ISIOLO ABATTOIR

REFRIGERATION TENDER JULY 2022

TENDER CLOSING: Refer main tender document

SPECIFICATION AND TENDER FOR INSTALLATION OF REFRIGERATION WORKS AT ISIOLO EXPORT ABBATOIR IN BURAT WARD, ISIOLO KENYA.

NAME OF TENDERER: ADDRESS: TEL. NO: FAX. NO:	
CONSULTING ENGINEERS: AMC ENGINEERS (PTY) LTD POSTNET SUITE 142 PRIVATE BAG X VLAEBERG 8018	**EMPLOYER:** Refer to main tender document

Contents

1. Tender Notice and Invitation to Tender

As per the main tender document.

2. Conditions of Contract

As per the main tender document.

3. Detailed technical specification

3.1. General

This Specification shall be read in conjunction with the drawings, Standard Specification and Conditions of Contract which form part of the tender and contract documentation.

Any discrepancies between the documents and/or drawings shall be brought to the attention of the Engineer prior to submitting a tender.

It is to be noted that in all instances the design intent of the engineer is to be adhered to and the contractor is responsible for the execution of the project in its entirety and to provide a fully functional plant to the client. If any aspect of the specification is unclear the contractor is to raise this with the engineer at the time of submitting the tender.

It is a specific requirement of this specification that all OEM technical specifications, instructions and guidelines be adhered to unless agreed to in writing between the contractor and the engineer. The onus of applying these rest with the contractor. If at any time there is conflict between the specifications contained in this document, and OEM recommendations or requirements, it is to be brought to the attention of the Engineer in writing immediately.

All electrical work shall conform to the specification and shall comply with the local regulations and the requirements covering this type of work in the Kenya. It is the contractors' responsibility to ensure that all local rules and regulations are adhered to, and the engineer is made aware of any deviations from these regulations by the contractor.

The contract includes the supply, delivery, installation, commissioning, guarantee and 12 months “free” maintenance of the new refrigeration systems designed for the Employer. The one-year guarantee and maintenance period will commence once practical completion has been reached. The Engineer is AMC Engineers. The Engineer is the single point of contact and must be CC’d into all related correspondence.

The lowest, or any tender, will not necessarily be accepted. Any Tender which does not comply with the requirements stated in these documents may be considered invalid. Tenderers may include with their Tenders any descriptive matter which, if referred to in the Tender, will form part of the Tender. In case of any discrepancy, however, the issued Tender and Contract documents and information completed therein by the Tenderer, will be considered as the valid and binding Tender.

3.1.1. Site and Site Conditions

The site is located in Isiolo, Kenya. The site is existing and some modifications to the existing buildings will be made during construction.

3.1.2. Drawings

The following drawings form part of this contract:

Drawing number	Description	Revision
1200	REFRIGERATION PIPING LAYOUT	B
2508	REFRIGERATION DETAIL SHEET	B
5700	BUILDER'S WORK PIPING AND EQUIPMENT LAYOUT	B

3.1.3. Programming

The Contractor shall complete a detail programme in conjunction with the client and / or main contractor. The programme shall be submitted to the Engineer within two weeks from date of appointment.

3.1.4. Construction Electricity and Water

The cost of the electricity and water used during the construction and commissioning of this contract will be for the contractor's account.

3.1.4.1. Electricity

Electricity availability on site is uncertain. The contractor is to allow their own electricity supply in the event of no electricity being available on site. All temporary construction power supplies of all nature shall conform with all relevant regulations and signed off as required. Refer to the main tender documents for further details.

3.1.4.2. Water

Water availability on site is uncertain. The reticulation or transport of water to where it is required is for the contractors account. Refer to the main tender documents for further details.

3.1.4.3. Project Requirements

This contract shall include, but not be limited to the following:

- The refrigeration installation including the supplying, testing and commissioning
- Co-ordination with electrical, fire protection, insulation services, structural elements and other typical contractors installing services in and around the insulated envelope. This is described in further detail in the dedicated section below.
- The provision of installation / shop drawings and equipment ordering schedules for approval. The contractor must prepare and issue drawings and equipment schedules to the engineer for approval prior to the ordering and manufacturing of the equipment. The drawings shall include the exact electrical requirements for all equipment (where applicable). This information must be issued to the engineer within two (2) weeks from the date of appointment for this project. All equipment that will be installed must be issued to the engineer for approval prior to procurement and installation.
- The provision of lockable storage facilities (i.e. containers, etc.) on site for all materials, equipment, tools, etc., as required by the contractor remains the responsibility of the contractor.
- The supply and erection of all scaffolding, extension ladders, cranes, hoists and lifts etc. necessary for installing, testing and commissioning of the installation.
- Removal from site of excess and all waste material generated during the installation. This is to be removed during installation and after installation and at regular intervals, but no less than weekly.

- The workspace / areas shall be left clean and tidy daily after work is completed. This aspect will be strictly enforced.
- By submitting a tender, the contractor accepts that the current, and anticipated on-site conditions are understood and that sufficient allowances have been made.
- The tenderer must make allowance for the hoisting, rigging and lifting of all equipment into the areas where required.
- The training of the client's staff on the operation of the specialist installations and maintenance operations required.
- Twelve (12) months maintenance and guarantee is to be included in the price. These are to cover all aspects and items that are installed or supplied by the contractor.
- Installation and as-built drawings and electrical wiring and control diagrams are the responsibility of the contractor. The contractor must submit all as built drawings to the engineer before practical completion.
- The provision of Operating and Maintenance manuals in a single consolidated digital file, electronically transferred.
- The entire installation must conform to the requirements of this specification and must be complete in every respect. All items and procedures required to make this a complete working installation, whether expressly mentioned or not, must be allowed for in the contract price.
- The contractor is to include a detailed organogram updated to include their project specific resourcing. Allowance is to be made for full time site supervision together with the allocation of senior management to oversee this project and attend regular (weekly and ad hoc as required) site meetings. This organogram and responsible person matrix must be supplied to the engineer within two (2) weeks of appointment. The site team as listed on the organogram is to remain for duration of the project.
- The contractor must comply with all Health and Safety legislature and good practice requirements.

3.1.5. Responsibilities of others

3.1.5.1. Building Contractor

It is the responsibility if the Contractor to provide "Marked up" drawings timeously indicating all openings, frames, etc. as well as openings or walls to be left out temporarily for access of equipment. The following builders work will be by others:

- The provision of openings in structural concrete work, masonry brick work, roof or wall cladding, insulated panelling etc
- The final flashing and waterproofing of all pipe and duct penetrations through external walls and roofs, etc. (Temporary waterproof seals shall be carried out by The Contractor) including all back flashing and waterproofing of areas. Thus finishing of all building related aspects that pertain to the HVAC installation.
- The provision of openings in insulated sandwich panelling – The HVAC&R contractor is not allowed to make any cuts, penetrations or perform any other works on the insulated panels unless given written permission by the Engineer. All penetrations required are to be neatly marked out by the contractor to the exact size of the free opening required. The actual size required is to be written alongside the penetration on the portion of the panel that will be discarded.

3.1.5.2. Electrical Contractor

The Electrical Contractor will be responsible to provide a power supply to each piece of equipment for the HVAC system as listed below:

- The main electrical supply in the plant room as shown on the drawings.

Any variation in the electrical loading of any of the units or equipment in the tender from the specified electrical load on the tender drawings and schedule must be brought to the attention of the engineer within two weeks after appointment.

3.1.5.3. Plumber

The condensate drains shall be supplied and installed by the HVAC&R contractor as shown on the drawings. Piping is to be routed to the nearest drain point, provided by the plumber as indicated on the drawings.

3.1.6. Housekeeping

All waste generated on site and anywhere during construction is to be removed by the HVAC&R Contractor. The cleanliness and maintenance of a tidy and organised workspace is the responsibility of the HVAC&R Contractor and if not maintained he will be requested from time to time to have a dedicated person keep the work area tidy and clean up after installation of sections or components. If not adhered to then an external contractor will be requested to perform a cleaning function and the contractor will be contra charged.

3.1.7. Health and safety file

The contractor must compile a health and safety file to comply with requirements of the project Health and Safety Plan and to the OSH Act.

3.1.8. Rigging Handling and Lifting

All scaffolding, craneage, forklifts, lifting and rigging gear required to complete the installation as well as all associated safety equipment to operate must be provided by the HVAC&R Contractor. All operators of equipment are to be suitably trained and licensed to operate such equipment. A complete health and safety plan and file are to be kept on site during the construction of the project. Offloading of all equipment and rigging into position is the responsibility of the contractor.

The contractor, by returning the tender, confirms that he has satisfied himself that he has a full understanding of the site conditions, current progress on site and expected rigging and lifting requirements as well as all other requirements that might be unique to the site and has accommodated and allowed for all of these in his tender and pricing. No claims will be considered in this regard after the Contractor's appointment.

3.1.9. Quality and Quality Assurance

The Contractor is responsible to ensure that the installation meets the requirements of the specification.

To assist the Contractor, in order that corrective action can be taken in good time, at least the following quality control programme will be implemented:

Description of hold points required	Hold Point
Engineers approval of data sheets for all equipment prior to placing orders	Yes
Sample piping and pipe supports approved	Yes
Shop drawings indicating routes, electrical requirements, detail drawing	Yes
Specific items as per engineer's requirements	Yes

Samples of all air terminals, grilles and louvres	Yes

3.1.10. Shop drawings

The Contractor will be required to produce the following marked up drawings as a minimum requirement:

- Circuit diagrams and general arrangement drawings of all control boards
- Mechanical shop drawings of all equipment and ancillaries required for the complete installation.

The contractor will be required to keep a separate set of all approved drawings on site and to continually “mark-up” any alterations and additional information in order that he can produce as built information. As built drawings will be the responsibility of the HVAC&R Contractor.

To streamline the drawing production process, the refrigeration contractor shall allow for producing workshop drawings based on sketches provided by the engineer, in the event of the final design differing from the tender drawings. Workshop drawings are to bear the title block of both the contractor and the consulting engineers. Drawings shall be produced using AutoCAD or Revit. The consulting engineers’ drawings can be made available electronically to facilitate rapid drawing production. Builders work drawings and as built drawings are to be produced by the contractor as well.

The Engineer's approval of design or workshop drawings or samples shall not relieve the Contractor of responsibility for any deviation from the requirements of this Contract unless the Contractor has informed the Engineer in writing of such deviations at the time of submission of shop drawings or samples and the Engineer has given written approval for the specific deviation. Nor shall the Engineer's approval relieve the Contractor of responsibility for errors or omissions in the shop drawings or samples. The contractor’s submittals are approved to ensure design intent is met.

3.1.11. Installation Team

The installation team must be competent in accordance with the requirements stated in KS ISO 5149 latest edition.

3.1.12. Full Time Supervision

The Contractor is to allow for full time supervision and nominate this person as the responsible person to ensure each artisan who is welding, brazing, occurring or carrying out any operation that could cause a fire hazard, be equipped with a fire extinguisher. He is also to be responsible for his own personnel's site safety, ensuring that no dangerous practices are carried out whatsoever.

The responsible foreman on site is to be fully conversant with the OSH Act requirements and ensure that all safety related matters are dealt with and requirements adhered to by all members of the contractor’s team, including all subcontractors of the contractor.

3.1.13. Equipment submissions

Detailed technical submittals for each component used on this contract will be submitted by the contractor prior to procurement. Submittals are to be made timeously by the Contractor for those items not already submitted at the time of tender. The Engineer will be granted at least one week to review each of the submittal.

3.1.14. Plant commissioning and test reports

A condition for final hand-over of the installation will be the submission in tabular form of the results of final tests on the performance of all items of equipment supplied and installed under this

contract. This is to include running amps of all equipment. All air flow rates, as well as temperature and humidity are to be measured. This will be done at all cooling coils, heating coils, duct inlets, outlets (diffusers / grilles etc.), as well as exhaust outlets. All data given on the design drawings and tender documentation will be verified by means of measurement. In addition, marked up drawings showing final balancing figures for air systems shall be submitted before requesting final hand-over. The information provided shall be enough to establish that the system is operating as specified.

Copies of the approved versions of these reports shall be included in the operating and maintenance instruction manuals. The contractor is to provide a project engineer with full knowledge of HVAC&R design and hands on experience in commissioning and maintenance. The project engineer is to test fire interlocks, deal with changes, witnesses tests, attends to occupant complaints and attends site meetings.

All measuring equipment will have a valid calibration certificate.

In addition to this, the contractor shall ensure that each and every individual component of the plant, whether it be major or minor equipment, valves, sensors etc, is started up or commissioned in strict adherence to the OEM guidelines and specifications. Where these do not exist the onus to safely start up the equipment rests with the contractor.

Reference is made to ASME B31.5 section 538: Testing, for the method of pressure testing. The Contractor is to allow for staggered pressure testing of the system to accommodate the requirements of the project programme. The pressure testing is to comply with the requirements as set out in the standardised specification as well as the local authority regulations and guidelines.

