANDATORY

Digital Wireless Mouse Technical Specifications	**Sensor technology** • Darkfield high precision • Nominal value: 1000 dpi • DPI (Minimal and maximal value): 200 to 4000 dpi (can be set in increments of 50 dpi) **Buttons** 7 buttons (Left/Right-click, Back/Forward, App-Switch, Wheel mode-shift, Middle click) Scroll wheel: Yes, with auto-shift Thumbwheel: Yes Gesture button: Yes Wireless operating distance: 32.81 ft (10 m) **Battery**	MANDATORY

17.0 ENVIRONMENTAL RESTOTARATION AND WELLPAD FENCING

17. 1. Environmental Restoration

All disturbed area MUST be restored as much as possible to the way they were before excavation and installation works of connecting the makeup wells. The restoration will involve the following activities:

- Preparation of affected grounds and planting of grass specified by the Employer.
- Installation of gabions by use of back filling, use of stones bound in standard gauge chain links.
- Drainage of condensate and any storm water from the installed works.

17.2 Fencing of well pads

Fencing will be as per specifications given in the Bills of quantities.

SECTION VIII– PRICE SCHEDDULES

PRICE SCHEDULES/BILL OF QUANTITIES

1.0 Preamble

The Price Schedules shall be read in conjunction with the Instructions to Bidders, General and
Particular Conditions of Contract and the Employer's Requirement and Technical Specifications

The contractor will apply for payment after every two months the Engineers will evaluate the works done and advise the contractor invoice the agreed amount.

The Schedules may not generally give a full description of the works to be performed and the plant or equipment to be supplied under each item. Bidders shall be deemed to have read the Employer's Requirements and other sections of the Bidding Documents and reviewed the Drawings to ascertain the full scope of the requirements included in each item to filling the rates and prices.

A rate or price shall be entered against each item in the priced Price Schedules, whether quantities are stated or not. The cost of Items against which the Bidder has failed to enter a rate or price shall be deemed to be covered by other rates and prices entered in the Price Schedules.

The whole cost of complying with the provisions of the Contract shall be included in the Items provided in the priced Price Schedules, and where no Items are provided, the cost shall be deemed to be distributed among the rates and prices entered for the related Items of Work.

To the extent acceptable to the Employer for the purposes of making payments or partial payments, valuing variations or evaluating claims, or for such other purposes as the Employer may reasonably require, the Contractor may provide the Employer with a breakdown of any composite or lump sum items included in the Schedules.

The Provisional Sums included and so designated in the Price Schedules shall be expended in whole or in part at the direction and discretion of the Engineer.

Contingency amount shall only be spend on extra works which will arise in the process of executing the contract. In the event that such works does not arise or only part of it is spend, the whole amount or the remainder will be considered a saving on the part of the Employer.

Any arithmetical errors that appear in the computation or summation shall be corrected by the Employer as follows:

a) in the event of a discrepancy between amounts in figures and in words, the amount in words will govern; and
b) in the event of a discrepancy between the unit rate and the total amount derived by multiplying the unit price by the quantity, the unit rate as quoted shall prevail; provided, however, that if, in the opinion of the Employer, there has obviously been a gross misplacement of the decimal point in the unit price, the total amount as quoted shall prevail and the unit rate shall be corrected.

During execution of the works quantities will be remeasured to ensure that payment in done on work done. The price schedule will be read together with the specifications and drawings provided. For PCs sums and contingency, the technical schedule of rates will be used to determine the price of works, which will be quantified in the process of execution of the works.

16% Value Added Tax (VAT) Shall be considered as part of the taxes and therefore it will be deemed included in the grand total amount.

PRICE SCHEDULE NO. 1 PRELIMINARIES

A	PRELIMINARIES BASED ON THE FOLLOWING ITEMS				
ITEM	DESCRIPTION	QTY	UNITS	UNIT PRICE (KES)	TOTAL PRICE DPP (KES)
1	Mobilization	ITEM	ITEM		
2	Standard and equipped site office	ITEM	ITEM		
3	Performance bond	ITEM	ITEM		
4	All relevant insurance pertaining the project	ITEM	ITEM		
5	Seeking for relevant licences and approvals from relevant authorities	ITEM	ITEM		
6	Third party inspections where applicable	TEM	ITEM		
7	Compliance to health and safety requirements	ITEM	ITEM		
8	Compliance to heels gate national park rules	ITEM	ITEM		
9	Maintenance and operation manuals	ITEM	ITEM		
10	Laydown area and storage of materials	ITEM	ITEM		
11	Electricity water and other utilities to be used for construction.	ITEM	ITEM		
12	Security	ITEM	ITEM		
13	Demobilization	ITEM	ITEM		
14	Any other	ITEM	ITEM		

PRICE SCHEDULE NO.2 ~SUPPLY OF PLANT AND MATERIALS

	TWO PHASE PIPELINE FOR WELL OW-50A				
ITEM	DESCRIPTION	QTY	UNITS	UNIT PRICE (KES)	TOTAL PRICE DPP (KES)
	PIPES				
1	1" (DN25) SCH 80	12	M		
2	2" (DN 50) SCH 80	36	M		
3	3" (DN 80) SCH 80	12	M		
4	3" (DN80) SCH 40	12	M		
5	10" (DN250) SCH 80	12	M		
6	18" (DN 450) STD	24	M		
7	18" (DN450) SCH 80	12	M		
	ELBOWS				
1	2" 90° Long Radius elbow SCH 80	3	NO.		
2	3" 90° Long Radius elbow SCH 80	2	NO.		
3	3" 90° Long Radius elbow STD	6	NO.		
4	18" 90° Long Radius Elbow STD	3	NO.		
6	10" 45° Long Radius Elbow STD	4	NO.		
	FLANGES				
1	2" RTJ Flanges class 900	6	NO.		
2	3" RTJ Flanges class 900	4	NO.		
3	3" Raised Face Flanges class 300	4	NO.		
4	18" Raised Face Flange Class 300	8	NO.		
5	10" RTJ Blind Flange Class 900	1	NO.		
6	10" RTRJ Flange class 900	2	NO.		
7	18" RTJ Flange Class 900	4	NO.		
	TEE PIECES				
1	2"x2" Tee Piece SCH 80	1	NO.		

2	10"x 10" Tee Piece SCH 80	1	NO.		
3	18"x28" Tee Piece STD	1	NO.		
	REDUCER				
1	10"x 18" SCH 80 Reducer	1	NO.		
	SOCKETLETS				
1	1" SCH 80 Socketlets	3	NO.		
2	3" SCH 80 Socketlets	2	NO.		
3	3" SCH 40 Socklets	2	NO.		
	VALVES				
1	1" Weldon Gate Valve class 900	3	NO.		
2	2" Gate Valve with RTJ Flanges Class 900	4	NO.		
3	3" Gate Valve with RTJ Flanges class 900	2	NO.		
4	3" Gate Valve with Raised Face Flanges class 300	2	NO.		
6	18" Gate valve with RTJ Flanges class 900	1	NO.		
	RUPTURE DISC ASSEMBLY				
1	12" Raised Face Flanges class 300	4	NO.		
2	RUPTURE Disc holder in which a 12" RUPTURE Disc can fit	2	SET		
3	12" Rupture disc which a rating of 17.5 bar and 206°C	5	NO.		
	PIPE SUPPORTS				
1	Pipe bearing supports/ Tee supports see the typical issued drawing. The stanchion to be 8" (DN200) STD pipe with an average height of 4M out of which 1M will be within the concrete pile	5	NO.		
2	Pipe shoes	5	NO.		
3	Counterweight supports	2	NO.		

	INSULATION				
1	Insulation for 3" Pipe (80mm thick calcium Silicate	24	M		
2	Aluminium cladding for insulated 3" Pipe	24	M		
3	Insulation for 10" pipe (75mm) thick calcium silcate	12	M		
4	Aluminium cladding for 10" pipe	12	M		
5	Insulation for 18" Pipe (75mm thick Calcium Silicate	36	M		
6	Aluminium cladding for insulated 18" Pipe	36	M		
7	Insulation for 2" pipe (80mm) thick Calcium silcate	36	M		
8	Aluminium cladding for insulated 2" pipe	36	M		
	INSTRUMENTS AND THEIR FITTINGS				
1	½" (M) Glycerine filled pressure gauges (0-200 bar)	1	NO.		
2	½" (M) Glycerine filled pressure gauges 90-100 bar)	2	NO.		
3	1" Socketlets SCH 40	3	NO.		
4	½" 180° Q type syphon SS 316 10000 PSI MXM	3	NO.		
5	SS 316 ½" FxF GNV	3	NO.		
6	1"X1/2" MxF SS 316 reducer NPT 10000 PSI	3	NO.		
7	1" NPT valve class 300	3	NO.		
8	1" SCH 40 Pipes (SS)	12	M		
TOTAL FOR OW-50A					

B	TWO PHASE PIPELINE FOR WELL OW-50B				
ITEM	DESCRIPTION	QTY	UNITS	UNIT PRICE (KES)	TOTAL PRICE DPP (KES)
	PIPES				
1	1" (DN25) SCH 80	12	M		
2	2" (DN 50) SCH 80	36	M		
3	3" (DN 80) SCH 80	12	M		
4	3" (DN80) SCH 40	12	M		
5	10" (DN 250) XS	12	M		
6	18" (DN 450) XS	12	M		
7	18" (DN 450) STD	24	M		
	ELBOWS				
1	1" 90° Long Radius elbow SCH 80	3	NO.		
2	3" 90° Long Radius elbow SCH 80	4	NO.		
3	3" 90° Long Radius elbow SCH 40	4	NO.		
5	10" 45° Long Radius Elbow XS	4	NO.		
6	18" 90° Long Radius Elbow STD	4	NO.		
	FLANGES				
1	2" RTJ Flanges class 900	6	NO.		
2	3" RTJ Flanges class 900	4	NO.		
3	3" Raised Face Flanges class 300	4	NO.		
4	10" RTJ Flange Class 900	4	NO.		
5	10" RTJ Blind Flange Class 900	1	NO.		
6	18" RTRJ Flange class 900	4	NO.		
	TEE PIECES				
1	2"x2" Tee Piece SCH 80	1	NO.		
2	10"x10" Tee piece XS	1	NO.		

