INVITATION TO BID (SBD 1)

YOU ARE HEREBY INVITED TO BID FOR THE FOLLOWING SPECIFIED SUPPLY REQUIREMENTS

BID NUMBER: NRF/iThemba LABS/2015-16:07
CLOSING DATE: 14 DECEMBER 2015
CLOSING TIME: 11:00

BID DESCRIPTION

REPLACEMENT OF EXISTING CHILLERS IN PLANT ROOM AT ITHEMBA LABS, FAURE

Preferential Procurement System Applicable (points for price: points for procurement preference) 90:10

BID DOCUMENTS ARE TO BE DEPOSITED IN THE BID BOX SITUATED AT:

EITHER PHYSICALLY OR BY COURIER

iThemba LABS
Main Reception Area
Old Faure Road
Faure
Cape Town
7131

Bidders should timeously deliver bids to the correct address. If the bid is late at the NRF address, it is not considered. The bid box is open from 08h00 to 16h30 South African times, 5 days a week (Monday to Friday).

ALL BIDS MUST BE SUBMITTED ON THE OFFICIAL FORMS IN THIS INVITATION (NOT TO BE RE-TYPED) WITH ADDITIONAL INFORMATION ON ATTACHED SUPPORTING SCHEDULES

THIS BID IS SUBJECT TO THE PREFERENTIAL PROCUREMENT POLICY FRAMEWORK ACT AND THE PREFERENTIAL PROCUREMENT REGULATIONS - 2011, THE GENERAL CONDITIONS OF CONTRACT (NRF WEBSITE) AND SPECIAL CONDITIONS OF CONTRACT AS STIPULATED IN THIS INVITATION.
# THE FOLLOWING PARTICULARS MUST BE FURNISHED AS LEAD PAGE OF THE BID RESPONSE

<table>
<thead>
<tr>
<th>BID NUMBER</th>
<th>NRF/iThemba LABS/2015-16:07</th>
<th>CLOSING DATE</th>
<th>14 DECEMBER 2015</th>
<th>CLOSING TIME</th>
<th>11:00</th>
</tr>
</thead>
</table>

**NAME OF BIDDER**

**REPRESENTED BY**

**POSTAL ADDRESS**

**PHYSICAL ADDRESS**

**TELEPHONE NUMBER**

**CELL PHONE NUMBER**

**FACSIMILE NUMBER**

**E-MAIL ADDRESS**

(Stipulate)

**VAT REGISTRATION NUMBER:**

**HAS AN ORIGINAL AND VALID TAX CLEARANCE CERTIFICATE BEEN SUBMITTED?**

**PREFERENCE CLAIM FORM BEEN SUBMITTED FOR YOUR PREFERENCE POINTS? (SBD 6.1)**

**A B-BBEE STATUS LEVEL VERIFICATION CERTIFICATE MUST SUPPORT PREFERENCE POINTS CLAIMED**

**IF YES, BY WHOM WAS THE B-BBEE CERTIFICATE ISSUED**

- An accounting officer as contemplated in the close corporation act (CCA)
- A verification agency accredited by the South African accreditation system (SANAS); or
- A registered auditor

[Tick Applicable Box]

**ARE YOU THE ACCREDITED REPRESENTATIVE IN SOUTH AFRICA FOR THE GOODS/SERVICES/WORKS OFFERED?**

**IF YES ENCLOSE PROOF**
SIGNATURE OF BIDDER

NAME of BIDDER

DATE

CAPACITY UNDER WHICH THIS BID IS SIGNED

ANY ENQUIRIES REGARDING THE BIDDING PROCEDURE DIRECTED TO:

Technical contact person is:
Mr. Alfredo Malgas, - BVi Consulting Engineers
Tel. No. (021) 527 7000, Fax No. (021) 527 7001, e-mail alfredom@bviwc.co.za

Supply Chain Management:
Natasja Pietersen- Supply Chain & Support Services Manager
Tel :021 843 – 1345, email: npietersen@tlabs.ac.za

Site Services Manager
Mr. Paul Gardiner – Divisional Manager: Technical Site Services
Tel: 021-843-1059; Cell: 079-783-6149; email: pgardiner@tlabs.ac.za

<table>
<thead>
<tr>
<th>BID RESPONSE SUBMISSION FORMAT / CHECKLIST</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No of originals</strong></td>
</tr>
<tr>
<td>Pack split into “Technical” and “Awarding” Sections</td>
</tr>
<tr>
<td>Please tick applicable</td>
</tr>
<tr>
<td>Proposal – Bidder’s B-BBEE Transformation Program</td>
</tr>
<tr>
<td>Certified copies of certificate of incorporation (as per entity type)</td>
</tr>
</tbody>
</table>
NRF - ITHEMBA LABS

BID NO: NRF/iThemba LABS/2015 - 16:07
REPLACEMENT OF EXISTING CHILLERS IN PLANT ROOM AT ITHEMBA LABS, FAURE

GENERAL TENDER INFORMATION

TENDER INVITED : NRF/iThemba LABS/2015 – 16:07

SITE VISIT/CLARIFICATION MEETING : 11h00 on 27 November 2015

VENUE FOR SITE VISIT/CLARIFICATION MEETING : NATIONAL RESEARCH FOUNDATION iThemba LABS Old Faure Road Faure

CLOSING DATE : 14 December 2015

CLOSING TIME : 11h00

CLOSING VENUE : NATIONAL RESEARCH FOUNDATION iThemba LABS Old Faure Road Faure

: The tender Documents completed in all respects, plus any additional supporting documentation required, must be submitted in a sealed envelope with the name and address of the tenderer, the tender No. and title and the closing date indicated on the envelope. The sealed envelope must be inserted into the appropriate official tender box before closing time.
# Contents

<table>
<thead>
<tr>
<th>Number</th>
<th>Heading</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>The Tender</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Part T1: Tendering procedures</strong></td>
</tr>
<tr>
<td>T1.1</td>
<td>Tender Notice and Invitation to Tender</td>
</tr>
<tr>
<td>T1.2</td>
<td>Tender Data</td>
</tr>
<tr>
<td></td>
<td><strong>Part T2: Returnable documents</strong></td>
</tr>
<tr>
<td>T2.1</td>
<td>List of Returnable Documents</td>
</tr>
<tr>
<td>T2.2</td>
<td>Returnable Schedules</td>
</tr>
<tr>
<td></td>
<td><strong>The Contract</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Part C1: Agreements and Contract Data</strong></td>
</tr>
<tr>
<td>C1.1</td>
<td>Contract Data</td>
</tr>
<tr>
<td>C1.2</td>
<td>Form of Guarantee</td>
</tr>
<tr>
<td>C1.3</td>
<td>Occupational Health and Safety Agreement</td>
</tr>
<tr>
<td></td>
<td><strong>Part C2: Pricing data</strong></td>
</tr>
<tr>
<td>C2.1</td>
<td>Pricing Instructions</td>
</tr>
<tr>
<td>C2.2</td>
<td>Bills of Quantities</td>
</tr>
<tr>
<td>C2.3</td>
<td>Contract Rates</td>
</tr>
<tr>
<td>C2.4</td>
<td>Special Items</td>
</tr>
<tr>
<td>C2.5</td>
<td>Schedule of Equipment Offered</td>
</tr>
<tr>
<td>C2.6</td>
<td>Schedule of Imported Materials</td>
</tr>
<tr>
<td></td>
<td><strong>Part C3: Scope of Work</strong></td>
</tr>
<tr>
<td>C3.1</td>
<td>Description of the Works</td>
</tr>
<tr>
<td>C3.2</td>
<td>Engineering</td>
</tr>
<tr>
<td>C3.3</td>
<td>Procurement</td>
</tr>
<tr>
<td>C3.4</td>
<td>Technical Specification</td>
</tr>
<tr>
<td>C3.5</td>
<td>Annexes</td>
</tr>
</tbody>
</table>
Part T1: Tendering procedures

T1.1  Tender Notice and Invitation to Tender.........................................................2 - 3
T1.2  Tender Data ........................................................................................................4 - 26
NRF - ITHEMBA LABS

BID NO: NRF/iThemba LABS/2015 – 16:07

REPLACEMENT OF EXISTING CHILLERS IN PLANT ROOM AT ITHEMBA LABS, FAURE

T1.1 Tender Notice and Invitation to Tender

NRF - ITHEMBA LABS invites tenders for Tender: REPLACEMENT OF EXISTING CHILLERS IN PLANT ROOM AT ITHEMBA LABS, FAURE.

It is estimated that tenderers should have a CIDB contractor grading designation of 6ME or higher.

Documents may be collected from iThemba Labs offices from the Friday, 13 November 2015 or downloaded from the website: http://www.nrf.ac.za/procurement/procurement-invitations or http://www.tlabs.ac.za/supply chain/bids.

A compulsory site visit/clarification meeting with representatives of the Employer will take place at the offices of NRF - iThemba LABS Old Faure Road, Faure (Refer to Locality Plan – Site Visit/Clarification Meeting Venue overleaf) on 27 November 2015.

The closing time for receipt of tenders is 14 December 2015.

Telegraphic, telephonic, telex, facsimile, e-mail and late tenders will not be accepted.

Tenders may only be submitted on the tender documentation that has been issued.

Requirements for sealing, addressing, delivery, opening and assessment of tenders are stated in the Tender Data.

Background to the National Research Foundation and its business units

The National Research Foundation (“NRF”) is a juristic person established in terms of section 2 of the National Research Foundation Act, Act 23 of 1998. The NRF is the government’s national agency responsible for promoting and supporting research and human capital development through funding the National Research Facilities and science outreach platforms and programs to the broader community in all fields of science and technology, including natural science, engineering, social science and humanities.

Context of the Project

iThemba LABS provides research platforms for pure and applied research and development in Accelerator Based Sciences. The key stakeholders of iThemba LABS have a legitimate expectation of state-of-the-art equipment that is well maintained and reliable, as well as efficient service delivery and expert in-house support.

Research platforms and equipment are fully reliant on a steady supply of temperature stabilized cooling water from a centralized cooling plant. The cooling plant as absolutely crucial to the operation of the facility and without which, the facility will not be able to function at all.