3.1.15. Training of the Client

The contractor is to include in his price for the full on-site training of the relevant staff members in the owners employ. A suitably qualified refrigeration/HVAC practitioner (in accordance with requirements of KS ISO 5249 latest edition) must provide this training. Careful note must be made that the training records must be recorded adequately by the contractor's representative. Should this record keeping not be done, the engineer may insist that the training be completed again, at the cost of the contractor.

Training is to be conducted at an agreed time with the client and his nominated operator, maintenance technician or employee.

The training is to cover all aspects of the plant and is to comply as a minimum with the following requirements:

- Detailed review with the client of the system description operation and general conditions at which the plant operate
- Detailed review of the refrigerant circuit drawings, explaining the functionality of each of the valves and pieces of equipment on the drawings
- Detailed review of the operation and maintenance manuals, specifically covering the following items:
  - Emergency procedures and shut off / shut down procedures
  - Start up and shut down procedures
  - Troubleshooting procedures
  - Procedures in case of malfunction of plant or equipment

- System software and operation
- Detailed description and instruction on all switches and indicators on all consoles.
- Maintenance required and the relevant maintenance schedules i.e.:
  - Daily
  - Weekly
  - Monthly
  - Etc. checks.
- Data logging and reporting information.

A record of training is to be drawn up and signed by all present at the training and the minimum aspects covered above are to be noted. This signed record is to form part of the O&M Manuals and hand over documentation.

3.1.16. O&M manual

A complete operating and maintenance manuals with all final, as built drawings is to be supplied by the Contractor before handing over. This shall be in electronic format.

The complete operating, maintenance manuals and as-built drawings will also be presented on a memory stick in electronic format. For the electronic format, only hand-written documents (such as commissioning values etc) will be allowed in a scanned format, all other documentation is to be printed to pdf or be the original equipment manufacturers specification.

3.1.17. 12 Month Guarantee and Maintenance period

The contract is to include a 12 month maintenance and guarantee period.

During this period the contractor is responsible for all maintenance aspects of the plant in full compliance with the OEM's requirements.

All items in terms of KS ISO 5149 are to be covered in this guarantee period. Specific mention is made of the regular testing of safety and emergency equipment and the documentation of service and maintenance actions in a log book.

A minimum of one visit every month, for maintenance purposes, is required for the plant. If the contractor feels that additional trips are required. This is to be specified in the tender. The onus however rests on the contractor to ensure that the plant is properly and adequately maintained during this period.

The clients' maintenance representative is to accompany the contractor during these maintenance visits and countersign the logbook in acknowledgement of the visit and the work undertaken.

All work completed, actions taken or observations made, even if none out of the ordinary are to be logged in detail in the log book provided during hand over.

3.2. Project Specific Technical Specification

This specification covers the detailed specification for the HVAC&R installation at the new Isiolo Abattoir.

The scope of work is shown in the tender drawings. This specification clarifies various aspects shown on the drawings and notes items that are not shown on the drawings.

A new refrigeration plant slab, open to atmosphere will be erected adjacent to the current abattoir as shown on the drawings. The plant will consist of all-weather proof condensing units, complete with compressor, condenser, receiver, electrical board and all required valves and ancillaries and shall be charged with R404a. Detailed design of each condensing unit in accordance with the performance specification stated in this document shall be by the condensing unit OEM.

The refrigerated and conditioned rooms and their design temperatures are listed in the table below.

Description	**Temp** [°C]
Passage	+8
Chiller 1	0
Chiller 2	0
Chiller 3	0
Shipment Area	+8
Suspect Chiller	0

3.2.1. General description of works

This specification covers the supply, delivery, erection, testing, commissioning, handing over in a complete working order and the subsequent maintenance and guarantee for a period of 12 months of the HVAC&R installations (HVAC&R is used throughout the course of this document and is interchangeable with “HVAC” and “Refrigeration”) installations. The work shall include but not be limited to:

- The complete HVAC&R installation including supplying, testing, commissioning and hand-over.
- Issuing electrical certificate of compliance and certificate of compliance for the HVAC&R installation is to form part of this contract.
- Co-ordination with electrical services, sprinkler services, plumbing and drainage services, insulated panelling and structure. All co-ordination with other services is to be by the contractor on site. Special note is to be made that this is an existing building and therefore the co-ordination of existing and new services is to be included.
- Timeous provision of all builder's work details and conduit work details for co-ordination purposes.
- Provision of galvanised steel channel formers, hangers, vibration mountings and holding down bolts for equipment foundations or mountings, which are required for all equipment.
- All necessary conduits, cable trunking, cable ladders, cable trays controls and wiring to ensure the system complies with and operates to specification and in accordance with the design intent.
- Painting of all exposed piping enclosures or cladding, ducting, fittings and control panels (including any repainting necessary) within the roof void and in the building.

- Any brackets, steel, supports or frames that are exposed to the elements (i.e. not internal to the building), OR, that are exposed to constant moisture (such as drip trays, condensation around bases etc) shall be of a fully hot dipped galvanised construction.
- All external openings to the building or equipment to be protected by vermin-proof screens.
- Connection and testing of condensate drain from equipment to the plumber's drainage points as indicated on the drawings.
- Each and every cold room that is supplied with refrigeration or HVAC in this scope will be supplied with a 100mm diameter temperature dial complete with a sensor mounted in an oil pot or similar to provide a visual indication of the room temperature. This unit will be mounted away from any localised sources of heat or cooling so as to provide a most appropriate room temperature indication.
- Provision and installation of permanent identification markers, labels and tags on all cables, piping and equipment for identification purposes. Indoor and outdoor units will be clearly marked to show which units are connected. Blower coils will be marked and labelled according to their systems from which they are served and fans will be labelled and marked to correspond to the control boards from where they are controlled.
- Installation drawings ('shop-drawings') as well as "as-built" drawings.
- Operating instructions and maintenance manuals.
- The contractor shall ensure that all work carried out by his staff (as well as his own subcontractors) is done in strict adherence to the applicable Occupational Health and Safety regulations and requirements.
- Removal from site of any excess waste material generated by the HVAC&R installation at regular intervals.
- The entire installation shall be in accordance with the National Building Regulations in Kenya, as amended and the latest applicable edition. All national laws shall be adhered to during construction.
- The entire installation shall be in accordance with KS 662, KS ISO 5149 latest editions and any other relevant KS standards.
- All other items to render the installation complete and operational

3.2.2. Design data

- Supply voltage 415/240 V, 50 Hz
- Altitude ±1067 m
- Corrosion classification: C3 Industrial Inland
- Outside air ambient design conditions (for condenser selections)
    - 34°C

3.2.3. Field equipment

- The field equipment will consist of but not be limited to the following: All weather proof condensing units as specified with integral compressors, condensers, receivers and all associated ancillaries
- Evaporators as specified, dressed with thermostatic expansion valves and ancillaries as shown on the typical details sheet
- A main refrigeration DB supplied as part of the refrigeration contract
- All interconnecting piping and electrical wiring

- Temperature indicators as specified
- Condensate drain piping to serve the evaporators
- All required interconnecting control, signal and electrical wiring

3.2.4. Outdoor Refrigeration Plant Room

The plant room will consist of but not be limited to the following:

Pack Designation	Type	New/ Existing	Room
MT1	All weather proof simplex condensing unit with CRII capacity control	New	Carcass Chiller 1
MT2	All weather proof simplex condensing unit with CRII capacity control	New	Carcass Chiller 2
MT3	All weather proof simplex condensing unit with CRII capacity control	New	Carcass Chiller 3
HT1	All weather proof simplex condensing unit with CRII capacity control	New	Passage
HT2	All weather proof simplex condensing unit with CRII capacity control	New	Shipment Area
MT4	All weather proof simplex condensing unit with CRII capacity control	New	Suspect Chiller

- 1 off plant monitoring and control system
- 1 off hard-wired alarm panel
- Safety equipment and signage as specified and required by the OHSACT and KS ISO 5149
- All evaporator controllers for new evaporators will be situated inside each all-weather pack at the plant room. Note is to be made that the carcass chillers must be provided with a PLC for each evaporator as specified. Each Carcass chiller must also have its own HMI as specified. The balance of the evaporators are to be supplied with conventional electronic controllers.

3.2.5. Electrical Installation

The electrical work associated with the HVAC&R installation shall comply with the requirements of the standard specification. All electric motors are to have high power factors in excess of 0,9. Motors of lower power factor shall be acceptable only in certain circumstances if specifically approved by the engineer, in writing.

The HVAC&R contractor shall provide and install any conduits, cable ladder, cable trays, trunking cables, cables on roofs, etc. and perform the wiring to local isolators necessary for the complete HVAC&R installation.

All fans shall be supplied with circuit breakers, contactors, phase failure and phase rotation protection, under or over voltage as well as motor overload protection.

The electrical contractor will be providing a suitably sized (refer drawings) 3 phase electrical supply to the enclosed plant area. The termination of the supply into the main circuit breaker will be by the HVAC&R Contractor in the presence of the electrical contractor. This philosophy is to be used for all electrical supplies to plant, field and equipment DB's for the installation. Where a supply terminates in with an isolator, the main electrical contractor is to supply the isolator and electrical supply. The

Contractor will then terminate his cable in the isolator and route the supply to the equipment as required. The HVAC&R contractor is to provide the electrical CoC for his entire installation.

The main DB mentioned above must be supplied by the refrigeration contractor and is supplied for the reticulation of power to the various elements of the compressor pack and to each of the field control boards supplied by the refrigeration contractor. This reticulation will be by the refrigeration contractor.

The fault rating at the main DB is (TBC). All DB's must comply with the requirements of the standard specification.

3.2.5.1. General

3.2.5.2. Electrical panels

3.2.5.2.1. General

Control panels and / or distribution boards shall incorporate wiring protection, under over voltage protection, phase failure protection, phase rotation protection, ammeters, volt meters, pilot lights and control switches as required. All motors shall have motor starters, overload protection control circuit breakers, starters, wiring, etc. which shall be sized to handle the electrical loads of the equipment being fed without overheating and while protecting it according to the OEM's recommendations.

Circuit breakers, control switches and pilot lights are to project through the face of the panel and are to be identified by means of Engraved Trafolite labels screwed to the panel. Labels fixed by adhesive will not be acceptable.

All circuits shall carry identifying tags and all terminals are to be numbered. All relays, contactors, etc., are to be identified by means of Dymo type labels.

Internal wiring shall be carried out neatly and methodically by means of copper bars or cables laid vertically and horizontally. Cables shall be supported in wiring harness saddles.

Control gear shall be standardised around the ABB, Moeller or approved alternative.

3.2.5.3. Evaporator control boards

Evaporator control boards will be installed as part of the outdoor condensing unit pack serving each evaporator. It is the responsibility of the refrigeration contractor to optimise the cabling, control and power supply to the field equipment to offer the most cost effective and competitive solution.

The HVAC&R Contractor is responsible for electrically balancing the load across the phases.

Each new evaporator control board must incorporate the following:

- Under and over voltage protection
- Panel mounted controller displays on the door of the board – Each evaporator should have its own controller
- Each component that is controlled via the outputs on the electronic controller must have an adequately sized and rated external relay (or contactor) to control power to that component.
- A dedicated circuit breaker for each power user
- A single phase 15A plug point
- Lockable square key door

- Circuit breakers serving power users remote from the board must be of lockable type. The contractor must supply each evaporator control board complete with five “lock-out keys” compatible with the circuit breakers supplied.
- The incoming isolator, circuit breakers, relays and contactors must be inside the distribution board and all the associated electrical equipment must be DIN rail mounted.
- All evaporator control boards installed outside must be all-weather proof

3.2.5.4. Controllers / PLCs for carcass chiller evaporators

Each Carcass Chiller is to be provided with the following:

- Controller / mini PLC of type: Eliwell RTX 6200D (or similar functionally equivalent prior approved alternative). Each room’s PLC is to be programmed to achieve the control philosophy as described later in the document.
- 7 inch HMI of type Schneider ST6400 (or similar functionally equivalent prior approved alternative) installed outside the room as shown on the drawings.

3.2.5.5. Evaporator controllers for rooms other than the carcass chillers

For the main offer controllers must be of Danfoss, Eliwell or Carel supply. The contractor may submit alternatives under a separate covering letter. Controllers shall be of type Eliwell RTX 600/ STD or similar functionally equivalent prior approved alternative.

Each evaporator controller must incorporate the following:

- All features required for temperature control and defrost management.
- At least three dedicated temperature probe inputs
    - Two (2) will be utilised for air-on and air-off temperatures respectively
    - One (1) will be used for the defrost termination
- Real time clocks
- Alarm capability
    - For temperature alarms
    - Other critical alarms required by any of the OEM or suppliers.
- Dedicated output terminals which comply with communication protocols for communication with the centralised monitoring system as specified.
- Dedicated output terminals for solenoid control
- Dedicated output terminals utilised to switch the fans serving the temperature controller’s associated blower coils, on and off.