3	18"x28" Tee Piece STD	1	NO.		
	REDUCER				
1	10"x 18" XS Reducer	1	NO.		
	SOCKET LETS				
1	1" SCH 80 Socketlets	3	NO.		
2	3" SCH 80 Socket lets	2	NO.		
3	3" SCH 40 Sockets	2	NO.		
	VALVES				
1	1" Weldon Gate Valve class 900	4	NO.		
2	2" Gate Valve with RTJ Flanges Class 900	4	NO.		
3	3" Gate Valve with RTJ Flanges class 900	2	NO.		
4	3" Gate Valve with Raised Face Flanges class 300	2	NO.		
5	18" Gate valve with RTJ Flanged face class 900	1	NO.		
	RUPTURE DISC ASSEMBLY				
1	12" Raised Face Flanges class 300	4	NO.		
2	Rupture disc holder in which a 12" RUPTURE Disc can fit	2	SET		
3	12" Rupture disc which a rating of 17.5 bar and 206°C	5	NO.		
	PIPE SUPPORTS				
1	Pipe bearing supports/ Tee supports see the typical issued drawing. The stanchion to be 8" (DN200) STD pipe with an average height of 4M out of which 1M will be within the concrete pile	3	NO.		
2	Pipe shoes	3	NO.		
3	Counterweight supports	2	NO.		
	INSULATION				

1	Insulation for 3" Pipe (80mm thick calcium Silicate	24	M		
2	Aluminium cladding for insulated 3" Pipe	24	M		
3	Insulation for 18" Pipe (75mm thick calcium Silicate)	24	M		
4	Aluminium cladding for insulated 18" Pipe	24	M		
5	Insulation for 10" Pipe (75mm thick Calcium Silicate	12	M		
6	Aluminium cladding for insulated 10" Pipe	12	M		
7	Insulation for 2" pipe (80mm) thick of calcium silicate	36	M		
8	Aluminium pipe for cladding of a 2" pipe	36	M		
	INSTRUMENTS AND THEIR FITTINGS				
1	½" (M) Glycerine filled pressure gauges (0-200 bar)	1	NO.		
2	½" (M) Glycerine filled pressure gauges 90-100 bar)	2	NO.		
3	1" Socketlets SCH 40	3	NO.		
4	½" 180° Q type syphon SS 316 10000 PSI MXM	3	NO.		
5	SS 316 ½" FxF GNV	3	NO.		
6	1"X1/2" MxF SS 316 reducer NPT 10000 PSI	3	NO.		
7	1" NPT valve class 300	3	NO.		
8	1" SCH 40 Pipes (SS)	12	M		
TOTAL FOR TWO PHASE PIPELINE FOR WELL OW-50B					

C	TWO PHASE PIPELINE FOR WELL OW-50C				
ITEM	DESCRIPTION	QTY	UNITS	UNIT PRICE (KES)	TOTAL PRICE DPP (KES)
	PIPES				
1	1" (DN25) SCH 80	12	M		
2	2" (DN 50) SCH 80	36	M		
3	3" (DN 80) SCH 80	12	M		
4	3" (DN80) SCH 40	12	M		
5	12" (DN 300) XS	12	M		
6	12" (DN 300) STD	24	M		
7	10" (DN 250) XS	24	M		
	ELBOWS				
1	2" 90° Long Radius elbow SCH 80	3	NO.		
2	3" 90° Long Radius elbow SCH 80	2	NO.		
3	3" 90° Long Radius elbow SCH 40	6	NO.		
4	12" 90° Long Radius Elbow STD	1	NO.		
5	10" 45° Long Radius Elbow XS	4	NO.		
	FLANGES				
1	2" RTJ Flanges class 900	6	NO.		
2	3" RTJ Flanges class 900	4	NO.		
3	3" Raised Face Flanges class 300	4	NO.		
4	12" RTJ flanges class 900	4	NO.		
5	10" RTJ Blind Flange Class 900	1	NO.		
6	10" RTRJ Flange class 900	4	NO.		
	TEE PIECES				
1	2"x2" Tee Piece SCH 80	1	NO.		
2	12"x28" Tee piece STD	1	NO.		

3	10"x10" Tee Piece XS	1	NO.		
	REDUCER				
1	10"x 12" Reducer	1	NO.		
	SOCKETLETS				
1	1" SCH 80 Socketlets	3	NO.		
2	3" SCH 80 Socketlets	2	NO.		
3	3" SCH 40 Socketlets	2	NO.		
	VALVES				
1	1" Weldon Gate Valve class 900	4	NO.		
2	2" Gate Valve with RTJ Flanges Class 900	4	NO.		
3	3" Gate Valve with RTJ Flanges class 900	2	NO.		
4	3" Gate Valve with Raised Face Flanges class 300	2	NO.		
5	12" Gate valve with RTJ Flanges class 900	1	NO.		
	RUPTURE DISC ASSEMBLY				
1	6" Raised Face Flanges class 300	4	NO.		
2	RUPTURE Disc holder in which a 6" RUPTURE Disc can fit	2	SET		
3	6" RUPTURE Disc which a rating of 17.5 bar and 206°C	5	NO.		
	PIPE SUPPORTS				
1	Pipe bearing supports/ Tee supports see the typical issued drawing. The stanchion to be 8" (DN200) STD pipe with an average height of 4M out of which 1M will be within the concrete pile	3	NO.		
2	Pipe shoes	3	NO.		
3	Counterweight supports	2	NO.		
	INSULATION				

1	Insulation for 3" Pipe (80mm thick calcium Silicate	24	M		
2	Aluminium cladding for insulated 3" Pipe	24	M		
3	Insulation for 12" Pipe (75mm thick calcium Silicate)	24	M		
4	Aluminium cladding for insulated 12" Pipe	24	M		
5	Insulation for 2" Pipe (80mm thick Calcium Silicate	36	M		
6	Aluminium cladding for insulated 2" Pipe	36	M		
7	Insulation for 10" Pipe (75mm thick Calcium Silicate)	12	M		
8	Aluminium cladding for insulated 10" pipe	12	M		
	INSTRUMENTS AND THEIR FITTINGS				
1	½" (M) Glycerine filled pressure gauges (0-200 bar)	1	NO.		
2	½" (M) Glycerine filled pressure gauges 90-100 bar)	2	NO.		
3	1" Socketlets SCH 40	3	NO.		
4	½" 180° Q type syphon SS 316 10000 PSI MXM	3	NO.		
5	SS 316 ½" FxF GNV	3	NO.		
6	1"X1/2" MxF SS 316 reducer NPT 10000 PSI	3	NO.		
7	1" NPT valve class 300	3	NO.		
8	1" SCH 40 Pipes (SS)	12	M		
TOTAL FOR TWO PHASE PIPELINE FOR WELL OW-50C					

	COMBINED TWO PHASE LINE				
ITEM	DESCRIPTION	QTY	UNITS	UNIT PRICE (KES)	TOTAL PRICE DPP (KES)
	PIPES				
1	3" (DN80) SCH 40	12	M		
2	28" (DN 700) STD	150	M		
3	14" (DN 350) STD	24	M		
	ELBOWS				
1	28" 90^{O} Long radius bend STD	6	NO.		
2	3" 90^{o} Long Radius elbow SCH 40	6	NO.		
3	14" 90^{o} Long Radius Elbow STD	4	NO.		
	FLANGES				
1	3" Raised Face Flanges class 300	10	NO.		
2	28" Raised face flanges class 300	12	NO.		
3	14" Raised face Flange class 300	4	NO.		
	TEE PIECES				
1	14"x28" Tee piece STD	2	NO.		
	SOCKETLETS				
1	1" SCH 80 Socket lets	3	NO.		
	VALVES				
1	1" Weldon Gate Valve class 900	4	NO.		
2	3" Gate Valve with Raised Face Flanges class 300	12	NO.		
3	28" Gate valve with Raised face Flange class 300	6	NO.		
	PIPE SUPPORTS				

1	Pipe bearing supports/ Tee supports see the typical issued drawing. The stanchion to be 8" (DN200) STD pipe with an average height of 4M out of which 1M will be within the concrete pile	28	NO.		
2	Pipe shoes	28	NO.		
	INSULATION				
1	Insulation for 3" Pipe (80mm thick calcium Silicate	24	M		
2	Aluminium cladding for insulated 3" Pipe	24	M		
3	Insulation for 28" Pipe (55mm thick calcium Silicate)	150	M		
4	Aluminium cladding for insulated 28" Pipe	150	M		
5	Insulation for 14" Pipe (75mm thick Calcium Silicate	24	M		
6	Aluminium cladding for insulated 14" Pipe	24	M		
	INSTRUMENTS AND THEIR FITTINGS				
1	½" (M) Glycerine filled pressure gauges (0-200 bar)	1	NO.		
2	½" (M) Glycerine filled pressure gauges 90-100 bar)	2	NO.		
3	1" Socketlets SCH 40	3	NO.		
4	½" 180° Q type syphon SS 316 10000 PSI MXM	3	NO.		
5	SS 316 ½" FxF GNV	3	NO.		
6	1"X1/2" MxF SS 316 reducer NPT 10000 PSI	3	NO.		
7	1" NPT valve class 300	3	NO.		
8	1" SCH 40 Pipes (SS)	12	M		
TOTAL FOR COMBINED TWO PHASE PIPELINE					

E	STEAM PIPELINE FROM SEPARATOR OW-50 TO TIE-IN NEAR OW-32				
ITEM	DESCRIPTION	QTY	UNITS	UNIT PRICE (KES)	TOTAL PRICE DPP (KES)
	PIPES				
1	3" (DN 80) SCH 40	12	M		
2	14" (DN 350) STD	24	M		
3	28" (DN 700500) STD	2420	M		
	ELBOWS				
1	3" 90° Long Radius elbow SCH 40	6	NO.		
2	28" 90° Long Radius Elbow STD	56	NO.		
3	28" 45° Long Radius Elbow STD	11	NO.		
	FLANGES				
1	3" Raised Face Flanges class 300	8	NO.		
2	28" Raised Face Flange Class 300	10	NO.		
3	14" Raised Face Flange Class 300	6	NO.		
	SOCKETLETS				
1	3" SCH 40 Socklets	2	NO.		
	VALVES				
1	2" Gate Valve with Raised Face Flanges Class 300	2	NO.		
2	3" Gate Valve with Raised Face Flanges class 300	6	NO.		
3	14" Gate valve with Raised Face Flanges class 300	8	NO.		
4	28" Gate Valve with Raised Face Flange class 300	2	NO.		
	STEAM TRAPS AND CDP FITTINGS				
1	Steam trap as per specifications in section VII	22	NO.		