Measurements have shown that the chiller units of the cooling plant are no longer performing efficiently. Worn components, widening tolerances between moving parts, corroded heat-transfer surfaces and other issues related to tens of thousands of run-time hours can lead to recurring failures and lost production capacity. The energy efficiency of new machines is also a key justification for making a large investment to replace the ageing units. Along with a sustainable energy cost saving, the replacement of the chiller units will also contribute to the reliable and stable operation of the state-of-the-art research platforms on offer to all stakeholders of the iThemba LABS facility.
ITHEMBA LABS
BID NO. NRF/iThemba LABS/2015 – 16:07
REPLACEMENT OF EXISTING CHILLERS IN PLANT ROOM AT ITHEMBA LABS, FAURE
LOCALITY PLAN – SITE VISIT/CLARIFICATION MEETING VENUE
THEMBA LABS

BID NO: NRF/iThemba LABS/2015 – 16:07

REPLACEMENT OF EXISTING CHILLERS IN PLANT ROOM AT THEMBA LABS, FAURE

T1.2 Tender Data

The conditions of tender are the Standard Conditions of Tender as contained in Annex F of Board Notice 86 of 2010 in Government Gazette No. 33239 of 28 May 2010, Construction Industry Development Board (CIDB) Standard for Uniformity in Construction Procurement. (see www.cidb.org.za) which are reproduced without amendment or alteration for the convenience of tenderers as an Annex to this Tender Data.

The Standard Conditions of Tender make several references to the Tender Data for details that apply specifically to this tender. The Tender Data shall have precedence in the interpretation of any ambiguity or inconsistency between it and the standard conditions of tender. Each item of data given below is cross-referenced to the clause in the Standard Conditions of Tender to which it mainly applies.

The following variations, amendments and additions to the Standard Conditions of Tender as set out in the Tender Data below shall apply to this tender:

Clause number  Tender Data
F.1  General
F.1.1  Actions
Add the following:
The Employer is iThemba LABS, represented by: Mr. Paul Gardiner.

F.1.2  Tender Documents
Add the following:
*The following documents form part of this tender:

VOLUME 1: The General Conditions of Contract for Construction Works (Second Edition) 2010 as published by the South African Institution of Civil Engineering. This publication is available and tenderers must obtain copies at their own cost from the South African Institution of Civil Engineering (SAICE), Private Bag X200, Halfway House 1685, Tel: (011) 805 5947, Fax: (011) 805 5971, e-mail: civilinfo@saice.org.za.

Volume 1 may also be inspected, by appointment, at the offices of the Employer’s agent during normal office hours.

The contract documents issued by the Employer comprise:

VOLUME 2: The Contract Document (this document), in which is bound:

The Tender
Part T1: Tendering procedures
T1.1 Tender notice and invitation to tender
T1.2 Tender data
Part T2: Returnable Documents
T2.1 List of returnable documents
T2.2 Returnable schedules
The Contract
Part C1: Agreements and Contract Data
C1.1 Contract data
C1.2 Form of Guarantee
C1.3 Health & Safety Agreement
Part C2: Pricing Data
C2.1 Pricing Assumptions
C2.2 Bills of Quantities
C2.3 Contract Rates
C2.4 Special Items
C2.5 Schedule of Equipment Offered
C2.6 Schedule of Imported Materials

Part C3: Scope of Work and Technical Specifications
C3.1 Description of the Works
C3.2 Engineering
C3.3 Procurement
C3.4 Technical Specification
C3.5 Annexes

VOLUME 2 is deemed the “Returnable Document” which must be returned to the Employer in terms of submitting a tender offer.

VOLUME 3: Drawings (listed in C3.2 Engineering)

F.1.4 Communication and employer’s agent
Add the following:
Attention is drawn to the fact that verbal information, given by the Employer's agent during site visits/clarification meetings or at any other time prior to the award of the Contract, will not be regarded as binding on the Employer. Only information issued formally by the Employer in writing to tenderers will be regarded as amending the Tender Documents.

The Employer’s agent is:
Name: Mr. Alfredo Malgas
Address: BVI Consulting Engineers Western Cape (Pty) Ltd
Block B2, Edison Square
c/o Edison Way & Century Avenue
CENTURY CITY
7441
Tel: (021) 527 7000
Fax: (021) 527 7001
E-mail: alfredom@bviwc.co.za

F.1.5 The Employers right to accept or reject any tender offer
Please revise F1.5.1 to read:
The Employer may subsequent to the cancellation or abandonment of a tender process or the rejection of all responsive tenders re-issue a tender covering substantially the same Scope of work at any time that so please him.

Please add F1.5.3 to read:
Notwithstanding 1.5.1 above, the Client reserves the right to disqualify any tenderer, at his discretion, based on present or previous performance on any contract or as a result of any outstanding or on-going concerns or problems that are being processed during the tender process.

F.2 Tenderer’s obligations
F.2.1 Eligibility
Add the following to F.2.1.1:
F.2.1.1 Only those tenderers who satisfy the following criteria are eligible to submit tenders:

F.2.1.1.1 Registration as Service Provider
Not applicable.
F.2.1.2 Construction Industry Development Board (CIDB) Registration

Only those tenderers who are registered with the CIDB, in a contractor grading designation equal to or higher than a contractor grading designation determined in accordance with the sum tendered, or a value determined in accordance with Regulation 25 (1B) or 25 (7A) of the Construction Industry Development Regulations, for a ME class of construction work, are eligible to have their tenders evaluated.

Joint Ventures are eligible to submit tenders provided that:
1. every member of the joint venture is registered with the CIDB;
2. the lead partner has a contractor grading designation in the ME class of construction work;
3. the combined contractor grading designation calculated in accordance with the Construction Industry Development Regulations is equal to or higher than a contractor grading designation determined in accordance with the sum tendered for a ME class of construction work or a value determined in accordance with Regulation 25 (1B) or 25 (7A) of the Construction Industry Development Regulations.

Notwithstanding the above, tenderers who are capable of being so registered prior to the evaluation of submissions may be evaluated at the sole discretion of the Employer (the evaluation of tenders shall be deemed to take place when the Employer’s Bid Evaluation Committee meets to make a recommendation to the Bid Adjudication Committee).

For alpha - numerics associated with the contractor Grading Designations see Annex G attached.

F2.1.3 Pricing Schedule for the Duration of the Contract (Standard Bidding Document SBD3.1 and SBD3.3)

<table>
<thead>
<tr>
<th>NOTE</th>
<th>Only firm prices will be accepted. Non-firm prices (including prices subject to rates of exchange variations) will not be considered</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Price quoted is fully inclusive of all costs including delivery to the specified NRF Business Unit geographical address and includes value-added tax, pay as you earn, income tax, unemployment insurance fund contributions and skills development levies.</td>
</tr>
<tr>
<td></td>
<td>Detailed information is optional and is provided as annexures to the details provided below.</td>
</tr>
<tr>
<td></td>
<td>No changes or extensions or additional ad hoc costs are accepted once the contract has been awarded.</td>
</tr>
<tr>
<td></td>
<td>Bid price to be quoted in South African Rand.</td>
</tr>
<tr>
<td></td>
<td>Pricing is subject to the addition of Preference Points as stipulated in Section 23 below - Standard Bidding Document 6.1 Preference claim form.</td>
</tr>
</tbody>
</table>

OFFER TO BE VALID FOR 150 days FROM THE CLOSING DATE OF BID.
### BID PRICE IN SOUTH AFRICAN RAND (ALL APPLICABLE TAXES INCLUDED)

<table>
<thead>
<tr>
<th>ITEM NO</th>
<th>QUANTITY (unit of measure)</th>
<th>DESCRIPTION OF WORKS / GOODS / SERVICES</th>
<th>BID/QUOTE PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Installation Cost (From Bill of Quantities Summary)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>Disbursements</td>
<td></td>
</tr>
</tbody>
</table>

**ADDITIONAL PRICE ITEMS OR DETAIL PRICE SCHEDULES ATTACHED**

- **Brand and model**: Attach information as additional schedules
- **Country of origin**: 
- **Does the offer comply with the specification(s)?**: YES/NO
- **If not to specification, indicate deviation(s) in a separate attached schedule**: 
- **Period required for delivery**: Firm / Not Firm

---

### Selection and Awarding of Contract

This bid is evaluated through a two stage process.

#### Stage 1 – Selection of Qualified Bidders (Technical / Quality Evaluation)

- **Bidders bid response / submission** is evaluated against the bid invitation specifications as well as the bidder’s capacity and capability.
- **Evaluation** is made in accordance to published evaluation criteria and the scoring set for each criterion.
- **All qualifying bidders** are shortlisted for the awarding stage.

#### Stage 2 – Awarding of the Contract

- **Bidders are compared** on a fair and equal basis taking into account all aspects of the proposals.
- **The award criterion** are:
  - **Price** – with the lowest priced bid on an equal and fair comparison basis receiving the highest price score as set out in the 2011 Preference Regulations.
  - **Preference** – preference points as claimed in the preference claim form are added to the price ranking scores and the highest combined score is nominated for the contract award.

**Administration**

Contracts are awarded where bidders have supplied the relevant administrative documentation especially the tax certificate.

The bid evaluation committee will, after the closing date, evaluate all submitted proposals’ technical envelopes containing the technical information first.

Only those bidders that achieve the minimum competence/delivery level as set out in this bid are evaluated in the second stage (Price and Preference).

The minimum competency level for the technical evaluation is for bidders to score at least **seventy (70%)** on the technical evaluation.

The Total Technical Points Scored is the total of the evaluations scored per category multiplied by the weighting percentage for each category expressed as a percentage of the Total Technical Points.