3.2.5.6. Compressor rack control boards

Supply compressor pack complete with a control board installed as part of the pack. The control board must incorporate the following:

- All components must be DIN rail mounted, except the incoming bus bars, which must not be of DIN rail mount type.
- Direct on-line starters for compressors (or as otherwise recommended by the compressor OEM)
- Contactors selected in accordance with manufacturer recommendations
- Lockable square key doors
- Phase failure and phase rotation protection
- Under and over voltage protection
- Single phase 15A plug point

- All wire terminals to be properly identified with a clear and sensible identification system
- Any manual safety cut outs must trip the compressor and indicate an alarm condition on the compressor pack control board.

The pack must have its own dedicated and suitable compressor pack controller to stage compressor capacity and condenser fans and to provide signals such that speed control condenser fans can be achieved. Since the compressors for this contract will utilise Bitzer CRII or similar technology, it is noted compatible controllers, approved by the compressor OEM complete with solid state relays **must be used**. It follows that compressor pack controllers for the contract shall be of Eliwell EWCM 436D Pro type, or similar, prior approved, functionally equivalent controllers by an alternative supplier. All OEM requirements relating to the CRII (or similar) technology must be strictly adhered to.

Controllers may be of Danfoss, Eliwell, Dixell or Carel supply.

The following hard-wired safeties must be in place for each new compressor:

- Low oil level cut-out
- Thermistor cut-out (manual reset)
- High pressure safety cut-out (manual reset)
- Compressor overload or trip condition (manual reset)
- Low pressure safety cut-out

The hard-wired safeties above must initiate an alarm on the control board and this alarm must send a digital input to the rack controller to indicate an alarm condition.

3.2.6. Piping, supports and valves

Field piping forming part of this contract must be installed in accordance with the requirements stated. All field piping must be new. Supports are to be installed at the interval stated and in accordance with the typical details shown on the drawings.

For this project the following piping will be used:

- R507a / R404a piping: ACR copper, rated for at least the design pressure of the system.

3.2.6.1. General

All the OEM specification of preparation and application are to be adhered to in case they deviate from the requirements above.

Special note must be taken that larger pipe sizes may affect oil return in dry suction risers and therefore is not allowed without the engineer's consent.

Refer to the standard specification for details and allowable type of pipe supports, support distances and valves. Any deviation from the standard specification is to be approved in writing prior to tender submittal.

Pipe installation, supports, support frequency and detailed pipe system design and installation will be strictly as per the specifications and details as laid out in ASME B31.5 latest edition and the responsibility for compliance with the standard rests with the contractor.

3.2.7. Pipe and duct Insulation

Piping insulation shall be of Armaflex type as specified. Armaflex insulation to all systems shall be at least 25mm thick. Armaflex to be installed as specified in the standard specification.

3.2.8. Condensate drainage

All condensate drainage from evaporators are to be piped to the nearest condensate drain points which are indicated on the drawing. Only condensate drains for evaporators are explicitly shown on drawings, the balance must be site run by The Contractor and form part of this scope of works.

All internal piping to be effected in 50mm, screwed galvanised mild steel SABS 62 seamless piping. P-traps are to be installed at all areas where individual drain pipes enter mains. P-trapping is to ensure that negative pressure created on the suction side of fans or AHU's does not affect the drainage of condensate away from drip trays and into the main line.

3.2.9. Control and monitoring software

The control and monitoring software is to have the following minimum characteristics:

- GSM cellular slot and communication ability to send and receive sms' of alarms and faults on the system. The contractor must supply sufficient airtime to last the entire 12 month guarantee period and this must be topped up for the period by the contractor, should it run out.
- A GSM data system to allow for remote logging into the plant to review the current operating status and key parameters.
- The system is to have a mapped display page showing the layout of the facility and key operating details of all areas.
    - When clicking on certain components the details of that components is to be shown.

As a minimum the following information is to be displayed and logged on the system:

- All analogue and digital inputs from the plant. This is to include all temperatures, pressures, fan speeds, compressor speeds / loadings, condenser fan status (on / off) etc.

All set points are to be adjustable on the control and monitoring System.

Allowance is to be made to connect the system to the client's intranet which will be located ±75m from the plant room for pricing purposes.

The monitoring system must log and create high temperature alarms (and any other additional alarms the end user may request.) In addition to showing alarms on the monitoring system itself, a hard-wired alarm should be wired from the alarm output on the monitoring system to a purpose made hard-wired alarm board, complete with buzzer, audible flashing light and suitable label. The final position of the hard-wired alarm board will be confirmed in due course, however, for the tender offer, it is to be assumed that the hard-wired alarm board will be situated 50m from the position of the monitoring system.

3.2.9.1. Product piercing probe sensors

Each Chiller room (1 to 3) is to be equipped with two off product piercing temperature probes of Carel NTCINF610, or approved alternative. These are to be located at the entrance and exit side of the three chiller rooms, thus a total of 6 sensors.

The temperature from the probes are to be logged on the monitoring system and displayed via a digital display at the sensor location. The probe is to be equipped with a spiral wound cable of 3m length.

3.2.10. Smoke control / fire detection

Each room's blower coils/ evaporators are to have the ability to shut down on the detection of a fire in the room. A normally closed signal will be provided by the fire contractor for each room / smoke zone as they require. This signal is to be accommodated in the fan control panels and allowed for in the tender.

3.2.11. Trapped Personnel Alarms

Install a trapped personnel alarm in the freezer as indicated on the drawings. The hard-wired alarm and buzzer must be installed in a constantly manned place. The alarm, flashing light and buzzer in the remote location is to be included.

The trapped personnel alarm kit is a safety system for cold rooms. The person trapped inside the cold room can press the emergency button to ask for help, and a siren ensures audible and visible signal outside, where the permanent presence of a person is guaranteed.

The system is to include a control unit to be fixed outside the cold room (with n.c. alarm relay), provided with siren to alert persons of an alarm. A back up battery housed inside the control unit, is to supply power in the event of electricity failure (12Vdc, 10h life time).

An Emergency button is to be installed inside the cold room. The LEDs that light up the emergency button are to be permanently on.

An approved supply is the Carel® ColdWatch, with the internal and external units shown below.

Allowance is to be made to wire the alarm to a permanently manned location / office in the building.

3.2.12. Signage

Plant signage to be strictly in accordance with KS ISO 5149 and the OHSACT. Vessels to be marked in accordance with SANS 347 or suitable local Kenyan code. Piping and operable valves to be marked as per typical detail on drawings. Any signage installed outside shall be UV resistant and shall not fade.

3.2.13. Erection and Welding

All welding and brazing will be done in accordance with requirements of the relevant part in the standard specification.

A complete Brazing Procedure Specification (BPS) followed by the appropriate BPAR and all testing and certification of the brazing team is to be provided to The Engineer for approval prior to starting construction.

For the erection and installation work the Contractor is to employ only thoroughly skilled and competent artisans.

The Contractor is required to co-operate with any other Contractors that the Employer may employ upon the site as reasonably demanded by the Engineer.

The Contractor is to furnish all requisite tools, scaffolding and other equipment and is to provide safe storage and accommodation for materials, tools, equipment and the like.

The Engineer accepts no responsibility for loss or damage to the Contractor's tools, equipment or materials.

All craneage required for the satisfactory completion of the work is to be allowed for by the Contractor.

The contractor shall take note of the additional risk associated with working in a prefabricated insulated panel cold room complex. Additional care shall be taken, in these areas such as manned fire extinguishers, asbestos blankets, no cutting torches etc. while working in these areas. The areas above the cold room panelling is never to be used as a manufacturing / assembly area. All work that can be done at low level needs to be done at low level. Only fit ups, welds and other manufacturing items that are required to take place in situ will be allowed on top of the panels.

3.2.14. Painting and corrosion protection

All components, whether constructed or OEM parts and units as well as all fittings fixtures, brackets, fixings etc. shall be adequately protected against corrosion to provide a suitable time between maintenance without showing any signs of rust or corrosion. Any item that starts showing any signs of corrosion will be rejected and will need to be replaced or adequately cleaned, prepared and protected to the Engineer’s satisfaction.

All supports must be painted and treated for corrosion protection. Any flashing and other steel exposed outdoors must be painted in accordance the standard specification. All steelwork shall be treated as specified or as a minimum (where not specified) by galvanising or with two coats of a reputable epoxy steel primer and anti-corrosion paint as well as two protective overcoats of a metal paint.

3.3. Major Equipment

3.3.1. Evaporators / Coolers – General

The following paragraphs specify the main capital equipment and items more detail.

3.3.1.1. Control philosophy for the carcass chiller coolers

This defrosting regime is for the primary carcass chiller rooms

Each carcass chiller evaporator coil shall have its own solenoid valve, controlled independently based on room temperature, however, both evaporators in each room shall be programmed to defrost simultaneously and switch simultaneously between the various control sequences described below.

The cooling cycle will last approximately 20 hours (adjustable). ±Two hours will be used for loading and ±two hours for unloading. During the unloading phase the liquid supply solenoid is to be shut for a period of 1 hour (adjustable) for an off cycle defrost. Upon completion of this off cycle defrost period, cooling is to resume. During an off cycle defrost, the fans will continue running, but electrical heaters not used.

During the 2 hour loading period cooling should continue. Depending on ice build up on the coils, which is to be monitored during commissioning, a “loading defrost” time period, which will be in the form of an off cycle defrost, can be introduced to optimise defrost and start cooling as soon as possible after loading is complete with an ice free coil.

After the two hour loading period the heat load will be at its peak.

If it is found that the above defrosting regime is not sufficient to defrost the coils then a further two defrost periods of 20 minutes each shall be scheduled in during the cooling cycle. These defrosts are to be effected by means of electrical heaters.

The above defrosting regime is to be allowed for and incorporated into the control system. The contractor is to include for an HMI at each room complete with well labelled buttons of the following functions (as described in more detail above):

1) Unloading Button, with initial adjustable off cycle defrost period, followed by cooling to resume.
2) Loading Button, cooling to resume, with one adjustable length off cycle defrost during this period.
3) Cooling Cycle Button, cooling to resume with adjustable length electrical defrost periods as required to keep the coil sufficiently frost free to cool efficiently and effectively.
4) Manual Defrost Button, which can be used at any time to initiate a defrost, should the coil have excessive ice build-up. Upon completion of a manual defrost, the PLC should return control to the state it was in prior to the manual defrost being initiated.

3.3.1. Synthetic Refrigerant Evaporators

3.3.1.1. General

All evaporators will be from Heating Centre, Thermocoil, LU-VE, Thermofin, Guentner or a prior approved alternative manufacturer. Where alternative coils are proposed the alternative supplier will be submitted to the engineer prior to the submission of the tender for approval. Full technical documentation and specifications of the coolers are to be submitted with the tender.

Secondary steel for support of the evaporators must be supplied and installed by the HVAC&R Contractor. Evaporators may not be supported directly from the insulated panels unless otherwise stated on the drawings **and** approved by the insulation contractor. It is the refrigeration contractor’s

responsibility to obtain this approval from the insulation contractor. Where this is done, suitable load spreading bars must be supplied by the refrigeration contractor..

The HVAC&R Contractor must install condensate drains from individual evaporators as might be shown on the contract drawings. Condensate drains must comply with the standard specification requirements. Condensate drains from all coolers and points of condensation generation are the responsibility of The Contractor and are to be allowed for in the tender.

Defrost for this project will be by electrical elements, suitably sized and positioned by the evaporator OEM to ensure complete and time efficient ice removal. The contractor is to connect these heaters such that they are balanced across the electrical phases. Special note is to be made of heater safeties and these must be tested on site by the contractor.

The contractor must select expansion valve models with the assistance of the specialist evaporator coil supplier and must issue the selections to AMC prior to ordering.

All evaporators are to be equipped with temperature safeties for the heating elements (if present) and all cabling and connections are to be as per KS 662 and all other relevant electrical standards that apply in Kenya. All other safeties recommend by the OEM and by all components installed in the units are to be adhered to. The system is to be a fully safe and functional system. Note must be made that the evaporator fans will need an isolator within 1m of each fan, supplied and installed by the HVAC&R Contractor or supplied by the evaporator OEM and connected by the HVAC&R Contractor.