2	22" Raised Face Flange class 300	22	NO.		
3	22' Raised Face blind Flange Class 300	22	NO.		
4	2" Socketlets SCH 80 SS 316	22	NO.		
5	2" 90° Elbows SCH 80 SS 316	66	NO.		
6	2" x 2" SCH 80 SS 316 Tee Piece	44	NO.		
7	2" Raised face Flanges class 300	120	NO.		
8	2" Gate valve with Raised Face Flange class 300	66	NO.		
9	2"X ¾" SCH 80 Tee Piece SS 316	44	NO.		
10	¾" Union SCH 80	22	NO.		
11	2" SCH 80 Pipe SS 316	150	M		
12	3/4" SCH 80 Pipes SS 316	66	M		
13	22" STD Pipe Carbon steel	22	M		
	FLOW METER FITTINGS				
1	2" Gate Valve with Raised face Flange Class 300	1	NO.		
2	2" Raised Face Flange class 300	2	NO.		
3	2" Socketlets SCH 80	1	NO.		
	INSTRUMENTS AND THEIR FITTINGS				
1	½ Inch (M) Glycerine Filled Pressure Gauges(0-20bar)	1	NO		
2	1 Inch Sockolets Sch 40	1	NO		
3	½ Inch,180° Q Type Syphon SS 316 10000Psi, M x M	1	NO		
4	SS 316, ½ FxF GNV	1	NO		

5	1-½ Inch, M x F SS316 reducer, NPT 10000Psi	1	NO		
6	1 Inch NPT Cl 300 Valve	1			
7	1 Inch SCH 40 Pipe(SS 316)	6	M		
	RUPTURE DISC ASSEMBLY				
1	6" Raised Face Flanges class 300	8	NO.		
2	RUPTURE Disc holder in which a 6" RUPTURE Disc can fit	4	SET		
3	6" RUPTURE Disc which a rating of 17.5 bar and 206°C	6	NO.		
	PIPE SUPPORTS				
1	Pipe bearing supports/ Tee supports see the typical issued drawing. The stanchion to be 8" (DN200) STD pipe with an average height of 4M out of which 1M will be within the concrete pile	360	NO.		
2	Pipe shoes	360	NO.		
	INSULATION				
1	Insulation for 3" Pipe (80mm thick calcium Silicate	12	M		
2	Aluminium cladding for insulated 3" Pipe	12	M		
3	Insulation for 14" Pipe (75mm thick calcium Silicate)	24	M		
4	Aluminium cladding for insulated 14" Pipe	24	M		
5	Insulation for 28" Pipe (55mm thick Calcium Silicate	2420	M		
6	Aluminium cladding for insulated 28" Pipe	2420	M		
TOTAL FOR STEAM PIPELINE FROM SEPARATOR OW-50 TO TIE-IN NEAR OW-32					

F	BRINE PIPELINE FROM SEPARATOR OW-50 TO TIE-IN TO BRINE LINE NEAR OW-38				
ITEM	DESCRIPTION	QTY	UNITS	UNIT PRICE (KES)	TOTAL PRICE DPP (KES)
	PIPES				
1	4" (DN 100) STD	24	M		
2	8" (DN 200) STD	1960	M		
3	10" (DN 250) SCH 80	18	M		
4	3" (DN 80) STD	12	M		
	ELBOWS				
1	4" 90° Long Radius elbow STD	12	NO.		
2	8" 45° Long Radius Elbow STD	13	NO.		
3	8"90° Long radius Elbow STD	34	NO.		
3	10" 45° Long Radius Elbow SCH 80	4	NO.		
	FLANGES				
1	4" Raised Face Flanges class 300	5	NO.		
2	8" Raised face Flanges class 300	14	NO.		
3	10" RTJ Flange Class 900	2	NO.		
4	10" RTJ Blind RTJ Flange class 600	2	N0.		
5	10" RTJ Blind RTJ blind Flange class 600	2			
	TEE PIECES				
1	4"X8" Tee Piece STD	1	NO.		
2	10"X10" Tee Piece SCH 80	1	NO.		
	REDUCER				
1	4"X8" STD Reducer	2	NO.		
2	8"x10" SCH 80 Reducer	1	NO.		
	VALVES				

1	4" Gate Valve with Raised Face Flanges Class 300	4	NO.		
3	10" Gate valve with RTJ Flanges class 600	2	NO.		
	RUPTURE DISC ASSEMBLY				
1	3" Raised Face Flanges class 300	4	NO.		
2	RUPTURE Disc holder in which a 3" Rupture disc can fit	2	SET		
3	3" Rupture disc which a rating of 30 bar and 233.84°C	4	NO.		
	PIPE SUPPORTS				
1	Pipe bearing supports/ Tee supports see the typical issued drawing. The stanchion to be 8" (DN200) STD pipe with an average height of 4M out of which 1M will be within the concrete pile	490	NO.		
2	Pipe shoes	490	NO.		
3	Counterweight	2	NO.		
	INSULATION				
1	Insulation for 4" Pipe (55mm thick calcium Silicate	36	M		
2	Aluminium cladding for insulated 4" Pipe	36	M		
3	Insulation for 8" Pipe (55mm thick calcium Silicate)	1960	M		
4	Aluminium cladding for insulated 8" Pipe	1960	M		
5	Insulation for 10" Pipe (55 mm thick Calcium Silicate	12	M		
6	Aluminium cladding for insulated 10" Pipe	12	M		
	FLASH TANK				
1	Flash tank as per the specifications in section VII	1	NO.		

2	3" Pipe SCH 40	6	M		
3	3" Raised Face Flange class 300	2	NO.		
4	3" Gate Valve with Raised Face Flange class 300	1	NO.		
5	2" 90º Elbow SCH 40	2	N0.		
6	4" Raised Face Blind flange Class 300	4	NO.		
7	24" Raised face blind Flange class 300	4	NO.		
8	2" Pipe XS	12	M		
	Flash tank Nozzles				
1	Manhole size DN 600 – XS,	1	ITEM		
2	24" (DN 600) Raised Face Flange class 300	2	NO.		
3	Inlet, DN 250 SCH 40, tangential	1	ITEM		
4	10" Weld neck, Raised Face Flange class 300	2	NO.		
5	Outlet weir box 4500 x 1085 x 850- and 12.7-mm thick carbon steel to ASTM A36	1	ITEM		
6	Hand holes (DN 150) SCH 120	1	NO.		
7	6" Raised Face Flange class 300	1	NO.		
	VENTS				
1	1 3/4" Socketlets SCH 80	6	NO		
2	1 ¾" Weld on Gate valves class 300	6	NO.		
3	1 ¾" 90º elbow SCH 80	6	NO.		
4	1 ¾" SCH 40 PIPE	24	M		
	INSTRUMENTS AND ASSOCIATED FITTINGS				
1	½ Inch (M) Glycerine Filled Pressure Gauges(0-200bar)	1	NO		

2	½ Inch (M) Glycerine Filled Pressure Gauges(0-100bar)	2	NO		
3	½ Inch (M) Glycerine Filled Pressure Gauges(0-20bar)	1	NO		
4	1 Inch Socklets Sch 40	4	NO.		
5	½ Inch,180° Q Type Syphon SS 316 10000Psi, M x M	4	NO.		
6	SS 316, ½ FxF GNV	4	NO.		
7	1-½ Inch, M x F SS316 reducer, NPT 10000Psi	4	NO.		
8	1 Inch NPT Cl 300 Valve	4	NO		
9	1 Inch SCH 40 Pipe(SS)	12	M		
	Flow Meter Fittings				
1	2 Inch gate valve, RF Flanged Cl 600	1	NO		
2	2 Inch RF Flanges Cl 600	2	NO		
3	2 Inch Sockolets SCH 80	1	NO		
TOTAL FOR BRINE PIPELINE FROM SEPARATOR OW-50 TO TIE-IN TO BRINE LINE NEAR OW-38 AND BACK CONNECTION TO WELL OW-R6					

H	WELLHEAD AND SEPARATOR FLASH TANK AT WELLPAD OW-50				
ITEM	DESCRIPTION	QTY	UNITS	UNIT PRICE (KES)	TOTAL PRICE DPP (KES)
1	FLASH TANK AS PER SPECIFICATIONS IN SECTION VII	1	NO.		
2	3" Pipe SCH 40	6	M		
3	3" Raised Face Flange class 300	2	NO.		
4	3" Gate Valve with Raised Face Flange class 300	1	NO.		
5	2" 90° Elbow SCH 40	2	N0.		
6	4" Raised Face Blind flange Class 300	4	NO.		
7	24" Raised face blind Flange class 300	4	NO.		
8	2" Pipe XS	12	M		
	Flash tank Nozzles				
1	Manhole size DN 600 – XS,	1	ITEM		
2	24" (DN 600) Raised Face Flange class 300	2	NO.		
3	Inlet, DN 250 SCH 40, tangential	1	ITEM		
4	10" Weld neck, Raised Face Flange class 300	2	NO.		
5	Outlet weir box 4500 x 1085 x 850- and 12.7-mm thick carbon steel to ASTM A36	1	ITEM		
6	Hand holes (DN 150) SCH 120	1	NO.		
7	6" Raised Face Flange class 300	1	NO.		
	PIPES				
1	3" (DN 80) STD	6	M		
2	28" (DN 500) SCH 40	102	M		
	Flanges				
1	28" Raised face Flange class 300	4	NO.		