Total Evaluation Score = \[
\frac{[\text{Score} \times \text{weighting} \times \text{No of Evaluators}]}{[\text{Maximum Score} \times \text{No of Evaluators}]}\]

**Example Total Score** = \[
\frac{[3 \times 40 \times 4 + (4 \times 30 \times 4) + (5 \times 30 \times 4)]}{[5 \times 100 \times 4]} = \frac{1560}{2000} = 0.78
\]

Each evaluator’s percentage thus calculated are aggregated and divided by the number of evaluators to establish an overall percentage mark.
### Scoring Range

<table>
<thead>
<tr>
<th>Scoring Range</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition</td>
<td>No Information to make assessment</td>
<td>Poor</td>
<td>Average</td>
<td>Meets Requirements</td>
<td>Exceeds Requirements</td>
<td>Exceeds Requirements and value adding</td>
</tr>
<tr>
<td>Score Range</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Definition</td>
<td>No Information to make assessment</td>
<td>Poor</td>
<td>Average</td>
<td>Meets Requirements</td>
<td>Exceeds Requirements</td>
<td>Exceeds Requirements and value adding</td>
</tr>
<tr>
<td>Scoring Range</td>
<td>0</td>
<td>3</td>
<td>6</td>
<td>9</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>Definition</td>
<td>No Information to make assessment</td>
<td>Poor</td>
<td>Average</td>
<td>Meets Requirements</td>
<td>Exceeds Requirements</td>
<td>Exceeds Requirements and value adding</td>
</tr>
</tbody>
</table>

### TOTAL POINTS ALLOCATED TO TECHNICAL

<table>
<thead>
<tr>
<th>NO</th>
<th>TECHNICAL ELEMENT</th>
<th>WEIGHT %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A portfolio of chilled water (water-cooled) and Building Management System projects covering a similar scope and works (restricted to a minimum of 3 projects).</td>
<td>15</td>
</tr>
<tr>
<td>2</td>
<td>A list of at least 5 (five) contactable references for the projects listed on item 1.</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>List of current and completed projects above R6mil</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>Provide details of capable team to execute the project to ensure it is delivered on time. Include names and qualifications, years of experience of technical manager/director, project manager, foremen, technicians and artisans to be assigned to the project, and the names and qualifications of any support staff. Provide project organogram.</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>Provide details and CV of electrician and his team to be assigned to the project (sub-contractor or internal). CV to include years of experience and list of current and related completed projects.</td>
<td>10</td>
</tr>
<tr>
<td>6</td>
<td>Signed letter from at least 3 chiller suppliers confirming experience and accredited installer with the 24/7 after sales service and technical support.</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>Proof of address to demonstrate that primary place of business is based in Cape Town within 60km radius from iThemba Labs</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>Score</td>
</tr>
<tr>
<td>---</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>8</td>
<td>Proof of ability to provide Technical support services on a 24/7 basis</td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td>Provide Approach Paper methodology indicating how the project will be executed and completed on time.</td>
<td>10</td>
</tr>
<tr>
<td>10</td>
<td>Last 3 years audited financial statements have been provided</td>
<td>5</td>
</tr>
<tr>
<td>11</td>
<td>Provide Training Schedule for iThemba LABS Technical Staff in all aspect of the new installation</td>
<td>5</td>
</tr>
<tr>
<td>12</td>
<td>Warranty Statement of the equipment</td>
<td>5</td>
</tr>
<tr>
<td>13</td>
<td>Manufacturers data sheet for all equipment exceeding R1000 in value</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

**CRITICAL CONSTRUCTION DATES FOR BIDDERS**

Tenderers must study the dates below before pricing the tender.

**NOTE:** The successful tenderer will have only 2 months (01 July to 31 August) to decommission, dismantle, remove, install and commission new chillers and all pumps including electrics and controls.

<table>
<thead>
<tr>
<th>Task Description</th>
<th>Duration</th>
<th>Start date</th>
<th>End date</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>STAGE 6 - CONSTRUCTION</strong></td>
<td>143 days</td>
<td>Mon 29/02/16</td>
<td>Wed 14/09/16</td>
</tr>
<tr>
<td>Site handover</td>
<td>1 day</td>
<td>Mon 29/02/16</td>
<td>Mon 29/02/16</td>
</tr>
<tr>
<td>Site Establishment</td>
<td>30 days</td>
<td>Tue 01/03/16</td>
<td>Mon 11/04/16</td>
</tr>
<tr>
<td>Preparation work</td>
<td>40 days</td>
<td>Tue 15/03/16</td>
<td>Mon 09/05/16</td>
</tr>
<tr>
<td>Equipment submittal and shop drawings</td>
<td>3 days</td>
<td>Tue 08/03/16</td>
<td>Thu 10/03/16</td>
</tr>
<tr>
<td>Approval of shop drawings</td>
<td>2 days</td>
<td>Fri 11/03/16</td>
<td>Mon 14/03/16</td>
</tr>
<tr>
<td>Procurement of chillers</td>
<td>80 days</td>
<td>Tue 15/03/16</td>
<td>Mon 04/07/16</td>
</tr>
<tr>
<td>Decommissioning of existing installation</td>
<td>2 days</td>
<td>Fri 01/07/16</td>
<td>Mon 04/07/16</td>
</tr>
<tr>
<td>Dismantling and removal of existing chillers</td>
<td>5 days</td>
<td>Tue 05/07/16</td>
<td>Mon 11/07/16</td>
</tr>
<tr>
<td>Installation of new Electrical control panel</td>
<td>30 days</td>
<td>Fri 22/04/16</td>
<td>Thu 02/06/16</td>
</tr>
<tr>
<td>Installation BMS controls</td>
<td>30 days</td>
<td>Tue 07/06/16</td>
<td>Mon 18/07/16</td>
</tr>
<tr>
<td>Installation of new chillers</td>
<td>30 days</td>
<td>Tue 12/07/16</td>
<td>Mon 22/08/16</td>
</tr>
<tr>
<td>Commissioning</td>
<td>5 days</td>
<td>Tue 23/08/16</td>
<td>Mon 29/08/16</td>
</tr>
<tr>
<td>Practical completion</td>
<td>2 days</td>
<td>Tue 30/08/16</td>
<td>Wed 31/08/16</td>
</tr>
<tr>
<td>Works completion</td>
<td>5 days</td>
<td>Thu 01/09/16</td>
<td>Wed 07/09/16</td>
</tr>
<tr>
<td>Close out</td>
<td>5 days</td>
<td>Thu 08/09/16</td>
<td>Wed 14/09/16</td>
</tr>
</tbody>
</table>

**F.2.7 Clarification meeting**

*Add the following:*

The arrangements for a compulsory site visit/clarification meeting are as stated in the Tender Notice and Invitation to Tender.
Tenderers should be represented at the site visit/clarification meeting by a person who is suitably qualified and experienced to comprehend the implications of the work involved.

**F.2.12 Alternative tender offers**

Add the following to F.2.12.1:

**F.2.12.1** If a tenderer wishes to submit an alternative tender offer, he shall do so as separate complete offer on a separate complete set of tender documents clearly marked as an “Alternative Tender” in order to distinguish it from the unqualified tender. The only criterion permitted for such alternative tender offer is that it demonstrably satisfies the Employer’s standard and requirements, the details of which may be obtained from the Employer’s agent.

Calculations, drawings and all other pertinent technical information and characteristics as well as modified or proposed Pricing Data must be submitted with the alternative tender offer to enable the Employer to evaluate the efficacy of the alternative and its principal elements, to take a view on the degree to which the alternative complies with the Employer’s standards and requirements and to evaluate the acceptability of the pricing proposals. Calculations must be set out in a clear and logical sequence and must clearly reflect all design assumptions. Pricing Data must reflect all assumptions in the development of the pricing proposal.

Acceptance of an alternative tender offer will mean acceptance in principle of the offer. It will be an obligation of the contract for the tenderer, in the event that the alternative is accepted, to accept full responsibility and liability that the alternative offer complies in all respects with the Employer’s standards and requirements.

The modified Pricing Data must include an amount equal to 5% of the full amount tendered for the alternative portion of the offer to cover the Employer’s costs in confirming the acceptability of the detailed design.

**F.2.13 Submitting a tender offer**

Add the following to F.2.13.1

**F.2.13.1** Where the tendering entity is a joint venture it is recommended that the standard CIDB Joint Venture Agreement be used.

Add the following after the first sentence of F.2.13.4:

**F.2.13.4** The tender shall be signed by a person duly authorised to do so. Tenders submitted by joint ventures of two or more firms shall be accompanied by the document of formation of the joint venture, authenticated by a notary public or other official deputed to witness sworn statements, in which is defined precisely the conditions under which the joint venture will function, its period of duration, the persons authorised to represent and obligate it, the participation of the several firms forming the joint venture, and any other information necessary to permit a full appraisal of its functioning.

Add the following to F.2.13.5:

**F.2.13.5** The Employer’s address for delivery of tender offers and identification details to be shown on each tender offer package are:

- **Location of tender box:** iThemba LABS Main Reception Area
- **Physical address:**
  - iThemba LABS
  - Old Faure Road
  - Faure

**Identification details:**
- **Tender number:** NRF/iThemba LABS/2015 – 16:07
- **Title of tender:** REPLACEMENT OF EXISTING CHILLERS IN PLANT ROOM AT ITHEMBA LABS, FAURE

Sealed tenders with the Tenderer’s name and address and the endorsement “TENDER FOR REPLACEMENT OF EXISTING CHILLERS IN PLANT ROOM AT ITHEMBA LABS, FAURE” on the envelope, must be placed in the appropriate official tender box at the abovementioned address.

Add the following to F.2.13.6:

**F.2.13.6** A two-envelope procedure will be followed (F.3.5).

Add the following sub-clause after F.2.13.9:

**F.2.13.10** By signing the offer part of C1.1 Form of Offer and Acceptance the tenderer declares that all information provided in the tender submission is true and correct.
F.2.15  Closing time
Add the following to F.2.15.1:

F.2.15.1  The closing time for submission of tender offers is as stated in the Tender Notice and Invitation to Tender.
Telephonic, telegraphic, telex, facsimile or e-mailed tender offers will not be accepted.

F.2.16  Tender offer validity
Add the following to F.2.16.1:

F.2.16.1  The tender offer validity period is 21 weeks (150 days).