3.3.1.2. Performance specification for evaporators

1	**Location Details**							
1,1	Site Altitude	[m]	1067,0					
1,1	Site location	[m]	Isiolo , Kenya					
2	**Room Details**							
2,1	Room name	[-]	**Passage 1**	**Chiller 1**	**Chiller 2**	**Chiller 3**	**Shipment Area**	**Suspect Chiller**
2,2	No. of coils per room	[-]	1	2	2	2	2	1
3	**Coil details**							
3,1	Min Coil sensible capacity	[kWR]	8,9	29,2	29,2	29,2	5,7	4,8
3,2	Min Coil latent Capacity	[kWR]	1,3	0,4	0,4	0,4	1,1	0,5
3,3	Min Total Capacity	[kWR]	10,1	29,7	29,7	29,7	6,8	5,3
3,4	Sensible heat ratio	[-]	0,87	0,985	0,985	0,985	0,84	0,90
4	**Refrigerant details**							
4,1	Refrigerant type	[-]	R404A	R404A	R404A	R404A	R404A	R404A
4,2	Evaporating Temperature	[°C]	+2	-6	-6	-6	+2	-6
4,3	Superheat at coil exit	[K]	5	5	5	5	5	5
4,4	Subcooling prior to expansion valve	[K]	0	0	0	0	0	0
5	**Air flow details**							
5,1	Air temperature - on	[°C]	+8	0	0	0	+8	0
5,2	Air temperature - off	[°C]	TBA	TBA	TBA	TBA	TBA	TBA
5,3	Air relative humidity - on coil	[%]	TBA	TBA	TBA	TBA	TBA	TBA
5,4	Air relative humidity - off coil	[%]	TBA	TBA	TBA	TBA	TBA	TBA
5,5	Coil air flow rate required	[m^3/s]	TBA	6,4	6,4	6,4	TBA	TBA
5,6	Maximum air face velocity	[m/s]	3,0	3,0	3,0	3,0	3,0	3,0
6	**Coil details**							
6,1	Approximate unit length	[mm]	1500	2400	2400	2400	2000	2000
6,2	Approximate unit height	[mm]	600	1100	1100	1100	600	600
6,3	Frost factor	[mm]	1	1	1	1	1	1
6,4	Fin spacing (FPI)	[mm]	6	8	8	8	6	6
6,5	Cooler tube material	[-]	Cu	Cu	Cu	Cu	Cu	Cu
6,6	Cooler fin material	[-]	Epoxy coated Al	Epoxy coated Al	Epoxy coated Al	Epoxy coated Al	Epoxy coated Al	Epoxy coated Al
6,7	Bluchem treatment	[-]	No	No	No	No	No	No
6,8	Cooler frame & casing material	[-]	StZn	StZn	StZn	StZn	StZn	StZn
6,9	Drip tray material	[-]	StZn	StZn	StZn	StZn	StZn	StZn
6.10	Drip tray insulated	[-]	No	Yes	Yes	Yes	No	No
6,11	Drip tray heated	[-]	No	No	No	No	No	No
6,12	Method of defrost	[-]	Electric	Electric	Electric	Electric	Electric	Electric
6,13	Coil weight	[kg]	TBA	TBA	TBA	TBA	TBA	TBA
6.20	Coil internal volume	[l]	TBA	TBA	TBA	TBA	TBA	TBA
7	**Fan details**							
7,1	No. of fans per coil	[-]	2	3	3	3	3	2
7,2	Nominal fan diameter	[mm]	TBA	TBA	TBA	TBA	TBA	TBA
7,3	Fan cowl heater required	[-]	No	No	No	No	No	No
7,4	Air flow rate per fan	[m^3/s]	TBA	2,1	2,1	2,1	TBA	TBA
7,5	Minimum fan pressure at design airflow	[mm Wg]	TBA	TBA	TBA	TBA	TBA	TBA
7,6	Fan stall pressure	[mm Wg]	TBA	TBA	TBA	TBA	TBA	TBA
7,7	Maximum fan speed	[rpm]	960	960	960	960	960	960
7,8	Minimum fan motor size	[kW]	TBA	TBA	TBA	TBA	TBA	TBA
7,9	Absorbed power at design point	[kW]	TBA	TBA	TBA	TBA	TBA	TBA
7.10	Max fan noise level	[dba]	TBA	TBA	TBA	TBA	TBA	TBA

All evaporators shall utilise thermostatic expansion valves to meet the capacities in the above table.

3.3.2. Compressors – Synthetic Refrigerants

The new compressor racks supplied (whether packaged by the contractor, a subcontractor or an OEM) must be fully approved by the OEM's of all major equipment forming part of the rack prior to installation. If for example individual compressors are purchased from an OEM, and the pack is constructed elsewhere, the package unit P&ID and GA drawings must be signed and approved by the compressor OEM.

Each pack must be delivered to site pre-built and should not be built on site. The rack manufacturer must submit a full company CV to AMC Engineers for approval prior to the contractor ordering final equipment. The rack manufacturer must demonstrate experience in the field and must provide reference sites as part of their submission.

All valves on the racks are to be mounted so that they are easily identifiable and operable. All steel utilised for the rack support shall be suitably treated and painted for corrosion protection.

All the racks for this project shall be installed outside. They shall be of all-weather type. Special attention must be paid to all pack electrics which must be suitable for installation outside.

Compressors must be of semi-hermetic reciprocating type, and shall be of Bitzer, Bock, Dorin, Copeland, Frascold or equal prior approved alternative manufacture.

The compressor OEM must:

- endorse the compressors offered for use in the application for this project,
- endorse the compressors offered for the design conditions including pressures, suction superheat values etc.
- supply comprehensive information to the Engineer and contractor as to acceptable compressor inlet and outlet conditions
- Verify that the compressor will be operating within its acceptable compressor operating envelope and the contractor should immediately inform the Engineer if this will not be the case. Compressors operating outside their envelope will not be accepted.

Each of the compressor packs must be supplied complete with each of the following (suitably sized and selected for the application):

- Suction and discharge shut-off valves
- Suction filter drier (replaceable core type)
- Liquid filter drier (replaceable core type)
- LP / HP switches
- Liquid receiver with suitable pressure relief valves
- Check valve on the discharge piping
- Sight glass on liquid line to the plant.
- Suction pressure indicator
- Discharge pressure indicator
- Vibration eliminators on suction and discharge ports in accordance with compressor OEM recommendations
- Conventional or helical type oil separator, c/w oil filter in piping back to the compressor sump
- Electronic oil level regulator complete with alarm functionality on each compressor
- All other valves and ancillaries to provide a full functional and working system.

Note must be made that each condenser arrangement must allow for sewer flow back to the receiver.

3.3.2.1. Compressor design operating conditions

Design operating conditions are as per the table below.

Pack	MT1	MT2	MT3	MT4	HT1	HT2
Refrigerant	R404a	R404a	R404a	R404a	R404a	R404a
Qty of compressors	1	1	1	1	1	1
Minimum capacity at evaporators [kWR]	59.3	59.3	59.3	5.5	10.2	13.5
Number of VSDs for comps	0 (CRII Cap control)	0 (CRII Cap control)	0 (CRII Cap control)	0 (CRII Cap control)	0 (CRII Cap control)	0 (CRII Cap control)
Coupling	NA - Semi-hermetic machines	NA - Semi-hermetic machines	NA - Semi-hermetic machines	NA - Semi-hermetic machines	NA - Semi-hermetic machines	NA - Semi-hermetic machines
Saturated Suction Temp at Compressor Suction Port [°C]	-8	-8	-8	-8	0	0
Saturated Discharge Temp at Discharge Port [°C]	45	45	45	45	45	45
Selected at Hz	50	50	50	50	50	50
Suction temperature at selection condition [°C]	0	0	0	0	+8	+8
Useful Superheat at Evaporators [K]	5	5	5	5	5	5
Liquid subcooling [K]	0	0	0	0	0	0
Head Cooling Fan Included	Yes	Yes	Yes	Yes	Yes	Yes

As noted above, all compressors shall have Bitzer CRII capacity control (or similar proprietary capacity control functionality). Minimum capacity shall be done to a minimum of 20% of full load capacity.

3.3.2.2. Compressor requirements

All compressors must be supplied complete with:

- Semi-hermetic reciprocating compressor
- Thermal protection
- Crankcase Heaters
- OEM IP65 supplied electrical box with connections
- Head cooling fan if determined required by the compressor OEM – Requirement to be confirmed in writing by the contractor complete with tender submission.
- Differential oil pressure switch with alarm capability
- Part wound motors for DOL starters
- POE oil suitable for use with the compressor and R404a as recommended by the OEM

- Discharge gas and motor temperature monitoring with alarm and trip capability
- Crank case heaters
- Suitable anti-vibration mountings recommended by compressor OEM

Where compressors selected by the contractor have the option of an oil pump for forced lubrication, these shall be supplied by the contractor and shall be supplied complete with a suitable oil pressure differential switch.

Compressors must be UL or CE approved.

All compressors shall be supplied with crankcase heaters and these shall be controlled to avoid over pressurizing the compressor.

Compressor control philosophy must include anti-recycle timers and sequential starting after a power failure.

3.3.3. Condensers

All condensers will be from Heating Centre, thermocoil LU-VE, Thermofin, Guentner or a prior approved alternative manufacturer.

Description	**[-]**	**MT1**	**MT2**	**MT3**	**MT4**	**HT1**	**LT1**
Qty	[-]	1	1	1	1	1	1
Type	[-]	Horizontal Discharge Condensing Unit - Condenser Integral to Pack					
Refrigerant	[-]	R404a	R404a	R404a	R404a	R404a	R404a
Design Pressure	[-]	> system level design pressure					
Minimum heat rejection capacity per unit	[kW]	106	106	106	21	16.5	21
Design temperature dry bulb	[°C]	34	34	34	34	34	34
Saturated Condensing Temperature	[°C]	45	45	45	45	45	45
Fan speed control	[-]	Yes	Yes	Yes	Yes	Yes	Yes
Approximate surface area	[m²]	TBC	TBC	TBC	TBC	TBC	TBC
Approximate Unit Length	[m]	TBC	TBC	TBC	TBC	TBC	TBC

Approximate Unit Height	[m]	TBC	TBC	TBC	TBC	TBC	TBC
Fin Material / Tubes Material	[-]	Al / Cu	Al / Cu	Al / Cu	Al / Cu	Al / Cu	Al / Cu
Fin Treatment	[-]	PU Coated	PU Coated	PU Coated	PU Coated	PU Coated	PU Coated

3.3.4. Vessels

A liquid receiver must be supplied by the contractor as part of each compressor pack. The receiver must accommodate the entire refrigerant charge for the system it serves when a maximum of 80% full.

All pressure vessels, whether mentioned in this section or not must be fully compliant with the following legal requirements and codes and be submitted complete with certificates reflecting the code of design:

- OHS Act
- KS IS 5149
- SANS 347, c/w conformity assessment (Or the equivalent standard in Kenya.)
    - The applicable / chosen safety standard approved by the DOL (design standard)

All vessels need to be stress relieved after manufacturing as per the applicable code.

All third party / AIA inspection on the vessels as well as required stamps and data books are to be included in the price by the contractor.

For this tender working drawings of the vessel are not supplied. The contractor is to allow for the production of workshop drawings of the vessels and these are to be submitted to the engineer for approval prior to manufacture.

The vessels are to be blast cleaned internally and externally before closing up to remove all loose mill scale, rust or other impurities. They are then to be cleaned with an appropriate solvent (compatible with the refrigerant in question). The exterior is then to be primed and painted with at least two coats of an anti-corrosion treatment to prevent corrosion and provide a protect barrier to the vessels. An overcoat / final coat of enamel or suitable alternative appropriate to the operating temperatures is to be applied by the manufacturer prior to shipping of vessels to site. Details of the painting specification offered is to be supplied on tender submittal.

Two complete sets of data books as well as one electronic copy of the data book is to be submitted with the O&M manual of the plant

Relief valves are to be supplied to the pressure vessels. These are to be of Danfoss, Herl or Parker. Dual relief valves are required for all vessels greater than 285 litres in volume. Pressure relief valves from vessels are to be piped as required by KS ISO 5149.

3.3.5. High level pack control description

Not all controls are described in detail. The full control solution is the design responsibility of the contractor (or his appointed rack manufacturer). A well established and field proven control system

must be utilised for the rack control. The full control philosophy must be issued to the engineer for approval prior to manufacturing. The control philosophy may be in the form of a controls OEM's documentation, however, enough supplementary information to describe full operation of the plant must be provided.

The pack control system must protect all pieces of equipment, and especially but not limited to compressors, from operating outside of their operating envelopes in accordance with OEM specifications and recommendations.

Each compressor's capacity shall be controlled using Bitzer's proprietary CRII system or an equal prior approved functionally equivalent alternative. The capacity shall be varied in order to maintain a stable suction pressure in accordance with the set point on the pack controller. All OEM recommendations relating to the CRII system (or similar) must be strictly adhered to by the contractor.

3.3.6. Design pressures

3.3.6.1. General

3.3.6.1.1. Pressure limiting during normal operation

This is achieved by:

- the pressure limiting devices as shown required by KS ISO 5149, and
- the pressure relief devices as required by KS ISO 5149

3.3.6.1.2. Pressure limiting during shipping

For gas-charged or refrigerant charged systems during shipping, the Contractor shall consider the maximum internal pressures associated with the highest anticipated temperature exposure and ensure that these are below the design pressures of the system

3.3.6.1.3. Vacuum Requirements

Refrigeration system components and equipment shall be designed for a vacuum of 737 mm of mercury.