2	28" Raised Face Blind Flange Class 300	1	NO.		
	Reducer				
1	12"x28" reducer SCH 40	1	NO.		
	PIPE SUPPORTS				
1	Pipe bearing supports/ Tee supports see the typical issued drawing. The stanchion to be 8" (DN200) STD pipe with an average height of 4M out of which 1M will be within the concrete pile	12	NO.		
2	Shoes	12	NO.		
TOTAL FOR WELLHEAD FLASH TANK AT WELLPAD OW-50					

I	SEPARATOR STATION FOR WELLS OW-50A/B/C				
ITEM	DESCRIPTION	QTY	UNITS	UNIT PRICE (KES)	TOTAL PRICE DPP (KES)
1	SEPARATOR AS PER SPECIFICATIONS IN SECTION VII	2	NO.		
TOTAL FOR SEPARATOR STATION FOR WELLS OW-50A/B/C					

SUMMARY PAGE FOR SUPPLY OF PLANT AND MATERIALS

ITEM	DESCRIPTION	AMOUNT (KES)
A	TOTAL FOR TWO PHASE PIPELINE FOR WELL OW-50A	
B	TOTAL FOR TWO PHASE PIPELINE FOR WELL OW-50B	
C	TOTAL FOR TWO PHASE PIPELINE FOR WELL OW-50C	
D	TOTAL FOR COMBINED TWO PHASE PIPILINE	
E	TOTAL FOR STEAM PIPELINE FROM SEPARATOR OW-50 TO TIE-IN NEAR WELL OW-32	
F	TOTAL FOR BRINE PIPELINE FROM SEPARATOR OW-50 TO TIE IN NEAR WELL OW-38 AND BACK CONNECTION TO WELL OW-R6	
G	TOTAL FOR WELLHEAD FLASH TANK AT WELLPAD OW-50	
H	TOTAL FOR SEPARATOR STATION FOR WELLS OW-50A/B/C	
	TOTAL FOR PLANT AND MATERIALS	

CIVIL WORKS

ITEM	DESCRIPTION	UNIT	QNTY	RATE	AMOUNT (KES)
	SECTION 1 PILE FOUNDATIONS				
	NOTE: - Upon finishing works, spread all soil mounds level; clean site; plant grass as shall be directed by engineer; water grass for a period of at least 30 consecutive days; dispose of any construction debris and leave site as clean as possible to the satisfaction of the client. Rates herein must allow for these works to be undertaken.		- -		
	PILE EXCAVATIONS				
1	Allow for excavation for PILE Foundations	CM	0		
	Concreting				
2	Concrete class 25/20mm (1: 1 1/2: 3) in Foundation Stub Columns	CM	3		
	Reinforcement				
	High yield tensile steel bar reinforcement to BS 4461 including cutting , bending, overlaps as applicable and tying wire in;-				
3	T-10mm diameter high yield tensile steel bar - RING	KG	18		
4	T-20mm diameter high yield tensile steel bar -		180		
5	T-25mm diameter high yield tensile steel bar - MAIN BAR	KG	216		
6	PILE FOUNDATION – FOR ONE PILE				
	TOTAL PILE FOUNDATION FOR 600 PILES (ITEM NO. 5 X 964) (Carried to Summary)				

ITEM	DESCRIPTION	UNIT	QNTY	RATE	AMOUNT (KES)
	SECTION 2 SEPARATOR STATION FOUNDATION				
	NOTE: - Upon finishing works, spread all soil mounds level; clean site; plant grass as shall be directed by engineer; water grass for a period of at least 30 consecutive days; dispose of any construction debris and leave site as clean as possible to the satisfaction of the client. Rates herein must allow for these works to be undertaken.		-		
	-		-		
	EXCAVATIONS				
1	Allow for excavation for separator Foundation	CM	0		
2	Fill excavated area with approved mix of hardcore bed and gravel fill in making up levels approximately 500mm; including grading, leveling, ramming and consolidating in 100mm thick layers, well compacted	CM	9.8		
3	Allow for backfilling to level around excavated foundations	CM	27		
	Blinding				
4	Plain In situ Blinding Concrete Class X Mix (1:4:8)	CM	1		
	Concreting				
5	Concrete class 25/20mm (1: 1 1/2: 3) in Foundation Stub Columns	CM	21		
	Reinforcement				
	High yield tensile steel bar reinforcement to BS 4461 including cutting , bending, overlaps as applicable and tying wire in;-				
6	T-12mm diameter high yield tensile steel bar	KG	572		
7	T-10mm diameter high yield tensile steel bar	KG	115		
8	TOTAL FOR ONE SEPARATOR				
	TOTAL FOR TWO SEPARATORS (ITEM NO. 8X2) (Carried to Summary)				

ITEM	DESCRIPTION	UNIT	QNTY	RATE	AMOUNT (KES)
	SECTION 3 FLASH TANK FOUNDATION				
	NOTE: - Upon finishing works, spread all soil mounds level; clean site; plant grass as shall be directed by engineer; water grass for a period of at least 30 consecutive days; dispose of any construction debris and leave site as clean as possible to the satisfaction of the client. Rates herein must allow for these works to be undertaken.		-		
	-		-		
	EXCAVATIONS				
1	Allow for excavation for separator Foundation	CM	0		
2	Fill excavated area with approved mix of hardcore bed and gravel fill in making up levels approximately 500mm; including grading, leveling, ramming and consolidating in 100mm thick layers, well compacted	CM	36		
3	Allow for backfilling to level around excavated foundations	CM	90		
	Blinding				
4	Plain In situ Blinding Concrete Class X Mix (1:4:8)	CM	6		
	Concreting				
5	Concrete class 25/20mm (1: 1 1/2: 3) in Foundation Stub Columns	CM	72		
	Reinforcement				
	High yield tensile steel bar reinforcement to BS 4461 including cutting , bending, overlaps as applicable and tying wire in;-				
6	T-12mm diameter high yield tensile steel bar	KG	1716		
7	T-12mm diameter high yield tensile steel bar	KG	345.6		
8	TOTAL FOR FLASH TANK FOUNDATION				
	TOTAL FOR TWO FLASH TANKS (ITEM NO. 8X2) (Carried to Summary)				

ITEM	DESCRIPTION	UNIT	QNTY	RATE	AMOUNT (KES)
	1 NO. CULVERT CROSSING				
	NOTE: - Upon finishing works, spread all soil mounds level; clean site; plant grass as shall be directed by engineer; water grass for a period of at least 30 consecutive days; dispose of any construction debris and leave site as clean as possible to the satisfaction of the client. Rates herein must allow for these works to be undertaken.		-		
	-		-		
	EXCAVATIONS				
1	Allow for excavation for culvert crossing	CM	0		
2	Fill excavated area with approved mix of hardcore bed and gravel fill in making up levels approximately 500mm; including grading, leveling, ramming and consolidating in 100mm thick layers, well compacted	CM	32		
	Blinding				
3	Plain In situ Blinding Concrete Class X Mix (1:4:8)	CM	3.2		
	Concreting				
4	Concrete class 25/20mm (1: 1 1/2: 3) in Foundation Stub Columns	CM	93.7		
	Reinforcement				
	High yield tensile steel bar reinforcement to BS 4461 including cutting , bending, overlaps as applicable and tying wire in;-				
	T-10mm diameter high yield tensile steel bar	KG	1051		
5	T-12mm diameter high yield tensile steel bar	KG	2251		
6	T-16mm diameter high yield tensile steel bar	KG	806		
7	1 NO. CULVERT CROSSING				
	TOTAL FOR 3NO. CULVERT CROSSING (ITEM NO. 7X3) (Carried to Summary)				

ITEM	DESCRIPTION	UNIT	QNTY	RATE	AMOUNT (KES)
	SECTION 5 POND AND SOAKPIT				
	NOTE: - Upon finishing works, spread all soil mounds level; clean site; plant grass as shall be directed by engineer; water grass for a period of at least 30 consecutive days; dispose of any construction debris and leave site as clean as possible to the satisfaction of the client. Rates herein must allow for these works to be undertaken.		-		
	Soak Pit		-		
8.01	Allow for excavation in soft material for soak pit	CM	0		
8.02	Extra over for excavation in rock	CM	0		
8.03	Supply and place rock fill for soak pit	CM	7.2		
	-				
	Concreting				
8.04	Cast a concrete wall class 25/20 (1: 1 1/2: 3) 100mm thick reinforced with A142 BRC	CM	6		
	Reinforcement				
	-				
	Supply and fix A142 BRC reinforcement including cutting , bending, overlaps as applicable and tying wire in;-	SM	60		
	Pond				
8.04	Allow for excavation in soft material for pond	CM	0		
8.05	Extra over for excavation in rock	CM	0		
8.06	Fill excavated area with approved mix of hardcore bed and gravel fill in making up levels approximately 300mm; including grading, leveling, ramming and consolidating in 150mm thick layers, well compacted	CM	1188		

ITEM	DESCRIPTION	UNIT	QNTY	RATE	AMOUNT (KES)
	SECTION 5 POND AND SOAKPIT				
8.07	Supply and install fused 0.75-1mm HDPE/EPDM pond line	SM	4000		
8.08	Supply and place complete with grouting 100mm thick stone pitching lining to exposed pond area	CM	400		
8.09	Allow for excavation for drains	CM	0		
8.10	Construct 100mm thick class 20/20 concrete lined drainage system. Rate to include for all the necessary formwork and steel reinforced grating cover	CM	21.6		
	Concreting				
8.11	Cast reinforced concrete class 25/20mm (1: 1 1/2: 3) beam all-round the pond.	CM	43.2		
	Reinforcement				
	High yield tensile steel bar reinforcement to BS 4461 including cutting , bending, overlaps as applicable and tying wire in;-				
8.12	T-12mm diameter high yield tensile steel bar	KG	3155.4		
8.13	R-8mm diameter high yield tensile steel bar	KG	3083.6		
	Fencing				
	Use 3mm thick GI class B pipe and 4mm thick chain link to fence 60 by 60 m all-round the pond area				
	Concreting				

ITEM	DESCRIPTION	UNIT	QNTY	RATE	AMOUNT (KES)
	SECTION 5 POND AND SOAKPIT				
	Cast reinforced concrete class 25/20mm (1: 1 1/2: 3) beam all-round the fencing line to support the fencing posts.	CM	51.8		
8.14	Supply and install 3mm thick GI class B pipe 3 m high	LM	453.6		
8.15	Supply and install 2.5M high galvanized steel chain link fence of Gauge 4mm.	M	288		
	Reinforcement				
	High yield tensile steel bar reinforcement to BS 4461 including cutting , bending, overlaps as applicable and tying wire in;-				
8.16	T-12mm diameter high yield tensile steel bar	KG	3086.18		
8.17	T-12mm diameter high yield tensile steel bar	KG	2506.3		
	10No. SOAK PITS AND 2 No. PONDS (carried to summary)				

SUMMARY PAGE FOR CIVIL WORKS

ITEM	DESCRIPTION	AMOUNT (KES)
A	SECTION 1 PILE FOUNDATION -	
B	SECTION 2 SEPARATOR FOUNDATION	
C	SECTION 3 FLASH TANK FOUNDATION	
D	SECTION 4 CULVERT CROSSING	
E	SECTION 5 10No. SOAK PITS AND 3No. PONDS	
-	TOTAL FOR CIVIL MATERIAL QUANTITIES	

TOTAL FOR PRICE SCHEDULE NO. 2

ITEM	DESCRIPTION	AMOUNT (KES)
A	TOTAL FOR MECHANICAL MATERIALS	
B	TOTAL FOR CIVIL MATERIALS	
	TOTAL FOR PRICE SCHEDULE NO.2	

PRICE SCHEDULE NO.3:

INSTALLATION WORKS

A	TWO PHASE PIPELINE FOR WELL OW-50A				
ITEM	DESCRIPTION	QTY	UNITS	UNIT PRICE (KES)	TOTAL PRICE DPP (KES)
	PIPES				
1	1" (DN25) SCH 80	12	M		
2	2" (DN 50) SCH 80	36	M		
3	3" (DN 80) SCH 80	12	M		
4	3" (DN80) SCH 40	12	M		
5	10" (DN250) SCH 80	12	M		
6	18" (DN 450) STD	24	M		
7	18" (DN450) SCH 80	12	M		
	ELBOWS				
1	2" 90° Long Radius elbow SCH 80	3	NO.		
2	3" 90° Long Radius elbow SCH 80	2	NO.		
3	3" 90° Long Radius elbow STD	6	NO.		
4	18" 90° Long Radius Elbow STD	3	NO.		
6	10" 45° Long Radius Elbow STD	4	NO.		
	FLANGES				
1	2" RTJ Flanges class 900	6	NO.		
2	3" RTJ Flanges class 900	4	NO.		
3	3" Raised Face Flanges class 300	4	NO.		
4	18" Raised Face Flange Class 300	8	NO.		
5	10" RTJ Blind Flange Class 900	1	NO.		
6	10" RTRJ Flange class 900	2	NO.		
7	18" RTJ Flange Class 900	4	NO.		
	TEE PIECES				
1	2"x2" Tee Piece SCH 80	1	NO.		