F.2.17  Clarification of tender offer after submission
Add the following to F.2.17:

F.2.17.1  A tender will be rejected as non-responsive if the tenderer fails to provide any clarification requested by the employer within the time for submission stated in the employer's written request for such clarification. A tender will also be rejected as non-responsive if the tenderer fails, within the time stated in writing by the Employer, to comply with the requirements of F.4.4.

F.2.18  Provide other material
Delete the following word in F.2.18.1:

F.2.18.1  notarized
Add the following to F.2.18.1: - NOT APPLICABLE

F.2.18.1  Provide, on written request by the Employer, where the tendered amount inclusive of VAT exceeds R 10 million:

i)  audited annual financial statement for 3 years, or for the period since establishment if established during the last 3 years, if required by law to prepare annual financial statements for auditing;

ii)  a certificate signed by the tenderer certifying that the tenderer has no undisputed commitments for municipal services towards a municipality or other service provider in respect of which payment is overdue for more than 30 days;

iii)  particulars of any contracts awarded to the tenderer by an organ of state during the past five years, including particulars of any material non-compliance or dispute concerning the execution of such contract;

iv)  a statement indicating whether any portion of the goods or services are expected to be sourced from outside the Republic, and, if so, what portion and whether any portion of payment from the municipality or municipal entity is expected to be transferred out of the Republic.

Each party to a Consortium/Joint Venture shall submit separate certificates/statements in the above regard.

F.2.23  Certificates
Add the following:
The tenderer is required to submit the following:

F.2.23.1  Tax Clearance Certificate
Tenderers shall be registered and in good standing with the South African Revenue Service (SARS) and shall submit documentary evidence in the form of an original valid Tax Clearance Certificate issued by SARS or proof that he or she has made arrangements with SARS to meet his or her outstanding tax obligations.

Each party to a Consortium/Joint Venture shall submit a separate Tax Clearance Certificate, or proof that he or she has made the necessary arrangements with SARS.

F.2.23.2  Bargaining Council Certificates
Where applicable, a certificate of compliance issued by the relevant Bargaining Council.

Each party to a Consortium/Joint Venture shall submit separate certificates in the above regard.

F.3  The Employer's undertakings

F.3.2  Issue Addenda
Add the following to F.3.2:

Notwithstanding any requests for confirmation of receipt of Addenda issued, the tenderer shall be deemed to have received such addenda if the employer can show proof of transmission thereof (or a notice in respect thereof) via electronic mail, facsimile or registered post.
Opening of tender submissions

Add the following to F.3.4.1:

The time and location for opening of the tender offers is:

Time: Tenders will be opened immediately after the closing time for receipt of tenders as stated in the Tender Notice and Invitation to Tender, or as stated in any Addendum extending the closing date.

Location: NRF - ITHEMBA LABS Old Faure Road, Faure

F.3.5 Two-envelope system

A two-envelope system will be followed. List of Tenders received will be compiled in public.

F.3.8 Test for responsiveness

Add the following:

Tenders will be considered non-responsive if, inter alia:
- the tender is not in compliance with the Scope of Work;
- the tenderer does not comply with the CIDB contractor grading designation specified in F.2.1.1.2 above;
- the tenderer has failed to clarify or submit any supporting documentation within the time for submission stated in the employer’s written request;

F.3.11 Evaluation of tender offers

F.3.11.1 General

Add the following:

The procedure for evaluation of responsive tenders is stated above Reference Section.

Add the following new subclause:

Risk Analysis

Notwithstanding compliance with regard to CIDB registration or any other requirements of the tender, the employer will perform a risk analysis in respect of the following:

a) reasonableness of the financial offer
b) reasonableness of unit rates and prices
c) the tenderers ability to fulfill its obligations in terms of the tender document, that is, that the tenderer can demonstrate that he/she possesses the necessary professional and technical qualifications, professional and technical competence, financial resources, equipment and other physical facilities, managerial capability, reliability, experience, reputation, personnel to perform the contract, etc.

No tenderer will be recommended for an award unless the tenderer has demonstrated that he/she has the resources and skills required.

F.3.13 Acceptance of tender offer

Add the following to F.3.13:

F.3.13.1 Tender offers will only be accepted if:

a) the tenderer is registered and in good standing with the South African Revenue Service (SARS) and has submitted evidence in the form of an original valid Tax Clearance Certificate issued by SARS or proof that he or she has made arrangements with SARS to meet his or her outstanding tax obligations;

b) the tenderer or any of its directors is not listed on the Register of Tender Defaulters in terms of the Prevention and Combating of Corrupt Activities Act of 2004 as a person prohibited from doing business with the public sector;

c) the tenderer has not:
   i) abused the Employer’s Supply Chain Management System; or
   ii) failed to pay municipal rates and taxes or service charges and such rates, taxes and charges are in arrears for more than three months;

d) the tenderer has completed the Compulsory Enterprise Questionnaire and there are no conflicts of interest which may impact on the tenderer’s ability to perform the contract in the best interests of the employer or potentially compromise the tender process.

F.3.14 Notice to unsuccessful tenderers

Replace the heading above with:

Notice to successful and unsuccessful tenderers
Replace sub-clause F.3.14.2 with the following:

F.3.14.2 The Employer shall, at the same time as notifying the successful tenderer of the Bid Adjudication Committee's decision to award the tender to the successful tenderer, also give written notice to the other tenderers informing them that they have been unsuccessful.

Provide copies of the contract

The number of paper copies of the signed contract to be provided by the Employer is one.

F.4 Additional Conditions of Tender

The additional conditions of tender are:

F.4.1 Compliance with Occupational Health and Safety Act 1993

Tenderers are to note the requirements of the Occupational Health and Safety Act No. 85 of 1993 and the Construction Regulations 2003 issued in terms of Section 43 of the Act. The tenderer shall be deemed to have read and fully understood the requirements of the above Act and Regulations and to have allowed for all costs in compliance therewith.

In this regard the Tenderer shall submit with his tender, appended to Schedule 11: Health and Safety Plan in T2.2: Returnable Schedules, a detailed Health and Safety Plan in respect of the Works in order to demonstrate the necessary competencies and resources to perform the construction work all in accordance with the Act and Regulations. Such Health and Safety Plan shall cover inter-alia the following details:

1) Management Structure, Site Supervision and Responsible Persons including a succession plan.
2) Contractor's induction training programme for employees, sub-contractors and visitors to the Site.
3) Health and safety precautions and procedures to be adhered to in order to ensure compliance with the Act, Regulations and Safety Specifications.
4) Regular monitoring procedures to be performed.
5) Regular liaison, consultation and review meetings with all parties.
6) Site security, welfare facilities and first aid.
7) Site rules and fire and emergency procedures.

Tenderers are to note that the Contractor is required to ensure that all sub-contractors or others engaged in the performance of the contract also comply with the above requirements.

The Contractor shall prepare and maintain a Health and Safety File in respect of the project, which shall be available for inspection on Site at all times and handed over to the Employer on Final Completion of the project.

The Contractor is required to submit to the Employer the Occupational Health and Safety Agreement (included in C1.4 of the Contract Document) and a letter of good standing from the Compensation Commissioner, or a licensed compensation insurer, within 14 days after the Commencement Date of the contract.

F.4.2 Claims arising after submission of tender

No claim for any extras arising out of any doubt or obscurity as to the true intent and meaning of anything shown on the Contract Drawings or contained in the Conditions of Contract, Scope of Work and Pricing Data, will be admitted by the Employer/Employer's Agent after the submission of any tender and the Tenderer shall be deemed to have:

1) inspected the Contract Drawings and read and fully understood the Conditions of Contract.
2) read and fully understood the whole text of the Scope of Work and Pricing Data and thoroughly acquainted himself with the nature of the works proposed and generally of all matters which may influence the Contract.
3) visited the site of the proposed works, carefully examined existing conditions, the means of access to the site, the conditions under which the work is to be done, and acquainted himself with any limitations or restrictions that may be imposed by the Municipal or other Authorities in regard to access and transport of materials, plant and equipment to and from the site and made the necessary provisions for any additional costs involved thereby.
4) requested the Employer or his duly authorised agent to make clear the actual requirements of anything shown on the Contract Drawings or anything contained in the Scope of Work and Pricing Data, the exact meaning or interpretation of which is not clearly intelligible to the Tenderer.
Before submission of any tender, the Tenderer should check the number of pages, and if any are found to be missing or duplicated, or the figures or writing indistinct, or if the Pricing Data contain any obvious errors, the tenderer must apply to the Employer/Employer’s Agent at once to have the same rectified, as no liability will be admitted by the Employer/Employer’s Agent in respect of errors in any tender due to the foregoing.

5) received any Addenda to the tender documents which have been issued in accordance with the Employer’s Supply Chain Management Policy.

F.4.3 Imbalance in tendered rates
In the event of tendered rates or lump sums being declared by the Employer to be unacceptable to it because they are either excessively low or high or not in proper balance with other rates or lump sums, the Tenderer may be required to produce evidence and advance arguments in support of the tendered rates or lump sums objected to. If, after submission of such evidence and any further evidence requested, the Employer is still not satisfied with the tendered rates or lump sums objected to, it may request the tenderer to amend these rates and lump sums along the lines indicated by it.

The Tenderer will then have the option to alter and/or amend the rates and lump sums objected to and such other related amounts as are agreed on by the Employer, but this shall be done without altering the tender offer as tendered or, if applicable, the corrected total of prices in accordance with F.3.9.3.

Should the Tenderer fail to amend his Tender in a manner acceptable to the Employer, the Employer may reject the Tender.

F.4.4 Invalid tenders
Tenders shall be considered invalid and shall be endorsed and recorded as such in the tender opening record, by the responsible official who opened the tender, in the following circumstances:

a) if the tender offer (the tender price/amount) is not submitted on the Form of Offer and Acceptance bound into this tender document (form C1.1, Part C1: Agreements and Contract Data);

b) if the tender is not completed in non-erasable ink;

c) if the Form of Offer and Acceptance has not been signed;

d) if the Form of Offer and Acceptance is signed, but the name of the tenderer is not stated or is indecipherable.