3.3.6.2. Freon Design Pressures

The following design pressures are noted for this plant.

	MAWP
Low Stage	Selected by contractor in accordance with KS ISO 5149
High Side – Discharge	Selected by contractor in accordance with KS ISO 5149

All pressure limiting devices must be set at <= 90% of the pressure-relief device setting for that portion of the system to avoid equipment shutdown or loss of refrigerant during normal operation, or as specified in KS ISO 5149, whichever is more onerous.

3.3.7. Refrigerant detection

Refrigerant leak detection is not required, provided the system R404a refrigerant charges for each of the systems shown on the drawings is within the limits shown in the below table:

Description	Volume	Practical limit	Allowable R404a Charge
	[m^3]	[kg/m^3]	[kg]
Passage	145	0.52	75
Chiller 1	297	0.52	155
Chiller 2	297	0.52	155
Chiller 3	297	0.52	155
Shipment Area	340	0.52	177
Suspect Chiller	31	0.52	16

The contractor must evaluate the above and confirm that the R404a charge will be below the limit in the above table. If the R404a charge will exceed the values shown for any one system, then the contractor must allow for the installation of refrigerant detectors ,in accordance with the requirements stated in KS ISO 5149. This must be included in the contractor's tender price.

3.3.8. Specific items where the contractor assumes design responsibility

The following is a non-exhaustive list of items that are brought to the contractors' attention and form part of the contractors' design responsibility:

- All steel supports, vessel stands, hanger rods, pipe supports, and equipment supports. The loadings, and design of which are not explicitly noted in the drawings or tender are the responsibility of the contractor.
- The complete hydraulic power pack and piping solution must be designed and supplied by the contractor.
- If required, the air cooled / water cooled head / oil cooling system for the compressors or other motors / equipment forming part of the proposal
- All pressure vessel design and compliance with the codes as set out in the OHS Act and described in SANS 347 (or equivalent Kenyan code), KS ISO 5149 as well as other applicable codes.
- Process control and philosophy as well as process control and descriptions for the complete operation of the plant by means of central or decentralised controllers or PLC's and in complete adherence to the OEM requirements.
- Detail design of the freon compressor pack including all oil reticulation, safeties, controls and compliance with OEM requirements and statutory regulations as set out in SANS 347 and 10147.
- All heat exchangers that form part of the contract must be designed by the contractor or OEM to achieve the performance specification stated in this document
- The full electrical installation forms part of the contractors design and supply responsibility. It is proposed that a main plant room DB is utilised, and that controls are situated in each pack, however the contractor is to allow for the most efficient design of the control and power electrics reticulation. Fault levels are to be confirmed with the client prior to procurement and electrical as well as control schematics are to be submitted to the engineer for approval prior to procurement. The tender submittal is to include a schematic of the proposed electrical reticulation and controls. Preliminary fault levels assumed are: 25kA at the refrigeration electrical board.

- The following items shall be selected by the contractor in accordance with the design conditions provided: Filter driers, TEVs, suction accumulators, oil separators, oil filter driers, compressors, oil reservoir, pressure relief valves, all control valves, electronic controllers, solenoid valves etc.

Any items not specifically designed or noted in the tender documentation or the associated drawings fall under the design responsibility of the contractor.

If there are specific items that the contractor is not comfortable designing then these are to be brought to the attention of the engineer at the time of tender. If not raised at tender it is accepted that the design is clear, the design intent is clear and the contractor is aware of which design responsibilities fall under their auspices.

As soon after the award of contract as practicable, and at least 3 weeks before commencement of any work, the HVAC&R shall submit for the Engineer's approval the following details and drawings:

- Pipe supports for insulated piping
- Pipe supports for uninsulated piping
- Evaporator supports and fixing to the main structure

4. Standard Specification

It is to be noted that any description of a component, system, equipment or other part of the installation noted under a specific heading applies to all other similar components, systems or equipment. E.g. if heater element safeties are noted, required and described under AHU's, then the same applies for all heater elements in the project and not only heaters in AHU's. This holds true unless explicitly noted that it is only required for the item under which heading it falls.

4.1. Piping for Synthetic Refrigerants

4.1.1. General

4.1.1.1. Scope

This section contains specifications for all refrigerant piping (for synthetic refrigerants) for this project.

4.1.1.2. Reference Standards

ASME B16.22	Wrought Copper and Wrought Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.50	Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings
ASME B31.5	Refrigeration Piping and Heat Transfer Components
ASTM B280	Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
BS EN 14234	Brazing. Guidance on the application of brazed joints
SANS 10147	Refrigerating systems, including plants associated with air-conditioning systems

4.1.1.3. Shop Drawings

Refer to the General Conditions section.

4.1.1.4. Quality Assurance

Contractor shall submit schedule indicating the ASTM specification number of the pipe being proposed along with its type and grade and sufficient information to indicate the type and rating of fittings for each service.

Statement from manufacturer on his letterhead that the pipe furnished meets the ASTM specification contained in this section.

4.1.1.5. Design Criteria

Use only new material, free of defects and scale, and meeting the latest revision of ASTM specifications as listed in this specification.

4.1.2. Products

4.1.2.1. Piping

All piping is to be hard copper to ASTM B280, cleaned and capped in accordance with ASTM B280, and marked "ACR". Soft drawn piping may be used in sized up to 15mm OD. All piping is to be suitable for the refrigerant and oil used.

4.1.2.2. Fittings & Joints

Fittings must comply with requirements of ASME B16.22 or ASME B16.50 wrought copper fittings depending on the joining method specified.

All joints must be brazed. Where flared joints are required, they may only be used with the express permission of the Engineer. In such cases, the flared joints must comply with the relevant sections of ASME B16.26.

All bends and elbows shall be of long radius type.

All fittings and valves are to be soldered or brazed joints unless where otherwise specified in this document and detailed in in the detailed technical specification.

4.1.3. Implementation

4.1.3.1. Delivery, Storage & Handling

If end caps are not present on tube bearing the "ACR" designation, clean and re -cap in accordance with ASTM B280. Refer to General piping specification.

4.1.3.2. Preparation

Refer to General Piping Section.

4.1.3.3. Erection

Install in accordance with ASME B31.5.

Refrigeration piping must be installed by companies who are experienced in installation of such piping and technicians must comply with the minimum requirements and qualifications as stated in KS ISO 5149.

Electrical cables shall not be fixed to refrigerant pipework.

Maximum distance between pipe supports must be as per ASME B31.5 and KS ISO 5149.

4.1.3.4. Routing

All insulated piping located outdoors shall be enclosed with an aluminium or galvanised sheet metal cladding or trunking to protect the insulation from UV damage.

The suction lines shall be designed to slope back to the compressor to avoid oil logging around the system.

Where the vertical rise in suction lines exceeds 3 metres, an oil trap shall be formed in the suction line at the base of the riser and at 3 metre intervals throughout the length of the riser, or at such intervals as are recommended by the refrigerant equipment manufacturer.

4.1.3.5. Refrigerant Piping Joints

Brazing shall be carried out in accordance with BS EN 14324 by operatives having approved qualifications in accordance with the relevant standards.

Suction and liquid piping shall not be soldered or brazed together. Tubing must be new and delivered to the job site with the original mill end caps in place. Clean and polish all joints before soldering. Avoid prolonged heating and burning during soldering. During brazing, permanent dry nitrogen purging shall be in place. The engineer may require sample welds to be cut out to ascertain that this requirement has been complied with. A nitrogen regulator shall be used for this purpose. Oxygen regulators shall not be allowed and direct connection of piping to the nitrogen cylinder shall not be allowed. Should defects be found then the engineer may request further samples. The cost of rectifying defective piping installation will be for the contractors' account.

Brazing and soldering shall be executed by competent qualified/certified operators fully experienced in the type and size of work being carried out.

In addition, the recommendations of the Copper Development Association shall be adhered to.

Welding rods, brazing filler materials, fluxes etc, shall comply with relevant Standards.

4.2. Refrigeration Piping Accessories (Synthetic Refrigerants)

4.2.1. General

4.2.1.1. Scope

This section contains specifications for all refrigeration piping accessories (related to synthetic refrigerants) for this project.

4.2.1.2. Shop Drawings

Refer to the General Conditions section.

4.2.1.3. Quality Assurance

All products contained here-in must be approved by UL or must be CE marked, or both.

All valves shall be pressure tested at the manufacturer's works in accordance with an appropriate standards specification. All valves shall have the name of the manufacturer and working pressure cast or stamped on the body.

4.2.1.4. Design Criteria

Valves shall be, as far as it is practicable, of the same manufacture and style to provide conformity and to simplify maintenance. In addition, they shall comply with the requirements of the relevant local authorities.

All valves used in the piping system shall not have a pressure rating less than that of the pipework.

4.2.2. Products

Valves should be of Danfoss, Henry, Castel, Parker Sporlan or GMC manufacture. Alternative manufacturers must be submitted to the engineer for approval prior to ordering of materials.

Where solder end connections are specified, this refers to the type of end connection and not the joining method to be used. For joining methods refer to the piping section and the detailed technical specification.

4.2.2.1. Ball Valves

Body material:	Copper alloy, brass alloy
Temperature range:	-40 to 121°C
Max working pressure:	45 bar
End connections:	Solder
Specification:	Quarter turn from fully open to fully closed; chrome plated brass alloy or stainless steel sphere with full bore aperture; PTFE seat; bi-directional flow; internal stop limiting movement to 90°; anti-blowout stem; Schrader valve access point where required; wrench operated

4.2.2.2. Globe Valves

Globe valves are not recommended where full, unobstructed flow is required

Body material:	Bronze, brass
Temperature range:	-40 to 135°C
Max working pressure:	31 bar

End connections:	Solder
Specifications:	PTFE seat gaskets; stainless steel or protected steel spindle; back seating stem to allow for replacement of gland packing while under pressure; solder angle connections available (Castel); hand or wrench operated

4.2.2.3. Three-Way Shut-off Valves

Body material:	Brass or steel
Temperature range:	-29 to 149°C
Max working pressure:	31 bar
End connections:	NPT thread or weld branch/nipple/flange
Specifications:	Valve must allow for one port to be sealed while letting fluid flow through the other port to allow for the replacement of safety valves; bi-directional flow; the piping should not impose loads on the valve due to misalignment, thermal expansion, etc.; specifically designed for use with double safety valve systems.

4.2.2.4. Check Valves – General

Check valves shall be selected with opening pressure differentials that are fit for purpose. Special care should be taken when selecting check valves for parallel compressor systems.

4.2.2.5. Piston Type Check Valves

Body material:	Copper alloy, brass alloy
Temperature range:	-40 to 150°C or better
Max working pressure:	45 bar
End connections:	Solder
Specification:	Stainless steel spring; suitable for discharge line of compressor; straightway or angled body; angle body check valves should be installed with inlet facing down or horizontal, see individual installation guides

4.2.2.6. Magnetic Type Check Valves

Body material:	Copper
Temperature range:	-29 to 121°C
Max working pressure:	45 bar
End connections:	Solder
Specification:	Brass seat; aluminium retainer; stainless steel flapper and screen; hermetically sealed copper body; mesh strainer for debris removal; must be suitable for discharge line of compressor

4.2.2.7. Solenoid Valves

Solenoid valves should be of Danfoss, Sporlan or Alco manufacture.

Body material:	Brass, cast iron or steel and copper alloy
Temperature range:	-35 to 105°C
Max working pressure:	31 bar
Max operating differential pressure:	
	AC solenoid with suitable max operating pressure differential must be used
End connections:	Solder
Specifications:	Normally closed; direct acting, diaphragm pilot operated or piston pilot operated (size dependent); piston pilot operated to be used for higher temperatures and pressures; AC coil; stainless steel plunger and plunger enclosure; installed upright on horizontal piping unless otherwise stated by the manufacturer; extended ends for soldering without disassembly

4.2.2.8. Evaporator Pressure Regulating Valves

Body material:	Brass, copper
Temperature range:	-40 to 110°C
Max working pressure:	18 bar
End connections:	Solder
Specifications:	Direct acting; hermetic construction or sealed with gaskets; stainless steel or brass equalisation bellows; Schrader valve access port; wrench or Allen key adjustable set screw; mount according to flow indicator

4.2.2.9. Thermostatic Expansion Valves

Should be of type Danfoss TES or equivalent Danfoss valve suitable for use with the refrigerants in use for this project as defined in the detailed technical specification.

Body material:	Brass
Temperature range:	-60 to 100°C
Max working pressure:	28 bar
End connections:	Solder
Specifications:	Stainless steel bulb and capillary tube; interchangeable orifice design; externally equalized; bulb to be mounted in accordance with manufacturer's installation instructions. Bulbs must be insulated with cork tape or equivalent and installed according to manufacturer's recommendations.