2	10"x 10" Tee Piece SCH 80	1	NO.		
3	18"x28" Tee Piece STD	1	NO.		
	REDUCER				
1	10"x 18" SCH 80 Reducer	1	NO.		
	SOCKETLETS				
1	1" SCH 80 Socketlets	3	NO.		
2	3" SCH 80 Socketlets	2	NO.		
3	3" SCH 40 Socklets	2	NO.		
	VALVES				
1	1" Weldon Gate Valve class 900	3	NO.		
2	2" Gate Valve with RTJ Flanges Class 900	4	NO.		
3	3" Gate Valve with RTJ Flanges class 900	2	NO.		
4	3" Gate Valve with Raised Face Flanges class 300	2	NO.		
6	18" Gate valve with RTJ Flanges class 900	1	NO.		
	RUPTURE DISC ASSEMBLY				
1	12" Raised Face Flanges class 300	4	NO.		
2	RUPTURE Disc holder in which a 12" RUPTURE Disc can fit	2	SET		
3	12" RUPTURE Disc which a rating of 17.5 bar and 206°C	5	NO.		
	PIPE SUPPORTS				
1	Pipe bearing supports/ Tee supports see the typical issued drawing. The stanchion to be 8" (DN200) STD pipe with an average height of 4M out of which 1M will be within the concrete pile	5	NO.		
2	Pipe shoes	5	NO.		
3	Counterweight supports	2	NO.		

	INSULATION				
1	Insulation for 3" Pipe (80mm thick calcium Silicate	24	M		
2	Aluminium cladding for insulated 3" Pipe	24	M		
3	Insulation for 10" pipe (75mm) thick calcium silcate	12	M		
4	Aluminium cladding for 10"pipe	12	M		
5	Insulation for 18" Pipe (75mm thick Calcium Silicate	36	M		
6	Aluminium cladding for insulated 18" Pipe	36	M		
7	Insulation for 2" pipe (80mm) thick Calcium silcate	36	M		
8	Aluminium cladding for insulated 2" pipe	36	M		
	INSTRUMENTS AND THEIR FITTINGS				
1	½" (M) Glycerine filled pressure gauges (0-200 bar)	1	NO.		
2	½" (M) Glycerine filled pressure gauges 90-100 bar)	2	NO.		
3	1" Socketlets SCH 40	3	NO.		
4	½" 180° Q type syphon SS 316 10000 PSI MXM	3	NO.		
5	SS 316 ½" FxF GNV	3	NO.		
6	1"X1/2" MxF SS 316 reducer NPT 10000 PSI	3	NO.		
7	1" NPT valve class 300	3	NO.		
8	1" SCH 40 Pipes (SS)	12	M		
TOTAL FOR OW-50A					

B	TWO PHASE PIPELINE FOR WELL OW-50B				
ITEM	DESCRIPTION	QTY	UNITS	UNIT PRICE (KES)	TOTAL PRICE DPP (KES)
	PIPES				
1	1" (DN25) SCH 80	12	M		
2	2" (DN 50) SCH 80	36	M		
3	3" (DN 80) SCH 80	12	M		
4	3" (DN80) SCH 40	12	M		
5	10" (DN 250) XS	12	M		
6	18" (DN 450) XS	12	M		
7	18" (DN 450) STD	24	M		
	ELBOWS				
1	1" 90° Long Radius elbow SCH 80	3	NO.		
2	3" 90° Long Radius elbow SCH 80	4	NO.		
3	3" 90° Long Radius elbow SCH 40	4	NO.		
5	10" 45° Long Radius Elbow XS	4	NO.		
6	18" 90° Long Radius Elbow STD	4	NO.		
	FLANGES				
1	2" RTJ Flanges class 900	6	NO.		
2	3" RTJ Flanges class 900	4	NO.		
3	3" Raised Face Flanges class 300	4	NO.		
4	10" RTJ Flange Class 900	4	NO.		
5	10" RTJ Blind Flange Class 900	1	NO.		
6	18" RTRJ Flange class 900	4	NO.		
	TEE PIECES				
1	2"x2" Tee Piece SCH 80	1	NO.		
2	10"x10" Tee piece XS	1	NO.		

3	18"x28" Tee Piece STD	1	NO.		
	REDUCER				
1	10"x 18" XS Reducer	1	NO.		
	SOCKETLETS				
1	1" SCH 80 Socketlets	3	NO.		
2	3" SCH 80 Socketlets	2	NO.		
3	3" SCH 40 Socklets	2	NO.		
	VALVES				
1	1" Weldon Gate Valve class 900	4	NO.		
2	2" Gate Valve with RTJ Flanges Class 900	4	NO.		
3	3" Gate Valve with RTJ Flanges class 900	2	NO.		
4	3" Gate Valve with Raised Face Flanges class 300	2	NO.		
5	18" Gate valve with RTJ Flanged face class 900	1	NO.		
	RUPTURE DISC ASSEMBLY				
1	12" Raised Face Flanges class 300	4	NO.		
2	RUPTURE Disc holder in which a 12" RUPTURE Disc can fit	2	SET		
3	12" RUPTURE Disc which a rating of 17.5 bar and 206^{o}C	5	NO.		
	PIPE SUPPORTS				
1	Pipe bearing supports/ Tee supports see the typical issued drawing. The stanchion to be 8" (DN200) STD pipe with an average height of 4M out of which 1M will be within the concrete pile	5	NO.		
2	Pipe shoes	5	NO.		
3	Counterweight supports	2	NO.		
	INSULATION				

1	Insulation for 3" Pipe (80mm thick calcium Silicate	24	M		
2	Aluminium cladding for insulated 3" Pipe	24	M		
3	Insulation for 18" Pipe (75mm thick calcium Silicate)	24	M		
4	Aluminium cladding for insulated 18" Pipe	24	M		
5	Insulation for 10" Pipe (75mm thick Calcium Silicate	12	M		
6	Aluminium cladding for insulated 10" Pipe	12	M		
7	Insulation for 2" pipe (80mm) thick of calcium silicate	36	M		
8	Aluminium pipe for cladding of a 2" pipe	36	M		
	INSTRUMENTS AND THEIR FITTINGS				
1	½" (M) Glycerine filled pressure gauges (0-200 bar)	1	NO.		
2	½" (M) Glycerine filled pressure gauges 90-100 bar)	2	NO.		
3	1" Socketlets SCH 40	3	NO.		
4	½" 180° Q type syphon SS 316 10000 PSI MXM	3	NO.		
5	SS 316 ½" FxF GNV	3	NO.		
6	1"X1/2" MxF SS 316 reducer NPT 10000 PSI	3	NO.		
7	1" NPT valve class 300	3	NO.		
8	1" SCH 40 Pipes (SS)	12	M		
TOTAL FOR TWO PHASE PIPELINE FOR WELL OW-50B					

C	TWO PHASE PIPELINE FOR WELL OW-50C				
ITEM	DESCRIPTION	QTY	UNITS	UNIT PRICE (KES)	TOTAL PRICE DPP (KES)
	PIPES				
1	1" (DN25) SCH 80	12	M		
2	2" (DN 50) SCH 80	36	M		
3	3" (DN 80) SCH 80	12	M		
4	3" (DN80) SCH 40	12	M		
5	12" (DN 300) XS	12	M		
6	12" (DN 300) STD	24	M		
7	10" (DN 250) XS	24	M		
	ELBOWS				
1	2" 90° Long Radius elbow SCH 80	3	NO.		
2	3" 90° Long Radius elbow SCH 80	2	NO.		
3	3" 90° Long Radius elbow SCH 40	6	NO.		
4	12" 90° Long Radius Elbow STD	1	NO.		
5	10" 45° Long Radius Elbow XS	4	NO.		
	FLANGES				
1	2" RTJ Flanges class 900	6	NO.		
2	3" RTJ Flanges class 900	4	NO.		
3	3" Raised Face Flanges class 300	4	NO.		
4	12" RTJ flanges class 900	4	NO.		
5	10" RTJ Blind Flange Class 900	1	NO.		
6	10" RTRJ Flange class 900	4	NO.		
	TEE PIECES				
1	2"x2" Tee Piece SCH 80	1	NO.		
2	12"x28" Tee piece STD	1	NO.		