F.4.5 Negotiations with preferred tenderers
The Employer may negotiate the final terms of a contract with tenderers identified through a competitive tendering process as preferred tenderers provided that such negotiation:

a) does not allow any preferred tenderer a second or unfair opportunity;

b) is not to the detriment of any other tenderer; and

c) does not lead to a higher price than the tender as submitted.

Minutes of any such negotiations shall be kept for record purposes.

F.4.6 UIF payments
The Tenderer shall submit to the Employer a letter from the Industrial Council indicating his good standing with regard to UIF payments upon being requested to do so.

F.4.7 Registration with Bargaining Council
Tenderers must be registered with a relevant Bargaining Council (if such be in place) and provide the applicable Certificate of Compliance in terms of the relevant Government Gazette.

F.4.8 Price variations
The Contract Price shall not be subject to contract price adjustment in accordance with the General Conditions of Contract. If special materials are specified in the Contract Data, then the provision of the General Conditions of Contract shall apply to such special materials.

F.4.9 Requests for contract documents, or parts thereof, in electronic format
The Employer shall not formally issue tender documents in electronic format as contemplated in F.2.13.2 and F.2.13.3 and shall only issue tender documents in hardcopy. An electronic version of the issued tender documents may be made available to the tenderer, upon written request in terms of this clause, subject to the following:

(a) Electronic copies of the contract document, or parts thereof, will only be provided to tenderers who have been issued with the tender documents as contemplated in F.1.2 in hardcopy.

(b) The electronic version shall not be regarded as a substitute for the issued tender documents.
(c) The Employer shall not accept tenders submitted in electronic format. Tenderers may not complete and submit a printed copy of the electronic version of the tender document or part thereof. Only those tenders that have been completed on the issued hard copy tender document shall be considered.

(d) The Employer accepts no responsibility or liability arising from any reliance on or use of the electronic version provided in terms of this clause. The Employer further does not guarantee that the electronic version corresponds with the issued tender documents in all respects. Tenderers are alerted to the fact that electronic versions of the tender documents may not reflect any notices or addenda that amend the tender document.

(e) Any non-compliance with these provisions, including effecting any unauthorised alterations to the tender document as contemplated in F.2.11, shall render the tender invalid. The Employer reserves the right to take any action against such tenderer allowed in law including, in circumstances where the tender had already been awarded, the right to cancel the contract.

(f) In requesting the electronic version of the tender document or parts thereof, the tenderer is deemed to have read, understood and accepted all of the above conditions.

F.4.10 Minimum Wages

The Tender is drawn to the fact that minimum wages must be paid in terms of the relevant legislation.
Annex F
(normative)

Standard Conditions of Tender

As contained in Annex F of Board Notice 86 of 2010 in Government Gazette No. 33239 of 28 May 2010

F.1 General

F.1.1 Actions

F.1.1.1 The employer and each tenderer submitting a tender offer shall comply with these conditions of tender. In their dealings with each other, they shall discharge their duties and obligations as set out in F.2 and F.3, timeously and with integrity, and behave equitably, honestly and transparently, comply with all legal obligations and not engage in anticompetitive practices.

F.1.1.2 The employer and the tenderer and all their agents and employees involved in the tender process shall avoid conflicts of interest and where a conflict of interest is perceived or known, declare any such conflict of interest, indicating the nature of such conflict. Tenderers shall declare any potential conflict of interest in their tender submissions. Employees, agents and advisors of the employer shall declare any conflict of interest to whoever is responsible for overseeing the procurement process at the start of any deliberations relating to the procurement process or as soon as they become aware of such conflict, and abstain from any decisions where such conflict exists or recuse themselves from the procurement process, as appropriate.

Note: 1) A conflict of interest may arise due to a conflict of roles which might provide an incentive for improper acts in some circumstances. A conflict of interest can create an appearance of impropriety that can undermine confidence in the ability of that person to act properly in his or her position even if no improper acts result.

2) Conflicts of interest in respect of those engaged in the procurement process include direct, indirect or family interests in the tender or outcome of the procurement process and any personal bias, inclination, obligation, allegiance or loyalty which would in any way affect any decisions taken.

F.1.1.3 The employer shall not seek and a tenderer shall not submit a tender without having a firm intention and the capacity to proceed with the contract.

F.1.2 Tender Documents

The documents issued by the employer for the purpose of a tender offer are listed in the tender data.

F.1.3 Interpretation

F.1.3.1 The tender data and additional requirements contained in the tender schedules that are included in the returnable documents are deemed to be part of these conditions of tender.

F.1.3.2 These conditions of tender, the tender data and tender schedules which are only required for tender evaluation purposes, shall not form part of any contract arising from the invitation to tender.

F.1.3.3 For the purposes of these conditions of tender, the following definitions apply:

a) conflict of interest means any situation in which:
   i) someone in a position of trust has competing professional or personal interests which make it difficult to fulfil his or her duties impartially;
   ii) an individual or organisation is in a position to exploit a professional or official capacity in some way for their personal or corporate benefit; or
   iii) incompatibility or contradictory interests exist between an employee and the organisation which employs that employee.

b) comparative offer means the tenderer's financial offer after all tendered parameters that will affect the value of the financial offer have been taken into consideration in order to enable comparisons to be made between offers on a comparative basis

c) corrupt practice means the offering, giving, receiving or soliciting of anything of value to influence the action of the employer or his staff or agents in the tender process; and

d) fraudulent practice means the misrepresentation of the facts in order to influence the tender process or the award of a contract arising from a tender offer to the detriment of the employer, including collusive practices intended to establish prices at artificial levels

e) organization means a company, firm, enterprise, association or other legal entity, whether incorporated or not, or a public body
f) **quality (functionality)** means the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs.

**F.1.4 Communication and employer's agent**

Each communication between the employer and a tenderer shall be to or from the employer's agent only, and in a form that can be readily read, copied and recorded. Communication shall be in the English language. The employer shall not take any responsibility for non-receipt of communications from or by a tenderer. The name and contact details of the employer's agent are stated in the tender data.

**F.1.5 The employer's right to accept or reject any tender offer**

F.1.5.1 The employer may accept or reject any variation, deviation, tender offer, or alternative tender offer, and may cancel the tender process and reject all tender offers at any time before the formation of a contract. The employer shall not accept or incur any liability to a tenderer for such cancellation and rejection, but will give written reasons for such action upon written request to do so.

F.1.5.2 The employer may not subsequent to the cancellation or abandonment of a tender process or the rejection of all responsive tender offers re-issue a tender covering substantially the same scope of work within a period of six months unless only one tender was received and such tender was returned unopened to the tenderer.

**F.1.6 Procurement procedures**

**F.1.6.1 General**

Unless otherwise stated in the tender data, a contract will, subject to F.3.13, be concluded with the tenderer who in terms of F.3.11 is the highest ranked or the tenderer scoring the highest number of tender evaluation points, as relevant, based on the tender submissions that are received at the closing time for tenders.

**F.1.6.2 Competitive negotiation procedure**

F.1.6.2.1 Where the tender data require that the competitive negotiation procedure is to be followed, tenderers shall submit tender offers in response to the proposed contract in the first round of submissions. Notwithstanding the requirements of F.3.4, the employer shall announce only the names of the tenderers who make a submission. The requirements of F.3.8 relating to the material deviations or qualifications which affect the competitive position of tenderers shall not apply.

F.1.6.2.2 All responsive tenderers, or not less than three responsive tenderers that are highest ranked in terms of the evaluation method and evaluation criteria stated in the tender data, shall be invited in each round to enter into competitive negotiations, based on the principle of equal treatment and keeping confidential the proposed solutions and associated information. Notwithstanding the provisions of F.2.17, the employer may request that tenders be clarified, specified and fine-tuned in order to improve a tenderer's competitive position provided that such clarification, specification, fine-tuning or additional information does not alter any fundamental aspects of the offers or impose substantial new requirements which restrict or distort competition or have a discriminatory effect.

F.1.6.2.3 At the conclusion of each round of negotiations, tenderers shall be invited by the employer to make a fresh tender offer, based on the same evaluation criteria, with or without adjusted weightings. Tenderers shall be advised when they are to submit their best and final offer.

F.1.6.2.4 The contract shall be awarded in accordance with the provisions of F.3.11 and F.3.13 after tenderers have been requested to submit their best and final offer.

**F.2 Tenderer's obligations**

**F.2.1 Eligibility**

F.2.1.1 Submit a tender offer only if the tenderer satisfies the criteria stated in the tender data and the tenderer, or any of his principals, is not under any restriction to do business with employer.

F.2.1.2 Notify the employer of any proposed material change in the capabilities or formation of the tendering entity (or both) or any other criteria which formed part of the qualifying requirements used by the employer as the basis in a prior process to invite the tenderer to submit a tender offer and obtain the employer's written approval to do so prior to the closing time for tenders.
F.2.2 Cost of tendering

Accept that, unless otherwise stated in the tender data, the employer will not compensate the tenderer for any costs incurred in the preparation and submission of a tender offer, including the costs of any testing necessary to demonstrate that aspects of the offer complies with requirements.

F.2.3 Check documents

Check the tender documents on receipt for completeness and notify the employer of any discrepancy or omission.

F.2.4 Confidentiality and copyright of documents

Treat as confidential all matters arising in connection with the tender. Use and copy the documents issued by the employer only for the purpose of preparing and submitting a tender offer in response to the invitation.

F.2.5 Reference documents

Obtain, as necessary for submitting a tender offer, copies of the latest versions of standards, specifications, conditions of contract and other publications, which are not attached but which are incorporated into the tender documents by reference.

F.2.6 Acknowledge addenda

Acknowledge receipt of addenda to the tender documents, which the employer may issue, and if necessary apply for an extension to the closing time stated in the tender data, in order to take the addenda into account.

F.2.7 Clarification meeting

Attend, where required, a clarification meeting at which tenderers may familiarize themselves with aspects of the proposed work, services or supply and raise questions. Details of the meeting(s) are stated in the tender data.

F.2.8 Seek clarification

Request clarification of the tender documents, if necessary, by notifying the employer at least five working days before the closing time stated in the tender data.