4.2.2.10. PWM Electronic Expansion Valves

PWM valves to be of Danfoss AKV, Eliwell PXV, Castel or Alco EX2 manufacture.

Body material:	Brass

Temperature range:	-40 to 50°C
Max working pressure:	28 bar
End connections:	Solder
Specifications:	Interchangeable orifice design; should have built in shut off function in case of power failure; AC or DC coils; angle way or straightway construction; install with coil assembly facing upwards & according to manufacturer's recommendations

4.2.2.11. Stepper Electronic Expansion Valves

Stepper valves to be of Alco EX3 or Carel E2V manufacture.

Temperature range:	-30 to 75°C
Max working pressure:	34.4 bar
End connections:	Solder
Specifications:	Unipolar or bipolar motor; should be equipped with solenoid valve that shuts off in the event of power interruption, if not, an additional solenoid valve must be installed in series with the expansion valve; the controller should be able to be reset to maintain synchronisation of steps between valve and controller; take apart construction

4.2.2.12. Rotalock Valves

Body material:	Plated steel or brass
Temperature range:	-29 to 121°C/-60 to 110°C
Max working pressure:	34.5 bar
End connections:	Threaded or solder
Specifications:	Standard Rotalock thread sizes; back seating design; PTFE connection gasket; bi-directional flow; Schrader access ports

4.2.2.13. Receiver Valves

Body material:	Brass
Temperature range:	-29 to 149°C/-60 to 110°C or better
Max working pressure:	34.5 bar or better
End connections:	NPT or solder
Specifications:	Steel spindle; vertical, horizontal or angled design; back seating design; Schrader access port; UL approved

4.2.2.14. Refrigerant pressure relief valves.

Body material:	Steel or brass
Temperature range:	-30 to 100°C
Max working pressure:	40 bar

Re-seating pressure (blowdown):	10-15% below set pressure
End connections:	NPT or flare
Specifications:	Install valve with spring housing vertical; seats and discs constructed of corrosion resistant material; avoid influence of static, dynamic and thermal stresses; operating pressure should be at least 5% below blowdown pressure to ensure perfect re-seating of valve; set pressure must not exceed pressure vessel operating pressure; valves must be fully open when pressure is 10% higher (maximum) than set pressure; ASME UV approved or CE marked In the case where fluid is discharged into the low pressure side of the system, a back pressure independent valve shall be selected. The suction pressure on the low pressure side of the system during normal operation should not exceed the allowed back pressure of the valve (see SANS 10147:2014 p30). The low pressure side of the system in this case must also be equipped with an appropriately sized pressure relief valve.

4.2.3. Implementation

4.2.3.1. Preparation

All valves must be free from corrosion, scale and internal obstruction.

4.2.3.2. Erection

All valves and accessory material necessary in the piping systems shall be furnished where indicated on the drawings and at all positions necessary for the proper working, regulation, control and maintenance of the installation (whether indicated on the design drawings or not) with the approval of the engineer.

All valves must be fitted in such a manner that they are accessible for operation and maintenance. Valve operating handles must be easily accessible, may not point down and their operation must not be impeded by structure or other services.

No isolating valve may be installed between the pressure relief valve and the apparatus to be protected.

4.2.3.2.1. Expansion Valves

The expansion valve type to be installed will be specified in the detailed technical specification. Where stepper valves are utilised special care must be taken to ensure that the distance between the valve and its associated electronic controller is kept to a minimum (and in accordance with the manufacturer's requirements).

The contractor is responsible for ensuring that the electronic controllers are compatible with the valves supplied.

4.2.3.3. Commissioning

During installation, care should be taken to ensure valve bodies are not exposed to excessive heat and, where applicable, valves should be installed such that the flow direction corresponds to the arrow stamped on the body of the valve. The refrigeration system should be clean before connecting

valves, especially when installing valves with PTFE gaskets. For valves which are manufactured to be hermetically sealed, it is necessary to ensure that solder does not leak into the internal parts of the valve as disassembly is not possible. See individual installation guides for details.

4.3. Pipe Insulation - Armaflex

4.3.1. General

4.3.1.1. Quality assurance

Material shall be delivered in non-broken, factory furnished packaging and stored in a clean, dry indoor space that provides protection against weather. Installation shall be applied by qualified personnel trained in appropriate installation methods. Insulation shall not be applied until all surfaces are clean, dry, and free of dirt, dust, grease, moisture, and debris. Work shall be performed at the temperatures recommended by the product manufacturer. The materials, components and completed installation shall conform to any local, applicable standards at the time of tendering. Progressive testing of the systems to be insulated shall have been completed, inspected, and approved by the owners' representative before the insulation is applied.

4.3.2. Products

4.3.2.1. General

All insulation materials shall be:

- fibre-free and dust free, and resist mould and mildew.
- Made of a closed-cell structure to prevent moisture from wicking
- Protected when installed outside and exposed to weather, with either a suitable weather resistant finish or metal cladding material. Installed without a reflective foil covering. If a reflective foil is supplied on the insulation surface, then the insulation thickness must be increased to avoid condensation that can occur due to the surface's low emission coefficient.
- Installed according to the manufacturer's recommendations.

4.3.2.2. Thermal Insulation

Pipes, vessels and equipment shall be insulated throughout with Class 0 Armaflex, or an equivalent elastomeric Nitrile-rubber foam insulation that is closed cell, flexible and has a built-in vapour barrier. Pipes shall be insulated with Class 0 Armaflex in pre-formed tubes. Pipes that are too large for tube insulation shall be insulated with Class 0 Armaflex in sheet form.

Insulation must have a thermal conductivity of ≤ 0.034 W/ (m.K) at 0°C and ≤ 0.036 W/ (m.K) at 24°C when measured according to ASTM C 177, ASTM C 518 or EN ISO 8497. Insulation must have water vapour permeability of 0.13 µgm/ (N.h) when measured to BS4370-2:1993. Insulation must have an operational temperature range of -50°C to +105°C (tubes) and -50°C to +85°C (flat sheets).

4.3.2.3. Protective Coverings

Protective coverings shall be installed on areas of insulation that are exposed to weather. The protective covering shall be: metal cladding, comprised of coated sheet metal, with all external joints and fixings made weather-proof with silicone sealant.

4.3.2.4. Pipe work and fittings

All pipes and fittings must be free of extraneous chemicals such as corrosive cleaners or building materials' dust prior to the installation of the insulation. The insulation must be clean and dry prior to installation.

For pre-formed insulation tubes, insulate each continuous run of piping with full-length tubes of insulation, with single pieces cut to complete the end of the run. Do not use cut pieces or scraps abutting each other. Insulation shall be pushed onto pipe, not pulled. All joins and seams shall be installed by Compression Fitting. Overlap insulation 5 – 10mm (¼") at butt-edge seams and compress the edges into place. There should be no gaps present at any joins. All seams shall be vapour sealed with Armaflex 520 Adhesive or Armaflex 820

Adhesive applied to the butt-edges of the insulation.

Insulation seams shall be staggered when applying multiple layers of insulation. All pipe insulation shall be continuous through wall and ceiling openings, except where fire-stop materials are required. At the beginning, and at every 4m to 6m, and at the ends of piping runs, the insulation shall be adhered directly to the pipe using a 50mm strip of adhesive.

All valves, flanges and fittings shall be insulated throughout, using Armaflex sheet or tube material at the same thickness as used for the insulation of the main pipework. Insulation shall be mitred, pre-adhered and longitudinally slit inside throat to fit over all tees and elbows or bends over 90°.

All joints and mitred seams shall be made with full coverage of Armaflex 520 adhesive or Armaflex 820 adhesive on both surfaces. Insulation shall not be stretched during the process. On all cold pipe work it is critical that all seams and joints are glued in their entirety to provide a continuous vapour seal. Butt joints must be fitted under compression, and all seams and butt joints must be glued in their entirety to create a continuous vapour seal. The adhesive must be suitable for the operational temperatures of the system.

No additional external water vapour barrier shall be necessary with Armaflex, as the vapour barrier is built into the insulation material. The insulation material shall have a moisture resistance factor of $\mu \geq 7{,}000$ or ≤ 0.02 Perm-inch, with testing performed according to EN 12086, DIN 52615 or ASTM E96 Procedure A.

4.3.2.5. Pipe supports and pipe fixing

Saddles shall be insulated on all insulated lines at clamps, hangers, or locations where insulation may be compressed.

The hangers and supports will be constructed from a suitable material to prevent compression. The pipe supports and hangers must be glued to the adjacent insulation to provide a vapour seal, and the completed assembly of suitable construction to prevent thermal bridging. The seams shall be sealed with Armaflex 520 or 820 contact adhesive.

No piping, or any other equipment, shall be fixed to any part of the building or supported from any part of the building without the prior approval of the Engineer or the structural engineer. No fixing to non-structural elements, such as purlins, is allowed in any instances. All fixing details and workshop drawings of fixing details are to be generated by The Contractor and submitted for approval prior to procurement and installation. Failure to do so could result in the rejection of fixing details at the Engineer's discretion.

4.4. Welding / Brazing

4.4.1. General

4.4.1.1. Reference Standards

All pipework will be carried out in accordance, and compliance, with the following standards (all refer to the latest available / published edition):

1. SANS 44:2009 / ISO 544:2003
2. SANS 954:2011
3. SANS 10238:2011
4. ASME Boiler and Pressure Vessel Codes
    a. Section II – Material Specifications, Part A – Ferrous
    b. Section II – Material Specifications, Part C – Welding Rods, Electrodes and Filler Metals.
    c. Section V – Non-destructive Examination
    d. Section VIII – Pressure Vessels, Division 1
    e. Section IX – Welding and Brazing Qualifications
5. ASME B31.5 Refrigerant Piping
6. SANS 347
7. SANS 10147
8. ASME B&PVC (2017), Boiler and Pressure Vessel Code, Pressure Vessels, Section VIII, Division 1.
9. ASME B16.5 (2017), Pipe Flanges and Flanged Fittings.
10. ASME B16.11 (2016), Forged Fittings, Socket-Welding and Threaded.
11. ASME B16.20 (2017), Metallic Gaskets for Pipe Fittings.
12. ASME B16.21 (2016), Nonmetallic Flat Gaskets for Pipe Flanges.
13. ASME B31.5 (2016), Refrigeration Piping and Heat Transfer Components.
14. ASME B16.22 (2018), Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
15. ASME B16.50 (2018), Wrought Copper and Copper Alloy Braze-Joint Pressure Fitting.
16. ASTM A53/A53M-18 (2018), Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
17. ASTM A197/A197M-00 (2015), Standard Specification for Cupola Malleable Iron.
18. ASTM E136-16a (2016), Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at (750 ^{o}C).
19. ASTM B280-18 (2018), Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service (ACR).
20. ASTM B88-16 (2016), Standard Specification for Seamless Copper Water Tube (Type K-L-M).
21. ASTM B42-15A (2015), Standard Specification for Seamless Copper Pipe.
22. ASTM B75/B75M-11 (2011), Standard Specification for Seamless Copper Tube.
23. ASTM A312/A312M-18A (2018), Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
24. ASTM A403/A403M-18A (2018), Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.

If any other code is / will be used then the engineer is to be informed of this in writing during the tender submittal. All South African standards shall be substituted for the applicable Kenyan standards where applicable by the contractor.

4.4.1.2. Submittals

All WPS's and PQR's shall be submitted to the engineer for approval prior to the start of fabrication or construction.

4.4.1.3. Quality Assurance

A project QCP (Quality control Plan) is to be submitted to the engineer before work commences on site. At the same time the nominated AIA is to approve QCP prior to work commencing. All aspects

of the QCP are to be adhered to during the construction, including the recording and traceability of all components / materials used as well as all welds and their relevant welders marked.

All material used in the construction of pressure parts, piping etc as defined or regulated by the PER shall be identifiable and traceable back to the steel mill or material supplier. The contractor shall demonstrate by means of a submitted quality control plan that all materials are traceable and identifiable. All records of material certificates (for all materials used in the construction of pressure parts) shall be kept by the contractor and form part of the installation data pack to be handed over in order to obtain final completion.

Where NDE is required by code or by request by the engineer, The NDE shall be performed strictly in accordance with the requirements and methods described in the applicable ASME codes. The engineer reserves the right to call for 100% NDE, should it be required.

4.4.1.4. Inspection and testing

All inspections and testing will be carried out in accordance with ASME B31.5 chapter VI, Examination, Inspection and Testing.

Specific note is to be taken of the NDT requirements set out in ASME B31.5 paragraph 536, “EXAMINATION”.

The AIA and all costs associated with the inspection on this project are for the contractor and are to be included in the tender amount.

If required by the AIA, due to failure, or in the case of repairs executed, or other reasons, additional testing of an NDA or other nature will be for the contractors account.

If additional AIA inspections are required due to expediting the contract or for whatsoever other reason which the contractor intends on claiming from the client, the client is to be informed about such visits in writing prior to them occurring. Approval for these inspections is required in writing by the client or engineer.