3	10”x10” Tee Piece XS	1	NO.		
	REDUCER				
1	10”x 12” Reducer	1	NO.		
	SOCKETLETS				
1	1” SCH 80 Socketlets	3	NO.		
2	3” SCH 80 Socketlets	2	NO.		
3	3” SCH 40 Socketlets	2	NO.		
	VALVES				
1	1” Weldon Gate Valve class 900	4	NO.		
2	2” Gate Valve with RTJ Flanges Class 900	4	NO.		
3	3” Gate Valve with RTJ Flanges class 900	2	NO.		
4	3” Gate Valve with Raised Face Flanges class 300	2	NO.		
5	12” Gate valve with RTJ Flanges class 900	1	NO.		
	RUPTURE DISC ASSEMBLY				
1	6” Raised Face Flanges class 300	4	NO.		
2	RUPTURE Disc holder in which a 6” RUPTURE Disc can fit	2	SET		
3	6” RUPTURE Disc which a rating of 17.5 bar and 206^{o}C	5	NO.		
	PIPE SUPPORTS				
1	Pipe bearing supports/ Tee supports see the typical issued drawing. The stanchion to be 8” (DN200) STD pipe with an average height of 4M out of which 1M will be within the concrete pile	5	NO.		
2	Pipe shoes	5	NO.		
3	Counterweight supports	2	NO.		
	INSULATION				

1	Insulation for 3" Pipe (80mm thick calcium Silicate	24	M		
2	Aluminium cladding for insulated 3" Pipe	24	M		
3	Insulation for 12" Pipe (75mm thick calcium Silicate)	24	M		
4	Aluminium cladding for insulated 12" Pipe	24	M		
5	Insulation for 2" Pipe (80mm thick Calcium Silicate	36	M		
6	Aluminium cladding for insulated 2" Pipe	36	M		
7	Insulation for 10" Pipe (75mm thick Calcium Silicate)	12	M		
8	Aluminium cladding for insulated 10" pipe	12	M		
	INSTRUMENTS AND THEIR FITTINGS				
1	½" (M) Glycerine filled pressure gauges (0-200 bar)	1	NO.		
2	½" (M) Glycerine filled pressure gauges 90-100 bar)	2	NO.		
3	1" Socketlets SCH 40	3	NO.		
4	½" 180° Q type syphon SS 316 10000 PSI MXM	3	NO.		
5	SS 316 ½" FxF GNV	3	NO.		
6	1"X1/2" MxF SS 316 reducer NPT 10000 PSI	3	NO.		
7	1" NPT valve class 300	3	NO.		
8	1" SCH 40 Pipes (SS)	12	M		
TOTAL FOR TWO PHASE PIPELINE FOR WELL OW-50C					

C	COMBINED TWO PHASE LINE				
ITEM	DESCRIPTION	QTY	UNITS	UNIT PRICE (KES)	TOTAL PRICE DPP (KES)
	PIPES				
1	3" (DN80) SCH 40	12	M		
2	28" (DN 700) STD	150	M		
3	14" (DN 350) STD	24	M		
	ELBOWS				
1	28" 90^{O} Long radius bend STD	6	NO.		
2	3" 90^{o} Long Radius elbow SCH 40	6	NO.		
3	14" 90^{o} Long Radius Elbow STD	4	NO.		
	FLANGES				
1	3" Raised Face Flanges class 300	10	NO.		
2	28" Raised face flanges class 300	12	NO.		
3	14" Raised face Flange class 300	4	NO.		
	TEE PIECES				
1	14"x28" Tee piece STD	2	NO.		
	SOCKETLETS				
1	1" SCH 80 Socket lets	3	NO.		
	VALVES				
1	1" Weldon Gate Valve class 900	4	NO.		
2	3" Gate Valve with Raised Face Flanges class 300	12	NO.		
3	28" Gate valve with Raised face Flange class 300	6	NO.		
	PIPE SUPPORTS				

1	Pipe bearing supports/ Tee supports see the typical issued drawing. The stanchion to be 8" (DN200) STD pipe with an average height of 4M out of which 1M will be within the concrete pile	36	NO.		
2	Pipe shoes	36	NO.		
	INSULATION				
1	Insulation for 3" Pipe (80mm thick calcium Silicate	24	M		
2	Aluminium cladding for insulated 3" Pipe	24	M		
3	Insulation for 28" Pipe (55mm thick calcium Silicate)	150	M		
4	Aluminium cladding for insulated 28" Pipe	150	M		
5	Insulation for 14" Pipe (75mm thick Calcium Silicate	24	M		
6	Aluminium cladding for insulated 14" Pipe	24	M		
	INSTRUMENTS AND THEIR FITTINGS				
1	½" (M) Glycerine filled pressure gauges (0-200 bar)	1	NO.		
2	½" (M) Glycerine filled pressure gauges 90-100 bar)	2	NO.		
3	1" Socketlets SCH 40	3	NO.		
4	½" 180° Q type syphon SS 316 10000 PSI MXM	3	NO.		
5	SS 316 ½" FxF GNV	3	NO.		
6	1"X1/2" MxF SS 316 reducer NPT 10000 PSI	3	NO.		
7	1" NPT valve class 300	3	NO.		
8	1" SCH 40 Pipes (SS)	12	M		

TOTAL FOR COMBINED TWO PHASE PIPELINE	

E	STEAM PIPELINE FROM SEPARATOR OW-50 TO TIE-IN NEAR OW-32				
ITEM	DESCRIPTION	QTY	UNITS	UNIT PRICE (KES)	TOTAL PRICE DPP (KES)
	PIPES				
1	3" (DN 80) SCH 40	12	M		
2	14" (DN 350) STD	24	M		
3	28" (DN 700500) STD	2420	M		
	ELBOWS				
1	3" 90° Long Radius elbow SCH 40	6	NO.		
2	28" 90° Long Radius Elbow STD	56	NO.		
3	28" 45° Long Radius Elbow STD	11	NO.		
	FLANGES				
1	3" Raised Face Flanges class 300	8	NO.		
2	28" Raised Face Flange Class 300	10	NO.		
3	14" Raised Face Flange Class 300	6	NO.		
	SOCKETLETS				
1	3" SCH 40 Socklets	2	NO.		
	VALVES				
1	2" Gate Valve with Raised Face Flanges Class 300	2	NO.		
2	3" Gate Valve with Raised Face Flanges class 300	6	NO.		
3	14" Gate valve with Raised Face Flanges class 300	8	NO.		
4	28" Gate Valve with Raised Face Flange class 300	2	NO.		
	STEAM TRAPS AND CDP FITTINGS				
1	Steam trap as per specifications in section VII	22	NO.		

2	22" Raised Face Flange class 300	22	NO.		
3	22' Raised Face blind Flange Class 300	22	NO.		
4	2" Socketlets SCH 80 SS 316	22	NO.		
5	2" 90° Elbows SCH 80 SS 316	66	NO.		
6	2" x 2" SCH 80 SS 316 Tee Piece	44	NO.		
7	2" Raised face Flanges class 300	120	NO.		
8	2" Gate valve with Raised Face Flange class 300	66	NO.		
9	2"X ¾" SCH 80 Tee Piece SS 316	44	NO.		
10	¾" Union SCH 80	22	NO.		
11	2" SCH 80 Pipe SS 316	150	M		
12	3/4" SCH 80 Pipes SS 316	66	M		
13	22" STD Pipe Carbon steel	22	M		
	FLOW METER FITTINGS				
1	2" Gate Valve with Raised face Flange Class 300	1	NO.		
2	2" Raised Face Flange class 300	2	NO.		
3	2" Socketlets SCH 80	1	NO.		
	INSTRUMENTS AND THEIR FITTINGS				
1	½ Inch (M) Glycerine Filled Pressure Gauges(0-20bar)	1	NO		
2	1 Inch Sockolets Sch 40	1	NO		
3	½ Inch,180° Q Type Syphon SS 316 10000Psi, M x M	1	NO		
4	SS 316, ½ FxF GNV	1	NO		

5	1-½ Inch, M x F SS316 reducer, NPT 10000Psi	1	NO		
6	1 Inch NPT Cl 300 Valve	1	NO		
7	1 Inch SCH 40 Pipe(SS 316)	6	M		
	RUPTURE DISC ASSEMBLY				
1	6" Raised Face Flanges class 300	8	NO.		
2	RUPTURE Disc holder in which a 6" RUPTURE Disc can fi	4	SET		
3	6" RUPTURE Disc which a rating of 17.5 bar and 206°C	6	NO.		
	PIPE SUPPORTS				
1	Pipe bearing supports/ Tee supports see the typical issued drawing. The stanchion to be 8" (DN200) STD pipe with an average height of 4M out of which 1M will be within the concrete pile	360	NO.		
2	Pipe shoes	360	NO.		
	INSULATION				
1	Insulation for 3" Pipe (80mm thick calcium Silicate	12	M		
2	Aluminium cladding for insulated 3" Pipe	12	M		
3	Insulation for 14" Pipe (75mm thick calcium Silicate)	24	M		
4	Aluminium cladding for insulated 14" Pipe	24	M		
5	Insulation for 28" Pipe (55mm thick Calcium Silicate	2420	M		
6	Aluminium cladding for insulated 28" Pipe	2420	M		
TOTAL FOR STEAM PIPELINE FROM SEPARATOR OW-50 TO TIE-IN NEAR OW-32					

F	BRINE PIPELINE FROM SEPARATOR OW-50 TO TIE-IN TO BRINE LINE NEAR OW-38				
ITEM	DESCRIPTION	QTY	UNITS	UNIT PRICE (KES)	TOTAL PRICE DPP (KES)
	PIPES				
1	4" (DN 100) STD	24	M		
2	8" (DN 200) STD	1960	M		
3	10" (DN 250) SCH 80	18	M		
4	3" (DN 80) STD	12	M		
	ELBOWS				
1	4" 90° Long Radius elbow STD	12	NO.		
2	8" 45° Long Radius Elbow STD	13	NO.		
3	8"90° Long radius Elbow STD	34	NO.		
3	10" 45° Long Radius Elbow SCH 80	4	NO.		
	FLANGES				
1	4" Raised Face Flanges class 300	5	NO.		
2	8" Raised face Flanges class 300	14	NO.		
3	10" RTJ Flange Class 900	2	NO.		
4	10" RTJ Blind RTJ Flange class 600	2	N0.		
5	10" RTJ Blind RTJ blind Flange class 600	2			
	TEE PIECES				
1	4"X8" Tee Piece STD	1	NO.		
2	10"X10" Tee Piece SCH 80	1	NO.		
	REDUCER				
1	4"X8" STD Reducer	2	NO.		
2	8"x10" SCH 80 Reducer	1	NO.		
	VALVES				

1	4" Gate Valve with Raised Face Flanges Class 300	4	NO.		
3	10" Gate valve with RTJ Flanges class 600	2	NO.		
	RUPTURE DISC ASSEMBLY				
1	3" Raised Face Flanges class 300	4	NO.		
2	RUPTURE Disc holder in which a 3" RUPTURE Disc can fi	2	SET		
3	3" RUPTURE Disc which a rating of 30 bar and 233.84°C	4	NO.		
	PIPE SUPPORTS				
1	Pipe bearing supports/ Tee supports see the typical issued drawing. The stanchion to be 8" (DN200) STD pipe with an average height of 4M out of which 1M will be within the concrete pile	490	NO.		
2	Pipe shoes	490	NO.		
3	Counter weight	2	NO.		
	INSULATION				
1	Insulation for 4" Pipe (55mm thick calcium Silicate	36	M		
2	Aluminium cladding for insulated 4" Pipe	36	M		
3	Insulation for 8" Pipe (55mm thick calcium Silicate)	1960	M		
4	Aluminium cladding for insulated 8" Pipe	1960	M		
5	Insulation for 10" Pipe (55 mm thick Calcium Silicate	12	M		
6	Aluminium cladding for insulated 10" Pipe	12	M		
	FLASH TANK				
1	Flash tank as per the specifications in section VII	1	NO.		