F.2.9 Insurance

Be aware that the extent of insurance to be provided by the employer (if any) might not be for the full cover required in terms of the conditions of contract identified in the contract data. The tenderer is advised to seek qualified advice regarding insurance.

F.2.10 Pricing the tender offer

F.2.10.1 Include in the rates, prices, and the tendered total of the prices (if any) all duties, taxes (except Value Added Tax (VAT), and other levies payable by the successful tenderer, such duties, taxes and levies being those applicable 14 days before the closing time stated in the tender data.

F.2.10.2 Show VAT payable by the employer separately as an addition to the tendered total of the prices.

F.2.10.3 Provide rates and prices that are fixed for the duration of the contract and not subject to adjustment except as provided for in the conditions of contract identified in the contract data.

F.2.10.4 State the rates and prices in Rand unless instructed otherwise in the tender data. The conditions of contract identified in the contract data may provide for part payment in other currencies.

F.2.11 Alterations to documents

Do not make any alterations or additions to the tender documents, except to comply with instructions issued by the employer, or necessary to correct errors made by the tenderer. All signatories to the tender offer shall initial all such alterations. Erasures and the use of masking fluid are prohibited.

F.2.12 Alternative tender offers

F.2.12.1 Unless otherwise stated in the tender data submit alternative tender offers only if a main tender offer, strictly in accordance with all the requirements of the tender documents, is also submitted. The alternative tender offer is to be submitted with the main tender offer together with a schedule that compares the requirements of the tender documents with the alternative requirements the tenderer proposes.
F.2.12.2 Accept that an alternative tender offer may be based only on the criteria stated in the tender data or criteria otherwise acceptable to the employer.

F.2.13 Submitting a tender offer

F.2.13.1 Submit one tender offer only, either as a single tendering entity or as a member in a joint venture to provide the whole of the works, services or supply identified in the contract data and described in the scope of works, unless stated otherwise in the tender data.

F.2.13.2 Return all returnable documents to the employer after completing them in their entirety, either electronically (if they were issued in electronic format) or by writing legibly in non-erasable ink.

F.2.13.3 Submit the parts of the tender offer communicated on paper as an original plus the number of copies stated in the tender data, with an English translation of any documentation in a language other than English, and the parts communicated electronically in the same format as they were issued by the employer.

F.2.13.4 Sign the original and all copies of the tender offer where required in terms of the tender data. The employer will hold all authorized signatories liable on behalf of the tenderer. Signatories for tenderers proposing to contract as joint ventures shall state which of the signatories is the lead partner whom the employer shall hold liable for the purpose of the tender offer.

F.2.14 Information and data to be completed in all respects

Accept that tender offers, which do not provide all the data or information requested completely and in the form required, may be regarded by the employer as non-responsive.

F.2.15 Closing time

F.2.15.1 Ensure that the employer receives the tender offer at the address specified in the tender data not later than the closing time stated in the tender data. Accept that proof of posting shall not be accepted as proof of delivery.

F.2.16 Tender offer validity

F.2.16.1 Hold the tender offer(s) valid for acceptance by the employer at any time during the validity period stated in the tender data after the closing time stated in the tender data.

F.2.16.2 If requested by the employer, consider extending the validity period stated in the tender data for an agreed additional period with or without any conditions attached to such extension.

F.2.16.3 Accept that a tender submission that has been submitted to the employer may only be withdrawn or substituted by giving the employer's agent written notice before the closing time for tenders that a tender is to be withdrawn or substituted.

F.2.16.4 Where a tender submission is to be substituted, submit a substitute tender in accordance with the requirements of F.2.13 with the packages clearly marked as "SUBSTITUTE".
F.2.17 Clarification of tender offer after submission

Provide clarification of a tender offer in response to a request to do so from the employer during the evaluation of tender offers. This may include providing a breakdown of rates or prices and correction of arithmetical errors by the adjustment of certain rates or item prices (or both). No change in the competitive position of tenderers or substance of the tender offer is sought, offered, or permitted.

Note: Sub-clause F.2.17 does not preclude the negotiation of the final terms of the contract with a preferred tenderer following a competitive selection process, should the Employer elect to do so.

F.2.18 Provide other material

F.2.18.1 Provide, on request by the employer, any other material that has a bearing on the tender offer, the tenderer’s commercial position (including notarized joint venture agreements), preferencing arrangements, or samples of materials, considered necessary by the employer for the purpose of a full and fair risk assessment. Should the tenderer not provide the material, or a satisfactory reason as to why it cannot be provided, by the time for submission stated in the employer’s request, the employer may regard the tender offer as non-responsive.

F.2.18.2 Dispose of samples of materials provided for evaluation by the employer, where required.

F.2.19 Inspections, tests and analysis

Provide access during working hours to premises for inspections, tests and analysis as provided for in the tender data.

F.2.20 Submit securities, bonds, policies, etc.

If requested, submit for the employer’s acceptance before formation of the contract, all securities, bonds, guarantees, policies and certificates of insurance required in terms of the conditions of contract identified in the contract data.

F.2.21 Check final draft

Check the final draft of the contract provided by the employer within the time available for the employer to issue the contract.

F.2.22 Return of other tender documents

If so instructed by the employer, return all retained tender documents within 28 days after the expiry of the validity period stated in the tender data.

F.2.23 Certificates

Include in the tender submission or provide the employer with any certificates as stated in the tender data.

F.3 The Employer’s undertakings

F.3.1 Respond to requests from the tenderer

F.3.1.1 Unless otherwise stated in the Tender Data, respond to a request for clarification received up to five working days before the tender closing time stated in the Tender Data and notify all tenderers who drew procurement documents.

F.3.1.2 Consider any request to make a material change in the capabilities or formation of the tendering entity (or both) or any other criteria which formed part of the qualifying requirements used to prequalify a tenderer to submit a tender offer in terms of a previous procurement process and deny any such request if as a consequence:

a) an individual firm, or a joint venture as a whole, or any individual member of the joint venture fails to meet any of the collective or individual qualifying requirements;

b) the new partners to a joint venture were not prequalified in the first instance, either as individual firms or as another joint venture; or

c) in the opinion of the Employer, acceptance of the material change would compromise the outcome of the prequalification process.
F.3.2 Issue Addenda

If necessary, issue addenda that may amend or amplify the tender documents to each tenderer during the period from the date the tender documents are available until three working days before the tender closing time stated in the Tender Data. If, as a result a tenderer applies for an extension to the closing time stated in the Tender Data, the Employer may grant such extension and, shall then notify all tenderers who drew documents.

F.3.3 Return late tender offers

Return tender offers received after the closing time stated in the Tender Data, unopened, (unless it is necessary to open a tender submission to obtain a forwarding address), to the tenderer concerned.

F.3.4 Opening of tender submissions

F.3.4.1 Unless the two-envelope system is to be followed, open valid tender submissions in the presence of tenderers’ agents who choose to attend at the time and place stated in the tender data. Tender submissions for which acceptable reasons for withdrawal have been submitted will not be opened.

F.3.4.2 Announce at the meeting held immediately after the opening of tender submissions, at a venue indicated in the tender data, the name of each tenderer whose tender offer is opened and, where applicable, the total of his prices, preferences claimed and time for completion for the main tender offer only.

F.3.4.3 Make available the record outlined in F.3.4.2 to all interested persons upon request.

F.3.5 Two-envelope system

F.3.5.1 Where stated in the tender data that a two-envelope system is to be followed, open only the technical proposal of valid tenders in the presence of tenderers’ agents who choose to attend at the time and place stated in the tender data and announce the name of each tenderer whose technical proposal is opened.

F.3.5.2 Evaluate the quality of the technical proposals offered by tenderers, then advise tenderers who remain in contention for the award of the contract of the time and place when the financial proposals will be opened. Open only the financial proposals of tenderers, who score in the quality evaluation more than the minimum number of points for quality stated in the tender data, and announce the score obtained for the technical proposals and the total price and any preferences claimed. Return unopened financial proposals to tenderers whose technical proposals failed to achieve the minimum number of points for quality.

F.3.6 Non-disclosure

Not disclose to tenderers, or to any other person not officially concerned with such processes, information relating to the evaluation and comparison of tender offers, the final evaluation price and recommendations for the award of a contract, until after the award of the contract to the successful tenderer.

F.3.7 Grounds for rejection and disqualification

Determine whether there has been any effort by a tenderer to influence the processing of tender offers and instantly disqualify a tenderer (and his tender offer) if it is established that he engaged in corrupt or fraudulent practices.

F.3.8 Test for responsiveness

F.3.8.1 Determine, after opening and before detailed evaluation, whether each tender offer properly received:

a) Complies with the requirements of these Conditions of Tender,
b) has been properly and fully completed and signed, and
c) is responsive to the other requirements of the tender documents.

F.3.8.2 A responsive tender is one that conforms to all the terms, conditions, and specifications of the tender documents without material deviation or qualification. A material deviation or qualification is one which, in the Employer's opinion, would:

a) detrimentally affect the scope, quality, or performance of the works, services or supply identified in the Scope of Work,
b) significantly change the Employer’s or the tenderer's risks and responsibilities under the contract, or
c) affect the competitive position of other tenderers presenting responsive tenders, if it were to be rectified.

Reject a non-responsive tender offer, and not allow it to be subsequently made responsive by correction or withdrawal of the non-conforming deviation or reservation.
F.3.9 Arithmetical errors, omissions and discrepancies

F.3.9.1 Check responsive tenders for discrepancies between amounts in words and amounts in figures. Where there is a discrepancy between the amounts in figures and the amount in words, the amount in words shall govern.

F.3.9.2 Check the highest ranked tender or tenderer with the highest number of tender evaluation points after the evaluation of tender offers in accordance with F.3.11 for:

a) the gross misplacement of the decimal point in any unit rate;
b) omissions made in completing the pricing schedule or bills of quantities; or
c) arithmetic errors in:
   i) line item totals resulting from the product of a unit rate and a quantity in bills of quantities or schedules of prices; or
   ii) the summation of the prices.