In terms of pressure testing, specific note is to be taken of the requirements as set out in ASME B31.5, clause 538, “Testing”

It is not foreseen that this specific project will require a staggered pressure testing regime to accommodate the timelines of the project.

4.4.2. Products

Welding consumables must comply with SANS 44:2009. Welding rods, electrodes and filler materials shall be approved for use with the ASME codes. All welding machines used should comply with SANS 954:2011. All Ferrous materials used shall be approved for use with the ASME codes.

4.4.3. Execution

All fabrication and assembly is to be carried out according to ASME B31.5, Chapter V, Fabrication and Assembly. All welding is to be carried out as per ASME B31.5. All welding operators, welders, brazing operators, brazers and all procedures used in welding and/or brazing must be strictly in accordance with the applicable ASME codes. All refrigerant and secondary coolant piping must be strictly in accordance with the requirements of ASME B 31.5. Pre-qualified procedures will only be accepted if specifically approved in the jurisdiction of use. All welding and thermal cutting processes shall be performed in accordance with the principles stated in SANS 10238:2011. All equipment utilised in

the preparation and execution of welding must comply with the relevant and applicable SANS and international standards. Design of all welds and all welding procedures are by the contractor.

4.4.3.1. Specific brazing requirements for copper piping

Purge with Nitrogen. Minimum Grade “L” as defined by the Compressed Gas Association with a minimum nitrogen content of 99.998%, and a maximum of 4 ppmv moisture.

Joints shall be silver solder, 45% Ag - 80% Cu - 5% P using non-corrosive flux for copper to steel or brass and 15% Ag for copper to copper.

Welded and brazed joints shall be fabricated as required by ASME B31.5, 2013, Refrigeration Piping and Heat Transfer Components and ASME Boiler and Pressure Vessel Code Section IX, 2013, Welding and Brazing Qualifications.

4.5. Painting

4.5.1. General

This section describes technical requirements of painted items that form part of the contract.

4.5.2. Products

As applicable.

4.5.3. Implementation

The entire installation, other than aluminium or stainless-steel pipe cladding, shall be painted, unless otherwise specified in the detailed specification.

Before any painting is applied, the surfaces shall be prepared according to SANS 10064, Code for Preparation of Steel Surfaces for Painting. All surfaces shall be moisture free, clean and properly prepared.

During painting, the Contractor shall ensure that all the necessary fire prevention and fire-fighting precautions have been taken. Name plates, labels and notices on equipment shall not be painted. Items which do not require painting such as diffusers and grilles, shall only be installed after the paintwork on the plant, ceiling or walls have been completed.

Painted surfaces on proprietary manufactured items shall be adequately protected. Equipment on which the paintwork has been damaged during installation shall be repainted before first delivery of the plant will be considered.

Unless otherwise specified in the detailed specification the installation shall be painted in accordance with KEBS colour coding where applicable.

Angle iron framework shall be painted with epoxy paint before side covers are fitted. All steel surfaces shall be cleaned and painted with a wash primer or zinc chromate primer (ungalvanised iron) before the epoxy paint is supplied.

4.6. Air Cooled Condensers

4.6.1. General

4.6.1.1. Scope

This section contains specifications for all cooling coils for this project.

4.6.1.2. Quality Assurance

Full manufacturing details (including complete drawings and weight) of the condensers are to be submitted to the Engineer at tender and approval must be obtained prior to manufacture.

4.6.1.3. Design Criteria

4.6.2. Products

Air cooled condensers shall be of HC Heat Exchangers, Recam, Thermocoil manufacture. Alternative offers to the main offer must be submitted under a separate covering letter.

Materials

All condensers are to have copper tubes and aluminium fins. Condenser fins are to either be PU coated, treated with Bluchem or Blygold or are to have similar approved anti-corrosion treatment.

4.6.3. Implementation

4.6.3.1. Erection

Mounting / Orientation

The condensers are to be mounted on TICO pads or similar approved vibration free mountings.

The refrigeration contractor is to ensure that the liquid outlet of the condenser is higher than the inlet on the receiver and where shown, the copper line between the two is to be installed to aid gravity flow back to the receiver. Each condenser will include for an inlet and outlet shut off valve, to allow for isolating of the condenser if required, unless otherwise stated in the detailed technical specification. Where simplex packaged units (all-weather packs or standard bases), the requirement is not a pre-requisite. Refer to the detail technical specification for details.

The final layout and orientation of condensers on site is to allow for adequate air flow according to the manufacturers recommendations. Should the layout to be used by the contractor differ significantly from the drawings, the contractor is to submit a proposed layout drawing of the condenser area to the Engineer for approval prior to installation.

4.6.3.1.1. Fans

Multiplex condensers are to be installed with speed controlled fans.

The method of speed control for multiplex condenser fans will be specified in the detailed installation specification.

4.6.3.1.2. Power Supply

The power supply to each condenser is to be provided with an electrical isolator, installed within 1m from the condenser it serves. Multiplex condensers with multiple fans require multiple isolators unless a sub breaker board is provided to allow for feed to each fan respectively, in which case the sub breaker board is to be supplied with a main isolator. Condensers that serve a simplex compressor pack only require a single isolator per condenser. Please note that all condensers situated outdoors are to have weather proof isolators which have a moisture ingress rating of at least IP 65.

4.7. Electrical Wiring

4.7.1. General

4.7.1.1. Reference Standards

SANS 10142-1: 2012

SANS 10142-2:2014

KEBS 662 Latest Edition

4.7.1.2. Quality Assurance

Only qualified and experienced electricians with the necessary qualifications as required by law may work on any part of the electrical installation.

The contractor must issue a Certificate of Compliance for all field wiring installed by the contractor. The CoC must signed and approved by a qualified person, which certifies that the installation complies with SANS 10142 / KEBS 622 in its entirety.

4.7.2. Products

All products utilised as part of the electrical installation must comply with the relevant national standards and must bear the applicable marks as required.

4.7.3. Execution

Design of the entire electrical distribution system from the point of control to the point of consumption must be by the contractor. The entire installation must conform to all requirements of the applicable national legislation and to the requirements of SANS 10142 / KEBS 662 (latest edition) and any reference standards in entirety. All work for the entire electrical installation to be performed by suitably qualified personnel.

4.8. Electrical Boards

4.8.1. General

This section describes the requirements for all electrical distribution boards, switchboards and control boards supplied by the contractor.

All electrical boards and DB design shall be done in such a manner that will allow the DB's and panels to operate up in areas up to 45°C ambient conditions. Any DB's or control panels that are exposed to direct sunlight shall be provided with a protective lean to or shade cover providing sufficient shade to ensure the DB internal temperatures do not exceed the OEM's recommendation on any single component.

4.8.1.1. Reference Standards

SANS 1473-1 / Kenyan or international equivalent

SANS 1973-1:2007 / Kenyan or international equivalent

SANS 1973-3:2008 / Kenyan or international equivalent

SANS 1973-8:2008 / Kenyan or international equivalent

SANS 10142-1:2012 / Kenyan or international equivalent

SANS 10142-2:2014 / Kenyan or international equivalent

ISO 61439-1

KEBS 662

4.8.1.2. Submittals

Submit shop drawings of all electrical panels to the engineer for approval prior to ordering and manufacture. Submit single line diagrams and general wiring diagrams to the engineer for approval prior to ordering and manufacture.

Submit complete data-pack in the project O&M manual.

A certificate of conformance stating that each electrical board complies with the relevant standards must be supplied by the contractor.

4.8.1.3. Quality Assurance

All materials and products shall be new, sound and uniform in quality, size, shape, colour and texture. The assembler shall be responsible for ensuring that the required standards of quality control as mentioned in relative sections are maintained for the proposed enclosures.

4.8.2. Products

4.8.2.1. Switchgear

Must be Schneider Electric, ABB or approved alternative manufacture.

4.8.2.2. Enclosures

Outdoor enclosures shall be IP65 or better. Shall be floor standing and made of galvanized steel. Enclosures shall be coated with epoxy-polyester powder hot polymerized in textured RAL 7035 for better corrosion resistance. In case that two or more enclosures are installed together the doors should be able to open without interfering with the adjacent enclosures.

4.8.2.3. Doors

Doors shall be supplied with an opening handle to allow easy door managing when equipped and shall be provided with a closing system locked by a double-bar / key / triangle tool / square tool as applicable.

4.8.3. Execution

All electrical panels must be manufactured in accordance with, and comply to, the requirements of the relevant parts of SANS 1973 (latest edition) and ISO 61439-1 (latest edition).

The detail design of the electrical distribution boards supplied as part of this contract, is by the contractor. All associated parts of the electrical installation must comply with the relevant national standards, including SANS 10142 / KEBS 662 (latest edition).

Clearly engraved labels must be installed at every switch.

The contractor shall balance the load across the phases.

Distribution boards shall be manufactured by a reputable firm which is a specialist in the field and who shall install and fit the switchgear and equipment and carry out all the internal wiring.

The boards shall be manufactured from pre-galvanised sheet metal with an epoxy paint. The contractor must paint boards and the colour of each board will be to the architect’s approval.

All doors and cover plates to have suitable neoprene gaskets. Boards must be vermin proof. Boards must be provided with suitable ventilation and any ventilation openings must be provided with suitable mesh.

4.9. Control system and Monitoring

The installation shall be supplied complete with a new monitoring and management system. Alternatives may be accepted and must be submitted to the engineer for approval. The main offer must be of Danfoss Adapcool, Eliwell TelevisGo or Carel Boss (or similar prior approved) with RS485 (or similar) and Screen. Allowance must be made for reticulation of wiring from all the controllers to the monitoring system as part of this contract. It can be assumed that the monitoring system will be installed inside the office block. Temperature indicators as specified must also be connected to the central monitoring system.

The system must have enough capacity to connect all controllers on the site via a suitable RS485 protocol. This connection must be by the refrigeration contractor and must be in accordance with the controls supplier's recommendations.

At least the following functionality and the set-up thereof forms part of this contract:

- Visual layout of the site and all major components to be generated
- Suction Pressure Optimisation
- Monitoring and recording of all major temperatures, pressures and other measured variables as measured by system controllers.
- Alarm management
- Collection of operating history and alarms to suit the client's HACCP plan.
- GSM or internet connectivity and sending of alarms via sms or email to the addresses and numbers provided by the client. This service must be provided free of charge to the client during the 12 month guarantee and maintenance period.

4.10. Identification of services

4.10.1. General

4.10.1.1. Scope

This section contains specifications for the identification of all services for this project.

4.10.1.2. Reference Standards

SANS 10140

SANS 1186

SANS 10147

4.10.2. Products

Plant labels must be weatherproof, UV proof, and must be metal or rigid plastic (Trafolite).

All methods of identification shall be compatible with the pipe and operating conditions.

4.10.3. Implementation

4.10.3.1. Identification of Plant

Each item of plant and equipment shall be labelled and permanently marked, indicating its unique reference code as used in the operating and maintenance documentation and P&ID drawings.

The plant numbering system shall be agreed with the Engineer prior to the commencement of the Works.

For existing sites, the plant numbering system shall be fully compatible with any existing numbering system.

All items of plant and equipment shall be provided with a manufacturer's nameplate indicating the plant type, reference, serial number, year of manufacturer, performance and electrical data.

Pressure vessels which have been hydraulically tested at the manufacturer's works shall indicate the test pressure, working pressure and date of test.

4.10.3.2. Identification Bands for Piping

Where required, pipework and ductwork shall be identified by colour bands 150 mm wide.

Identification bands shall be applied in a logical and tidy manner with lettering and flow arrows clearly visible. Where several pipelines are installed in parallel to each other the identification bands shall be applied at the same location on each pipe.

The bands shall be applied at termination points, junctions, entries and exits of plant rooms, walls and ducts, and control points to readily identify the service and spacing shall not exceed 4.0 metres.

The main supply pipes in any system shall also be marked to indicate the direction of flow. This shall be done at least every 10 m, and where pipes pass through any solid barriers.

4.10.3.3. Piping Colour Scheme

The following colour scheme is to be used.

Service	Base Colour	Band	Designation
Liquid Drain Pipe from Condenser to Receiver	Yellow	-	-
Liquid pipe to evaporators in plant areas and visible outside	Blue	-	-
Liquid pipe to evaporators in facility and hidden	None – (Copper)	-	-
Compressor Discharge to Condenser	Red	-	-
Compressor Suction	None – Insulated	-	-

The pipes running to and from the condensers are to be painted for corrosion and/or oxidation protection and identification purposes, irrespective of the location (part 4, section 4.21). The hot gas line and liquid lines are to be painted red and yellow respectively.

4.11. Twelve Months Guarantee and Maintenance Period

4.11.1. General

4.11.1.1. Scope

This section describes the requirements of the 12-month maintenance and Guarantee period which forms part of this contract.