2	3" Pipe SCH 40	6	M		
3	3" Raised Face Flange class 300	2	NO.		
4	3" Gate Valve with Raised Face Flange class 300	1	NO.		
5	2" 90° Elbow SCH 40	2	N0.		
6	4" Raised Face Blind flange Class 300	4	NO.		
7	24" Raised face blind Flange class 300	4	NO.		
8	2" Pipe XS	12	M		
	Flash tank Nozzles				
1	Manhole size DN 600 – XS,	1	ITEM		
2	24" (DN 600) Raised Face Flange class 300	2	NO.		
3	Inlet, DN 250 SCH 40, tangential	1	ITEM		
4	10" Weld neck, Raised Face Flange class 300	2	NO.		
5	Outlet weir box 4500 x 1085 x 850 and 12.7 mm thick carbon steel to ASTM A36	1	ITEM		
6	Hand holes (DN 150) SCH 120	1	NO.		
7	6" Raised Face Flange class 300	1	NO.		
	VENTS				
1	1 3/4" Socketlets SCH 80	6	NO		
2	1 ¾" Weld on Gate valves class 300	6	NO.		
3	1 ¾" 90° elbow SCH 80	6	NO.		
4	1 ¾" SCH 40 PIPE	24	M		
	INSTRUMENTS AND ASSOCIATED FITTINGS				
1	½ Inch (M) Glycerine Filled Pressure Gauges(0-200bar)	1	NO		

2	½ Inch (M) Glycerine Filled Pressure Gauges(0-100bar)	2	NO		
3	½ Inch (M) Glycerine Filled Pressure Gauges(0-20bar)	1	NO		
4	1 Inch Socklets Sch 40	4	NO.		
5	½ Inch,180° Q Type Syphon SS 316 10000Psi, M x M	4	NO.		
6	SS 316, ½ FxF GNV	4	NO.		
7	1-½ Inch, M x F SS316 reducer, NPT 10000Psi	4	NO.		
8	1 Inch NPT Cl 300 Valve	4	NO		
9	1 Inch SCH 40 Pipe(SS)	12	M		
	Flow Meter Fittings				
1	2 Inch gate valve, RF Flanged Cl 600	1	NO		
2	2 Inch RF Flanges Cl 600	2	NO		
3	2 Inch Sockolets SCH 80	1	NO		
TOTAL FOR BRINE PIPELINE FROM SEPARATOR OW-50 TO TIE-IN TO BRINE LINE NEAR OW-38 AND BACK CONNECTION TO WELL OW-R6					

H	WELLHEAD AND SEPARATOR FLASH TANK AT WELLPAD OW-50				
ITEM	DESCRIPTION	QTY	UNITS	UNIT PRICE (KES)	TOTAL PRICE DPP (KES)
1	FLASH TANK AS PER SPECIFICATIONS IN SECTION VII	1	NO.		
2	3" Pipe SCH 40	6	M		
3	3" Raised Face Flange class 300	2	NO.		
4	3" Gate Valve with Raised Face Flange class 300	1	NO.		
5	2" 90° Elbow SCH 40	2	N0.		
6	4" Raised Face Blind flange Class 300	4	NO.		
7	24" Raised face blind Flange class 300	4	NO.		
8	2" Pipe XS	12	M		
	Flash tank Nozzles				
1	Manhole size DN 600 – XS,	1	ITEM		
2	24" (DN 600) Raised Face Flange class 300	2	NO.		
3	Inlet, DN 250 SCH 40, tangential	1	ITEM		
4	10" Weld neck, Raised Face Flange class 300	2	NO.		
5	Outlet weir box 4500 x 1085 x 850 and 12.7 mm thick carbon steel to ASTM A36	1	ITEM		
6	Hand holes (DN 150) SCH 120	1	NO.		
7	6" Raised Face Flange class 300	1	NO.		
	PIPES				
1	3" (DN 80) STD	6	M		
2	28" (DN 500) SCH 40	102	M		
	Flanges				
1	28" Raised face Flange class 300	4	NO.		

2	28" Raised Face Blind Flange Class 300	1	NO.		
	Reducer				
1	12"x28" reducer SCH 40	1	NO.		
	PIPE SUPPORTS				
1	Pipe bearing supports/ Tee supports see the typical issued drawing. The stanchion to be 8" (DN200) STD pipe with an average height of 4M out of which 1M will be within the concrete pile	12	NO.		
2	Shoes	12	NO.		
TOTAL FOR WELLHEAD FLASH TANK AT WELLPAD OW-50					

I	SEPARATOR STATION FOR WELLS OW-50A/B/C				
ITEM	DESCRIPTION	QTY	UNITS	UNIT PRICE (KES)	TOTAL PRICE DPP (KES)
1	SEPARATOR AS PER SPECIFICATIONS IN SECTION VII	2	NO.		
TOTAL FOR SEPARATOR STATION FOR WELLS OW-50A/B/C					

SUMMARY PAGE FOR INSTALLATION WORKS

ITEM	DESCRIPTION	AMOUNT (KES)
A	TOTAL FOR TWO PHASE PIPELINE FOR WELL OW-50A	
B	TOTAL FOR TWO PHASE PIPELINE FOR WELL OW-50B	
C	TOTAL FOR TWO PHASE PIPELINE FOR WELL OW-50C	
D	TOTAL FOR COMBINED TWO PHASE PIPILINE	
E	TOTAL FOR STEAM PIPELINE FROM SEPARATOR OW-50 TO TIE-IN NEAR WELL OW-32	
F	TOTAL FOR BRINE PIPELINE FROM SEPARATOR OW-50 TO TIE IN NEAR WELL OW-38 AND BACK CONNECTION TO WELL OW-R6	
G	TOTAL FOR WELLHEAD FLASH TANK AT WELLPAD OW-50	
H	TOTAL FOR SEPARATOR STATION FOR WELLS OW-50A/B/C	
	TOTAL FOR INSTALLATION WORKS	

CIVIL WORKS

ITEM	DESCRIPTION	UNIT	QNTY	RATE	AMOUNT (KES)
	SECTION 1 PILE FOUNDATIONS				
	NOTE: - Upon finishing works, spread all soil mounds level; clean site; plant grass as shall be directed by engineer; water grass for a period of at least 30 consecutive days; dispose of any construction debris and leave site as clean as possible to the satisfaction of the client. Rates herein must allow for these works to be undertaken.		-		
	PILE EXCAVATIONS				
1	Allow for excavation for PILE Foundations	CM	3		
	Concreting				
2	Concrete class 25/20mm (1: 1 1/2: 3) in Foundation Stub Columns	CM	3		
	Reinforcement				
	High yield tensile steel bar reinforcement to BS 4461 including cutting , bending, overlaps as applicable and tying wire in;-				
3	T-10mm diameter high yield tensile steel bar - RING	KG	18		
4	T-20mm diameter high yield tensile steel bar -		180		
5	T-25mm diameter high yield tensile steel bar - MAIN BAR	KG	216		
6	PILE FOUNDATION – FOR ONE PILE				
	TOTAL PILE FOUNDATION FOR 600 PILES (ITEM NO. 5 X 964) (Carried to Summary)				

ITEM	DESCRIPTION	UNIT	QNTY	RATE	AMOUNT (KES)
	SECTION 2 SEPARATOR STATION FOUNDATION				
	NOTE: - Upon finishing works, spread all soil mounds level; clean site; plant grass as shall be directed by engineer; water grass for a period of at least 30 consecutive days; dispose of any construction debris and leave site as clean as possible to the satisfaction of the client. Rates herein must allow for these works to be undertaken.		-		
	-		-		
	EXCAVATIONS				
1	Allow for excavation for separator Foundation	CM	48.00		
2	Fill excavated area with approved mix of hardcore bed and gravel fill in making up levels approximately 500mm; including grading, leveling, ramming and consolidating in 100mm thick layers, well compacted	CM	9.8		
3	Allow for backfilling to level around excavated foundations	CM	27		
	Blinding				
4	Plain In situ Blinding Concrete Class X Mix (1:4:8)	CM	1		
	Concreting				
5	Concrete class 25/20mm (1: 1 1/2: 3) in Foundation Stub Columns	CM	21		
	Reinforcement				
	High yield tensile steel bar reinforcement to BS 4461 including cutting , bending, overlaps as applicable and tying wire in;-				
6	T-12mm diameter high yield tensile steel bar	KG	572		
7	T-10mm diameter high yield tensile steel bar	KG	115		
8	TOTAL FOR ONE SEPARATOR				
	TOTAL FOR TWO SEPARATORS (ITEM NO. 8X2) (Carried to Summary)				

ITEM	DESCRIPTION	UNIT	QNTY	RATE	AMOUNT (KES)
	SECTION 3 FLASH TANK FOUNDATION				
	NOTE: - Upon finishing works, spread all soil mounds level; clean site; plant grass as shall be directed by engineer; water grass for a period of at least 30 consecutive days; dispose of any construction debris and leave site as clean as possible to the satisfaction of the client. Rates herein must allow for these works to be undertaken.				
	EXCAVATIONS				
1	Allow for excavation for separator Foundation	CM	150.00	-	
2	Fill excavated area with approved mix of hardcore bed and gravel fill in making up levels approximately 500mm; including grading, leveling, ramming and consolidating in 100mm thick layers, well compacted	CM	3 6	-	
3	Allow for backfilling to level around excavated foundations	CM	90		
	Blinding				
4	Plain In situ Blinding Concrete Class X Mix (1:4:8)	CM	6		
	Concreting				
5	Concrete class 25/20mm (1: 1 1/2: 3) in Foundation Stub Columns	CM	72		
	Reinforcement				
	High yield tensile steel bar reinforcement to BS 4461 including cutting , bending, overlaps as applicable and tying wire in;-				
6	T-12mm diameter high yield tensile steel bar	KG	1716		
7	T-12mm diameter high yield tensile steel bar	KG	345.6		
8	TOTAL FOR FLASH TANK FOUNDATION				
	TOTAL FOR TWO FLASH TANKS (ITEM NO. 8X2) (Carried to Summary)				