F.3.9.3 Notify the tenderer of all errors or omissions that are identified in the tender offer and either confirm the tender offer as tendered or accept the corrected total of prices.

F.3.9.4 Where the tenderer elects to confirm the tender offer as tendered, correct the errors as follows:

a) If bills of quantities or pricing schedules apply and there is an error in the line item total resulting from the product of the unit rate and the quantity, the line item total shall govern and the rate shall be corrected. Where there is an obviously gross misplacement of the decimal point in the unit rate, the line item total as quoted shall govern, and the unit rate shall be corrected.
b) Where there is an error in the total of the prices either as a result of other corrections required by this checking process or in the tenderer's addition of prices, the total of the prices shall govern and the tenderer will be asked to revise selected item prices (and their rates if bills of quantities apply) to achieve the tendered total of the prices.

F.3.10 Insurance provided by the employer

If requested by the proposed successful tenderer, submit for the tenderer's information the policies and/or certificates of insurance which the conditions of contract identified in the contract data, require the employer to provide.

F.3.11 Acceptance of tender offer

Accept the tender offer, if in the opinion of the employer, it does not present any unacceptable commercial risk and only if the tenderer:

a) is not under restrictions, or has principals who are under restrictions, preventing participating in the employer's procurement,
b) can, as necessary and in relation to the proposed contract, demonstrate that he or she possesses the professional and technical qualifications, professional and technical competence, financial resources, equipment and other physical facilities, managerial capability, reliability, experience and reputation, expertise and the personnel, to perform the contract,
c) has the legal capacity to enter into the contract,
d) is not insolvent, in receivership, bankrupt or being wound up, has his affairs administered by a court or a judicial officer, has suspended his business activities, or is subject to legal proceedings in respect of any of the foregoing,
e) complies with the legal requirements, if any, stated in the tender data, and
f) is able, in the opinion of the employer, to perform the contract free of conflicts of interest.

F.3.12 Prepare contract documents

F.3.12.1 If necessary, revise documents that shall form part of the contract and that were issued by the employer as part of the tender documents to take account of:

a) addenda issued during the tender period,
b) inclusion of some of the returnable documents, and
c) other revisions agreed between the employer and the successful tenderer.

F.3.12.2 Complete the schedule of deviations attached to the form of offer and acceptance, if any.
F.3.13 Complete adjudicator's contract

Unless alternative arrangements have been agreed or otherwise provided for in the contract, arrange for both parties to complete formalities for appointing the selected adjudicator at the same time as the main contract is signed.

F.3.14 Notice to unsuccessful tenderers

F.3.14.1 Notify the successful tenderer of the employer’s acceptance of his tender offer by completing and returning one copy of the form of offer and acceptance before the expiry of the validity period stated in the tender data, or agreed additional period.

F.3.14.2 After the successful tenderer has been notified of the employer's acceptance of the tender, notify other tenderers that their tender offers have not been accepted.

F.3.15 Provide copies of the contracts

Provide to the successful tenderer the number of copies stated in the Tender Data of the signed copy of the contract as soon as possible after completion and signing of the form of offer and acceptance.

F.3.16 Provide written reasons for actions taken

Provide upon request written reasons to tenderers for any action that is taken in applying these conditions of tender, but withhold information which is not in the public interest to be divulged, which is considered to prejudice the legitimate commercial interests of tenderers or might prejudice fair competition between tenderers.
Annex G
(normative)

Alpha - numerics associated with the Contractor Grading Designations

Table G1: Contractor grading designations and associated parameters

<table>
<thead>
<tr>
<th>Contractor Grading Designation</th>
<th>Tender Value Range designation</th>
<th>Maximum value of contract that a contractor is considered capable of performing (R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (class of construction works)</td>
<td>1</td>
<td>200 000</td>
</tr>
<tr>
<td>2 (class of construction works)</td>
<td>2</td>
<td>650 000</td>
</tr>
<tr>
<td>3 (class of construction works)</td>
<td>3</td>
<td>2 000 000</td>
</tr>
<tr>
<td>4 (class of construction works)</td>
<td>4</td>
<td>4 000 000</td>
</tr>
<tr>
<td>5 (class of construction works)</td>
<td>5</td>
<td>6 500 000</td>
</tr>
<tr>
<td>6 (class of construction works)</td>
<td>6</td>
<td>13 000 000</td>
</tr>
<tr>
<td>7 (class of construction works)</td>
<td>7</td>
<td>40 000 000</td>
</tr>
<tr>
<td>8 (class of construction works)</td>
<td>8</td>
<td>130 000 000</td>
</tr>
<tr>
<td>9 (class of construction works)</td>
<td>9</td>
<td>No Limit</td>
</tr>
</tbody>
</table>

Table G2: Classes of construction work (see next page)
### Table G2: Classes of Construction Work

<table>
<thead>
<tr>
<th>Description</th>
<th>Designation</th>
<th>Definition</th>
<th>Works Types</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civil engineering works</td>
<td>CE</td>
<td>Construction works that are primarily concerned with materials such as steel, concrete, earth and rock and their application in the development, extension, installation, maintenance, removal, renovation, alteration, or dismantling of building and engineering infrastructure</td>
<td>Water, sewerage, roads, railways, harbours and transport, urban development and municipal services</td>
<td>Structures such as a cooling tower, bridge, culvert, dam, grand stand, road, railway, reservoir, runway, swimming pool, silo or tunnel. The results of operations such as dredging, earthworks and geotechnical processes. Township services, water treatment and supply, sewerage works, sanitation, soil conservation works, irrigation works, storm-water and drainage works, coastal works, ports, harbours, airports and pipelines.</td>
</tr>
<tr>
<td>Electrical engineering works (Infrastructure)</td>
<td>EP</td>
<td>Construction works that are primarily concerned with development, extension, installation, removal, renovation, alteration or dismantling of engineering infrastructure: a) relating to the generation, transmission and distribution of electricity; or b) which cannot be classified as EB.</td>
<td>Electrical power generation, transmission, control and distribution equipment and systems.</td>
<td>Power generation Street and area lighting Substations and protection systems Township reticulations Transmission Lines Supervisory control and data acquisition systems</td>
</tr>
<tr>
<td>Electrical engineering works (buildings)</td>
<td>EB</td>
<td>Construction works that are primarily concerned with the installation, extension, modification or repair of electrical installations in or on any premises used for the transmission of electricity from a point of control to a point of consumption, including any article forming part of such an installation</td>
<td>All electrical equipment forming an integral and permanent part of buildings and/or structures, including any wiring, cable jointing and laying and electrical overhead line construction</td>
<td>Electrical installations in buildings Electrical reticulations within a plot of land (erf) or building site Standby plant and uninterrupted power supply Verification and certification of electrical installations on premises</td>
</tr>
<tr>
<td>Description</td>
<td>Designation</td>
<td>Definition</td>
<td>Works types</td>
<td>Examples</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>General building works</td>
<td>GB</td>
<td>Construction works that: a) are primarily concerned with the development, extension, installation, renewal, renovation, alteration, or dismantling of a permanent shelter for its occupants or contents; or b) cannot be categorised in terms of the definitions provided for civil engineering works, electrical engineering works, mechanical engineering works, or specialist works.</td>
<td>Buildings and ancillary works other than those categorised as being: a) civil engineering works; b) electrical engineering works; c) mechanical engineering works; or d) specialist works.</td>
<td>Buildings for domestic, industrial, institutional or commercial occupancies Car ports Fences other than classified as SS [SQ] Stores Walls</td>
</tr>
<tr>
<td>Mechanical engineering works</td>
<td>ME</td>
<td>Construction works that are primarily concerned with the development, extension, installation, removal, alteration, renewal of engineering infrastructure for gas transmission and distribution, solid waste disposal, heating, ventilation and cooling, chemical works, metallurgical works, manufacturing, food processing and, materials handling</td>
<td>Machine systems including those relating to the environment of building interiors: a) gas transmission and distribution systems b) pipelines c) solid waste disposal d) materials handling, lifting machinery, heating, ventilation and cooling, pumps, e) continuous process systems f) chemical works, metallurgical works, manufacturing, food processing such as that in concentrator machinery and apparatus, oil and gas wells, smelters, cyanide plants, acid plants, metallurgical machinery, equipment and apparatus, and works necessary for the beneficiation of metals, minerals, rocks, petroleum and organic substances and other chemical processes.</td>
<td>Air-conditioning and mechanical ventilation Boiler installations and steam distribution Central heating Centralised hot water generation Cranes and hoists Dust and sawdust extraction Compressed air, gas and vacuum installations Conveyor and materials handling installations Continuous process systems involving chemical works, metallurgical works, oil and gas wells, acid plants, metallurgical machinery, equipment and apparatus, and works necessary for the beneficiation of metals, minerals, rocks, petroleum and organic substances and other chemical processes Kitchen equipment Laundry equipment Lift installations and escalators Refrigeration and cold rooms Waste handling systems (including compactors)</td>
</tr>
<tr>
<td>Description</td>
<td>Designation</td>
<td>Definition</td>
<td>Works types</td>
<td>Examples</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Specialist works</td>
<td>SB</td>
<td>A subset of construction works identified and defined by the Board that involves specialist capabilities for its execution</td>
<td>The extension, installation, repair, maintenance or renewal, or removal, of asphalt</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SC</td>
<td></td>
<td>The development, extension, installation, removal, and dismantling, as relevant, associated with building excavations, shaft sinking and lateral earth support</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td></td>
<td>The development, extension, installation, repair, renewal, removal, or alteration of corrosion protection systems (cathodic, anodic and electrolytic)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SE</td>
<td></td>
<td>Demolition of buildings and engineering infrastructure and blasting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SF</td>
<td></td>
<td>The development, extension, installation, renewal, removal, renovation, alteration or dismantling of fire prevention and protection infrastructure (drencher and sprinkler systems and fire installation)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SG</td>
<td></td>
<td>The development, extension, installation, renewal, removal, renovation, alteration or dismantling of glazing, curtain walls and shop fronts</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SH</td>
<td></td>
<td>The development, extension, installation, maintenance, renewal, removal, alteration or dismantling, as relevant, of landscaping, irrigation and horticultural works</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SI</td>
<td></td>
<td>The development, extension, installation, repair, maintenance, renewal, removal, alteration or dismantling of lifts, escalators, travelators and hoisting machinery</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SJ</td>
<td></td>
<td>The development, installation, removal, or dismantling, as relevant, of piles and other specialized foundations for buildings and structures</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SK</td>
<td></td>
<td>The installation, renewal, removal, alteration or dismantling, as relevant, road markings and signage</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SL</td>
<td></td>
<td>The development, extension, installation, renewal, removal, renovation, alteration or dismantling of structural steelwork and scaffolding</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SM</td>
<td></td>
<td>Timber buildings and structures</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SN</td>
<td></td>
<td>The extension, installation, repair, maintenance, renewal, removal, renovation or alteration, as relevant, of the waterproofing of basements, roofs and walls using specialist systems.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SO</td>
<td></td>
<td>The development, extension, installation, renewal, removal, alteration or dismantling or demolition of water installations and soil and waste water drainage associated with buildings (wet services, plumbing)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SQ</td>
<td></td>
<td>The development, extension, installation, repair, removal, alteration, dismantling or demolition of precast concrete or steel fencing</td>
<td></td>
</tr>
</tbody>
</table>
Part T2: Returnable Documents