4.11.1.2. Reference Standards

SANS 10147:2014

4.11.1.3. Products

Not Applicable

4.11.1.4. Implementation

4.11.1.5. Guarantee

The contractor shall guarantee the new material, apparatus and workmanship delivered by him for a period of twelve (12) months. The guarantee must be valid for a period starting on the date when the contract is accepted by the engineer as complete and in working condition. The complete installation must be guaranteed against defects which result from patent and latent defects of the equipment design and apparatus, as well as against faulty materials and workmanship. The guarantee must provide that all parts, spares and appurtenances which become defective during the guarantee period will be replaced free of charge.

The cost of labour and transportation required to replace such a part of a defective installation shall be borne by the contractor and shall be included in his guarantee. The contractor shall cede to the employer the remainder of any equipment guarantee which he has received from his suppliers which extend beyond the period of twelve months mentioned herein.

In the event of the project being phased, guarantee on installation and equipment shall commence on the date on which it is put into operation for beneficial use to the satisfaction of the engineer.

4.11.1.5.1. Maintenance

A maintenance period of 12 months on all equipment and workmanship will commence at practical completion. The HVAC&R Contractor is to allow for a minimum of 12 service visits (once a month) and for instruction of the operating staff. A monthly preventative maintenance service schedule is to be completed and inserted into plastic sleeves in plant room logbook. The contractor is to pay special attention to the detailed technical specification for details on the number of required service visits in the 1-year guarantee period.

The full details and names of service personnel in the area are to be supplied within two (2) days of the tender being awarded.

The service is to include, but is not limited to the following:

- Check insulation sweating on suction lines and lines conveying liquids below ambient temperature.
- Check overhead drip trays for water or suspected refrigerant leaks and general condition.
- Check general condition of condensers including corrosion and possibility of leaks.
- Clean condenser fins, coils, or sumps.
- Check compressor general running conditions, freezing back on suction line, whether all covers are fitted and secure, refrigerant leaks, oil levels, HP/LP settings, electrical wiring and terminals and possible filters blockage.
- Check for condition of isolators, circuit breakers, controllers, wiring, terminals, discolouring of wiring (hot spots) in the DB.
- Check the monitoring system to ensure the effective reading of the refrigeration systems. Simulate an alarm test.

- Check blower coils for ice build-up, ensure condensate drains are clear from blockage; and heater elements are in working condition.
- Check the general condition of drip trays, refrigeration piping, expansion valves, etc.
- Check the condition of blower coils and rooms, and report stacking of merchandise on top of rooms.
- Brush down blower coils in MT/HT rooms.
- Clean plant room & remove debris.
- Confirm superheat at the compressor packs is sufficient.
- Take a sample of the closed circuit glycol / water system and have it tested to ensure it complies with the requirements for a closed system.

In addition to the above service tasks, the contractor is to note that all service & maintenance tasks & inspections as prescribed by SANS 10147:2014 and all applicable regulations (Including the OSHACT and SANS 347) must be adhered to and carried out by the contractor. This implies by inference that the Contractor must utilise and appoint on behalf of the client any and all "competent persons" as required by regulation to perform the necessary inspections and tasks.

Should the system, for any reason, require pumping down, refrigerant gas reclaim is to be utilized such that legal and ethical aspects pertaining to this topic may be complied with.

4.12. Operation and Maintenance Manuals

4.12.1. General

4.12.1.1. Scope

This section describes the requirements for Operation and Maintenance Manuals for this contract.

4.12.1.2. Quality Assurance

The HVAC&R Contractor shall, in addition to the operating and maintenance manuals, give detailed explanations of, and instructions to the owner on the operation of the complete installation, as finally commissioned and handed over.

The HVAC&R Contractor shall operate the whole plant for a period of five consecutive days after the plant is handed over. During this period the contractor shall provide the owner with operation instruction.

4.12.2. Products

Not applicable

4.12.3. Implementation

The contractor shall provide an approved comprehensive maintenance and operating instruction manual complete with all equipment data, schedule of maintenance, equipment layout drawings, control and wiring diagrams, commissioning data and contacts for suppliers. The supply is to include a logbook in the plant room. Storage space for the logbook should be allowed for in the plant room area.

A full set of operation and maintenance manuals is to be submitted to the engineer for approval prior to final completion being granted.

The O&M manuals are to be delivered in the following formats and quantities:

- One hard copy comprising all original documentation and records.
- One duplicate copy for the engineer

- Two complete and comprehensive electronic copies on memory sticks, one for the client and one for the engineers' records.

4.12.3.1. Preparation

Each copy of the manual is to include the following minimum contents:

1. A description of the plant and equipment (accompanied by a refrigerant circuit diagram and an electrical circuit diagram);
2. Detailed information for starting up, shutting down the plant, and emergency procedures;
3. Notes on possible failures, their causes, and methods of repair;
4. Maintenance instructions (preferably accompanied by a schedule);
5. Detailed information on first-aid procedures in the event of injury to persons;
6. The designation of the refrigerant and the charge in kilograms required for normal operation;
7. A warning against erroneously charging with the wrong refrigerant;
8. A warning against the freezing of water in condensers, coolers, etc.;
9. A detailed warning that substitution of a refrigerant shall not be made without the approval of a competent person;
10. An equipment and controls list giving the following; description, quantity, makes, model number, location;
11. A schedule of the servicing to be done on each item of equipment and controls and frequency;
12. Description of automatic control system, accompanied by control schematics;
13. Step-by-step instructions for starting/stopping each item of equipment;
14. Technical data sheets on construction in accordance with KS ISO 5149;
15. Certification by a competent person that the plant complies with KS ISO 5149
16. A material safety data sheet for the refrigerant in the system;
17. The contractor shall provide a logbook in which the following shall be entered:
    17.1. The name(s) of the competent person(s) or the name of his/her employer;
    17.2. The name and address of the manufacturer or, when relevant, of the supplier of the system;
    17.3. The maximum rated refrigerating capacity stated by the manufacturer, in kilowatts, and the temperatures at which the capacity is calculated, in degrees Celsius;
    17.4. The refrigerant used and its charge in kilograms;
    17.5. The maximum working pressure, in kilopascals;
    17.6. All information and tests in accordance with statutory requirements;
18. Subject to the requirements of the local regulations a manufacturer shall issue a certificate of manufacture for all pressure equipment supplied, with a verification signature by an approved inspection authority when required.
19. Record of pressure tests performed.

20. All commissioning data:
    20.1. Flow rates
    20.2. Motor speeds
    20.3. Temperatures
    20.4. Pressures
    20.5. Motor and other electrical equipment amps
20.5.1. This is required for all motors on the site.

21. Record of training provided to staff at the facility.

22. All OEM manuals and technical information from the suppliers.
    22.1. The original O&M and technical brochures submitted with the product is to be included in plastic sleeves.

4.12.3.2. COC's

4.12.3.2.1. Refrigeration COC

A COC as required in terms of the Occupational Health and Safety Act is required. This COC is to be signed by the contractor and included in the hand over pack.

The Contractor must issue the client with a valid certificate of construction (by an approved AIA) and a Certificate of Conformity for Gas installation as per the Occupational Health and Safety Act, 1993 Regulations 17(3) of the Pressure Equipment Regulations, 2009 signed by a Level C competent person as defined in SANS 10147:2014. This is an express condition of the contract.

4.12.3.2.2. Electrical COC

An electrical COC is required for the entire electrical installation.

4.12.3.3. Plant room drawings

The contractor is to allow for a complete set of the P&ID's to be printed, laminated, framed and installed in the plant room in a suitable frame to ensure that they remain intact and legible for the life of the plant.

The P&ID is to indicate the valves to be shut in an emergency and all valve numbers are to correspond to the actual valve numbers affixed to the valves in the plant room.

All valves in the plant room are to be numbered in this fashion.

5. List of Returnable Documents

In addition to other documents listed in the Contract Document, the contractor must submit the following schedules or documents in accordance with the timeframes stated in the text. Where the example documents or schedules are not included in the contract documents, the contractor is to produce his own set of documents.

- A detailed pricing document must be prepared by the HVAC contractor and submitted with their tender submission.

In addition to other documents listed in the Contract Document, the contractor must submit the following schedules or documents in accordance with the timeframes stated in the text.

Where the example documents or schedules are not included in the contract documents, the contractor is to produce his own set of documents.

- The form of tender must be completed by the tenderer and submitted with their tender submission
- Summary of programme of works (with tender return or as stated in text)
- Full detailed programme of works (on appointment or as stated in text)
- Additional Builder's work requirements
- Schedule of subcontracts*
- Certificate of Acquaintance*

5.1. The Pricing Document

5.1.1. Notes on the Pricing Document

The Pricing Document for this project is **not** in the form of a full and comprehensive Bill of Quantities (BoQ). The Schedule of Rates provided is intended as a guide only. Measurement of the full contract is the responsibility of the tenderer. No additional costs will be entertained for items missing on the SoR provided. The contractor is to review the contract documents in full and list additional items in the SoR as required to deliver all requirements stated in the contract.

The Contractor must check the tender price schedule before submitting his tender, and if the figures or writing is indistinct, or the tender price schedule contains any obvious errors, he should inform the engineer immediately and have the same rectified. The engineer and client will admit no liability whatsoever in respect of errors in tender due to the foregoing or lack thereof.

The tender price schedule forms part of, and must be read in conjunction with the full contract document which contains a full description of the work to be done and material and equipment to be used. Unless otherwise described in the tender price schedule, reference should be made to the full contract document for the full meaning and description of work to be done, and materials and equipment to be used in this service. The Contractor must tender prices on the materials as specified in detailed specification and on the drawings.

Contractors are to enter here the costs for providing all facilities and for compliance with all contractual requirements to complete the project.

The attention of the Contractor is drawn to the following clauses:

- Contractors must complete the pricing document and detail the unit rate and total amount of each item. The "total" shall constitute the basis for the evaluation, comparison and adjudication of all the submitted tenders and the contractor must include this full tender price on the form of tender.
- Contractors are advised to check their item extension and total additions, as arithmetical errors occurring in the priced document cannot be considered as influencing the tender amount.
- No alteration, erasure or addition may be made in the text of the pricing document. Should any alteration, erasure or additions be made, it will not be recognised but the original wording of the pricing document will be adhered to. The only exception is that additional items may be added where explicitly shown on the pricing document.
- The Engineer will check the completed pricing document and reserves the right to adjust any individual price and rectify any discrepancy, whilst the total tender price, as quoted, remains unaltered.
- The unit prices quoted in the pricing document must include for such small installation materials as are required for the complete installation in accordance with the specification.
- A lump sum figure is indicated for the contract data and form of tender. Even if a value is not provided for each individual item, the lump sum is deemed to cover all the listed items.
- All rates are to EXCLUDE VAT where applicable.
- Rates are to be strictly in accordance with the specification. Where alternatives are offered, they are to be listed separately.
- Materials are to be ordered off construction drawings and must correlate with the pricing document . Any discrepancy and/or unclear quantities must be brought to the attention of the project engineer.
- Rates are to include for the manufacture, supply, installation, sundry materials, wastage, office expenses, labour, administration, drawing office expenses, commissioning, transportation to site, guarantee for a period of 12 months and profit.

5.1.2. The Pricing Document – Schedule of Rates

5.1.2.1. Notes to the Schedule of Rates

Prices and Rates shall include:

- Net cost of materials and equipment necessary for each installation and delivered to site.
- Net cost of labour as necessary for each item.
- All temporary works, stocking, scaffolding, tooling, hoisting and rigging, transport on site, handling, waste, travelling time etc., not included in the preliminary and general provisions for the subcontract.
- Profit and Overhead.
- Drafting, Engineering, Contract Management.
- The schedule of rates will form part of the tender submission and must be completed on the SoR template.

5.1.2.2. The Schedule of Rates

Refer attachment

5.1.2.3.

As

5.2. Certificate of Acquaintance

I / We*, the undersigned

.....

.....

.....

do hereby certify that I / We* have made myself / ourselves* acquainted with the contract document, all related documents and the drawings, for the Isiolo Abattoir.

Signed

....

At: .....

This ..... Day of: .....

As witnesses:

1. .....

2. .....

Date: .....

Signature of Tenderer: .....

*Select applicable option clearly

5.3. Schedule of Sub Contractors

State in the schedule below the names of all sub-contractors the Tenderer wishes to employ in the works, define their duties and outline their experience.

Name of Subcontractor	Proposed Duties	Experience

Date:

Signature of Tenderer

5.4. Details concerning rates of exchange for imported content value of contract

Fixed portion of tender price:

.....

(not subject to escalation or price adjustment due to variations in the rates of exchange).

IMPORTED CONTENT (F.O.B. Value)

Country of Origin	**Rate of Exchange**	**Country of Origin Rate of Exchange Percentage of Tender Price**
	=	%
	=	%
	=	%
	=	%
	=	%
	=	%

Local Content:

.....

(Not subject to Contract Price Adjustment in terms of the Contract).

Signature of Tenderer:

.....

As witnesses:

1. .....

2. .....

Date:

.....