ITEM	DESCRIPTION	UNIT	QNTY	RATE	AMOUNT (KES)
	1 NO. CULVERT CROSSING				
	NOTE: - Upon finishing works, spread all soil mounds level; clean site; plant grass as shall be directed by engineer; water grass for a period of at least 30 consecutive days; dispose of any construction debris and leave site as clean as possible to the satisfaction of the client. Rates herein must allow for these works to be undertaken.				
	EXCAVATIONS				
1	Allow for excavation for culvert crossing	CM	207.79		
2	Fill excavated area with approved mix of hardcore bed and gravel fill in making up levels approximately 500mm; including grading, leveling, ramming and consolidating in 100mm thick layers, well compacted	CM	32		
	Blinding			-	
3	Plain In situ Blinding Concrete Class X Mix (1:4:8)	CM	3.2		
	Concreting				
4	Concrete class 25/20mm (1: 1 1/2: 3) in Foundation Stub Columns	CM	93.7		
	Reinforcement				
	High yield tensile steel bar reinforcement to BS 4461 including cutting , bending, overlaps as applicable and tying wire in;-				
	T-10mm diameter high yield tensile steel bar	KG	1051		
5	T-12mm diameter high yield tensile steel bar	KG	2251		
6	T-16mm diameter high yield tensile steel bar	KG	806		
7	1 NO. CULVERT CROSSING				
	TOTAL FOR 3NO. CULVERT CROSSING (ITEM NO. 7X3) (Carried to Summary)				

ITEM	DESCRIPTION	UNIT	QNTY	RATE	AMOUNT (KES)
	SECTION 5 POND AND SOAKPIT				
	NOTE: - Upon finishing works, spread all soil mounds level; clean site; plant grass as shall be directed by engineer; water grass for a period of at least 30 consecutive days; dispose of any construction debris and leave site as clean as possible to the satisfaction of the client. Rates herein must allow for these works to be undertaken.				
	Soak Pit				
8.01	Allow for excavation in soft material for soak pit	CM	60.00 -		
8.02	Extra over for excavation in rock	CM	20.00		
			-		
8.03	Supply and place rock fill for soak pit	CM	72		
	Concreting				
8.04	Cast a concrete wall class 25/20 (1: 1 1/2: 3)100mm thick reinforced with A142 BRC -	CM	6		
	Reinforcement				
	Supply and fix A142 BRC reinforcement including cutting , bending, overlaps as applicable and tying wire in;-	SM	60		
	Pond -				
8.04	Allow for excavation in soft material for pond	CM	8,100.00		
8.05	Extra over for excavation in rock	CM	810.00		

ITEM	DESCRIPTION	UNIT	QNTY	RATE	AMOUNT (KES)
	SECTION 5 POND AND SOAKPIT				
8.06	Fill excavated area with approved mix of hardcore bed and gravel fill in making up levels approximately 300mm; including grading, leveling, ramming and consolidating in 150mm thick layers, well compacted	CM	990.00		
8.07	Supply and install fused 0.75-1mm HDPE/EPDM pond line	SM	4000		
8.08	Supply and place complete with grouting 100mm thick stone pitching lining to exposed pond area	CM	400		
8.09	Allow for excavation for drains	CM	36.00		
8.10	Construct 100mm thick class 20/20 concrete lined drainage system. Rate to include for all the necessary formwork and steel reinforced grating cover	CM	21.6		
	Concreting				
8.11	Cast reinforced concrete class 25/20mm (1: 1 1/2: 3) beam all-round the pond.	CM	43.7		
	Reinforcement				
	High yield tensile steel bar reinforcement to BS 4461 including cutting , bending, overlaps as applicable and tying wire in;-				
8.12	T-12mm diameter high yield tensile steel bar	KG	3155.6		
8.13	R-8mm diameter high yield tensile steel bar	KG	3083.6		
	Fencing				
	Use 3mm thick GI class B pipe and 4mm thick chain link to				

ITEM	DESCRIPTION	UNIT	QNTY	RATE	AMOUNT (KES)
	SECTION 5 POND AND SOAKPIT				
	fence 60 by 60 m all-round the pond area				
	Concreting				
	Cast reinforced concrete class 25/20mm (1: 1 1/2: 3) beam all-round the fencing line to support the fencing posts.	CM	51.8		
8.14	Supply and install 3mm thick GI class B pipe 3 m high	LM	453.6		
8.15	Supply and install 2.5M high galvanized steel chain link fence of Gauge 4mm.	M	288		
	Reinforcement				
	High yield tensile steel bar reinforcement to BS 4461 including cutting , bending, overlaps as applicable and tying wire in;-				
8.16	T-12mm diameter high yield tensile steel bar	KG	3086		
8.17	T-12mm diameter high yield tensile steel bar	KG	2506.3		
	10No. SOAK PITS AND 2 No. PONDS (carried to summary)				

SUMMARY PAGE FOR CIVIL WORKS

ITEM	DESCRIPTION	AMOUNT (KES)
A	SECTION 1 PILE FOUNDATION ~	
B	SECTION 2 SEPARATOR FOUNDATION	
C	SECTION 3 FLASH TANK FOUNDATION	
D	SECTION 4 CULVERT CROSSING	
E	SECTION 5 10No. SOAK PITS AND 3No. PONDS	
~	TOTAL FOR CIVIL MATERIAL WORKS	

TOTAL FOR PRICE SCHEDULE NO. 3

ITEM	DESCRIPTION	AMOUNT (KES)
A	TOTAL FOR MECHANICAL WORKS	
B	TOTAL FOR CIVIL WORKS	
	TOTAL FOR PRICE SCHEDULE NO.3	

PRICE SCHEDULE NO.4:

PRICE SCHEDULE FOR SERVICES

PRICE SCHEDULE FOR SERVICES

ITEM	DESCRIPTION	QTY	UNITS	UNIT PRICE (KES)	TOTAL PRICE DPP (KES)
	SERVICES				
2	SURVEYING SERVICES	1	ITEM		
3	NON-DESTRUCTIVE TESTING – 20 % RADIOGRAPHY OF WELDED JOINTS	1	ITEM		
4	FACTORY ACCEPTANCE TEST FOR THE 1. SEPARATOR. 2. PIPES 3. VALVES	1	ITEM		
5	LAPTOPS AS SPECIFIED IN THE TENDER	5	NO.		
6	SOFTWARE AS SPECIFIED IN THE TENDER	1	ITEM		
7	TRAINING AS SPECIFIED IN THE TENDER	1	ITEM		
8	CODES AND STANDARDS AS SPECIFIED IN THE TENDER IN PDF FORMAT IN PDF FORM	1	ITEM		
TOTAL FOR SERVICES					
TOTAL FOR PRICE SCHEDULE NO. 4					

PRIME COST SUMS AND CONTIGENCY

PRIME COST SUMS AND CONTINGENCY

ITEM	DESCRIPTION	QTY	UNITS	UNIT PRICE (KES)	TOTAL PRICE DPP (KES)
	PRIME COST SUMS				
1	ELECTRICAL WORKS	1	ITEM		15,000,000.00
2	INSTRUMENTATION	1	ITEM		15,000,000.00
3	CONTIGENCY AMOUNT	1	ITEM		45,000,000.00
TOTAL FOR SCHEDULE 4					**75,000,000.00**

SUMMARY PAGE FOR PRICE SCHEDULES

ITEM	DESCRIPTION	TOTAL PRICE DPP (KES)
1	PRICE SHEDULE NO. 1, PRELIMINARIES	
1	PRICE SCHEDULE NO. 2, SUPPLY OF PLANT AND MATERIALS	
2	PRICE CHEDULE NO.3 INSTALLATION WORKS	
3	PRICE SCHEDULE NO.4 SERVICES	
4	PRIME COST SUMS AND CONTIGENCY	75,000,000.00
TOTAL		
TAXES		
GRAND TOTAL FOR SUPPLY OF MATERIALS TO SITE, INSTALLATION WORKS, TESTING AND COMMISTIONG OF WORKS AND HAND OVER OF PROJECT TO THE EMPLOYER INCLUSIVE OF ALL TAXES.		

16% Value Added Tax (VAT) Shall be considered as part of the taxes and therefore it will be deemed included in the grand total amount.

Tenderers Name _____

Tenderer's Signature _____

Tenderer's Rubber Stamp _____

MANUFACTURER AUTHORIZATION FORM

[The tenderer shall require the Manufacturer to *fi*ll in this Form in accordance with the instructions indicated. This letter of authorization should be on the letterhead of the Manufacturer and should be signed by a person with the proper authority to sign documents that are binding on the Manufacturer. The tenderer shall include it in its Tender, if so indicated in the TDS.]

Date:.....[insert date (as day, month and year) of Tender submission]

ITT No.:.....[insert number of ITT process] Alternative No.:.....[insert identi*fi*cation

No if this is a Tender for an alternative]

To: ..... [Insert complete name of Procuring Entity]
WHEREAS

We..... [insert complete name of Manufacturer], who are official manufacturers of.....[insert type of goods manufactured], having factories at [insert full address of Manufacturer's factories], do hereby authorize [insert complete name of tenderer] to submit a Tender the purpose of which is to provide the following Goods, manufactured by us..... [insert name and or brief description of the Goods], and to subsequently negotiate and sign the Contract.

We hereby extend our full guarantee and warranty in accordance with Clause 28 of the General Conditions of Contract, with respect to the Goods offered by the above firm.

Signed:..... [Insert signature(s) of authorized representative(s) of the Manufacturer]

Name:.....[Insert complete name(s) of authorized representative(s) of the Manufactur
er]

Title:..... [Insert title]

Dated on_____day of_____,_____[insert date of signing]

SITE VISIT CERTIFICATE

This is to certify that (IN BLOCK LETTERS)

Name:.....

Cell Phone No:.....

Email:.....

Being the authorized representative of (IN BLOCK LETTERS)

M/S [Firm/Company].....

Official Tel No.....

Official Email:.....

Participated in the organized inspection visit of the site of the works for:

KGN-GDD-056-2023-TENDER FOR CONNECTION OF MAKE UP WELLS OW-50A, OW-50B AND OW-50C TO OLKARIA 1 AU POWER PLANT

Held on.....Day of.....20.....

To be filled by KenGen Representative

.....
(Name of KenGen's Representative)

.....
(Designation)

.....DATE.....
(Signature KenGen's Representative)

NOTE: This form is to be completed at the time of the organized site visit; Bidder to bring along with him duly filled site visit certificate during the site visit