<table>
<thead>
<tr>
<th></th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>T2.1 List of Returnable Documents</td>
<td>29</td>
</tr>
<tr>
<td>T2.2 Returnable Schedules</td>
<td>29 - 54</td>
</tr>
</tbody>
</table>
Part T2: Returnable Documents

T2.1 List of Returnable Documents

The tenderer must complete the following Returnable Documents:

1. Envelope 1 (Technical Information): Returnable Schedules required for tender evaluation purposes

   1: COMPULSORY ENTERPRISE QUESTIONNAIRE .................................................................30-31
   2: SITE VISIT / CLARIFICATION MEETING CERTIFICATE ..............................................32
   3: AUTHORITY OF SIGNATORY ........................................................................................33
   4: SCHEDULE OF WORK EXPERIENCE .........................................................................34-35
   5: SCHEDULE OF CONSTRUCTION EQUIPMENT (Not Used) .........................................36-37
   6: PRELIMINARY PROGRAMME .......................................................................................38
   7: SCHEDULE OF ESTIMATED MONTHLY EXPENDITURE (Not Used) ..............................39
   8: TAX CLEARANCE DECLARATION ...............................................................................40
   9: SCHEDULE OF SUBCONTRACTORS (Not Used) ..........................................................41
  10: DETAILS OF SITE AGENT’S AND GENERAL FOREMAN’S EXPERIENCE .....................42
  11: HEALTH AND SAFETY PLAN .....................................................................................43
  12: SCHEDULE OF SPECIAL MATERIALS .......................................................................44
  13: DECLARATION OF INTEREST (SBD 4) .......................................................................45-46
  14: DECLARATION OF BIDDER’S PAST SUPPLY CHAIN MANAGEMENT PRACTICES (SBD 8) .......47
  15: CERTIFICATE OF INDEPENDENT BID DETERMINATION (SBD 9) ..............................48-52

2. Other documents required for tender evaluation purposes
   • A Joint Venture Agreement (if applicable) – append to Schedule 3
   • An original valid Tax Clearance Certificate issued by the South African Revenue Services – append to Schedule 8.
   • Documentary evidence / proof of CIDB Contractor registration - append to Schedule 1.

3. Returnable Schedules that will be incorporated into the Contract

   16: ADDENDA / NOTICE(S) TO TENDERERS ..................................................................53
   17: ALTERATIONS BY TENDERER ..................................................................................54

4. Envelope 2 (Awarding /Price): Returnable Schedules for evaluation of tender offers

   18: PREFERENCE POINTS CLAIMED FORM IN TERMS OF THE PREFERENTIAL PROCUREMENT REGULATIONS 2001

All Pricing Documents

C1.1 Contract Data (Part 2) ................................................. 58
C2.2 Bills / Schedules of Quantities Summary Page ........................................ 77

NB: TENDERERS MUST COMPLETE THESE SCHEDULES / DATA SHEETS / FORMS IN BLACK INK.
NRF - ITHEMBA LABS

BID NO: NRF/iThemba LABS/2015 – 16:07

REPLACEMENT OF EXISTING CHILLERS IN PLANT ROOM AT ITHEMBA LABS, FAURE

T2.2 Returnable Schedules
NRF - ITHEMBA LABS

BID NO: NRF/iThemba LABS/2015 – 16:07

REPLACEMENT OF EXISTING CHILLERS IN PLANT ROOM AT ITHEMBA LABS, FAURE

SCHEDULE 1: COMPLUSORY ENTERPRISE QUESTIONNAIRE

The following particulars must be furnished. In the case of a joint venture, separate enterprise questionnaires in respect of each partner must be completed and submitted.

| Section 1: Name of enterprise: | ................................................................. |
| Address of enterprise: | ................................................................. |

| Section 2: VAT registration number, if any: | ................................................................. |

| Section 3: CIDB registration number, if any: | ................................................................. |

| Section 4: Particulars of sole proprietors and partners in partnerships |

<table>
<thead>
<tr>
<th>Name*</th>
<th>Identity number*</th>
<th>Personal income tax number*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Complete only if sole proprietor or partnership and attach separate page if more than 3 partners

<table>
<thead>
<tr>
<th>Section 5: Particulars of companies and close corporations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company registration number ........................................</td>
</tr>
<tr>
<td>Close corporation number ...........................................</td>
</tr>
<tr>
<td>Tax reference number .................................................</td>
</tr>
</tbody>
</table>

| Section 6: Record of service of the state |

Indicate by marking the relevant boxes with a cross, if any sole proprietor, partner in a partnership or director, manager, principal shareholder or stakeholder in a company or close corporation is currently or has been within the last 12 months in the service of any of the following:

- ☐ a member of any municipal council
- ☐ a member of any provincial legislature
- ☐ a member of the National Assembly or the National Council of Province
- ☐ a member of the board of directors of any municipal entity
- ☐ an official of any municipality or municipal entity
- ☐ an employee of any provincial department, national or provincial public entity or constitutional institution within the meaning of the Public Finance Management Act, 1999 (Act 1 of 1999)
- ☐ a member of an accounting authority of any national or provincial public entity
- ☐ an employee of Parliament or a provincial legislature
If any of the above boxes are marked, disclose the following:

<table>
<thead>
<tr>
<th>Name of sole proprietor, partner, director, manager, principal shareholder or stakeholder</th>
<th>Name of institution, public office, board or organ of state and position held</th>
<th>Status of service (tick appropriate column)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>current</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*insert separate page if necessary

Section 7: Record of spouses, children and parents in the service of the state

Indicate by marking the relevant boxes with a cross, if any spouse, child or parent of a sole proprietor, partner in a partnership or director, manager, principal shareholder or stakeholder in a company or close corporation is currently or has been within the last 12 months been in the service of any of the following:

- [ ] a member of any municipal council
- [ ] an employee of any provincial department, national or provincial public entity or constitutional institution within the meaning of the Public Finance Management Act, 1999 (Act 1 of 1999)
- [ ] a member of any provincial legislature
- [ ] a member of the National Assembly or the National Council of Province
- [ ] an official of any municipality or municipal entity
- [ ] a member of the board of directors of any municipal entity
- [ ] an employee of Parliament or a provincial legislature
- [ ] an employee of any national or provincial public entity
- [ ] an employee of any accounting authority of any national or provincial public entity
- [ ] an employee of any provincial department, national or provincial public entity
- [ ] an employee of any municipal council
- [ ] a member of any provincial legislature
- [ ] an employee of any provincial department, national or provincial public entity or constitutional institution within the meaning of the Public Finance Management Act, 1999 (Act 1 of 1999)
- [ ] a member of any provincial legislature
- [ ] a member of the National Assembly or the National Council of Province
- [ ] an official of any municipality or municipal entity
- [ ] a member of the board of directors of any municipal entity
- [ ] an employee of Parliament or a provincial legislature
- [ ] a member of any municipal council
- [ ] an employee of any provincial department, national or provincial public entity or constitutional institution within the meaning of the Public Finance Management Act, 1999 (Act 1 of 1999)
- [ ] a member of any provincial legislature
- [ ] a member of the National Assembly or the National Council of Province
- [ ] an official of any municipality or municipal entity
- [ ] a member of the board of directors of any municipal entity
- [ ] an employee of Parliament or a provincial legislature
- [ ] a member of any municipal council
- [ ] an employee of any provincial department, national or provincial public entity or constitutional institution within the meaning of the Public Finance Management Act, 1999 (Act 1 of 1999)
- [ ] a member of any provincial legislature
- [ ] a member of the National Assembly or the National Council of Province
- [ ] an official of any municipality or municipal entity
- [ ] a member of the board of directors of any municipal entity
- [ ] an employee of Parliament or a provincial legislature

<table>
<thead>
<tr>
<th>Name of spouse, child or parent</th>
<th>Name of institution, public office, board or organ of state and position held</th>
<th>Status of service (tick appropriate column)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>current</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*insert separate page if necessary

The undersigned, who warrants that he/she is duly authorised to do so on behalf of the enterprise:

i) authorizes the Employer to obtain a tax clearance certificate from the South African Revenue Services that my / our tax matters are in order;

ii) confirms that the neither the name of the enterprise or the name of any partner, manager, director or other person, who wholly or partly exercises, or may exercise, control over the enterprise appears on the Register of Tender Defaulters established in terms of the Prevention and Combating of Corrupt Activities Act of 2004;

iii) confirms that no partner, member, director or other person, who wholly or partly exercises, or may exercise, control over the enterprise appears, has within the last five years been convicted of fraud or corruption;

iv) confirms that I / we are not associated, linked or involved with any other tendering entities submitting tender offers and have no other relationship with any of the tenderers or those responsible for compiling the scope of work that could cause or be interpreted as a conflict of interest;

iv) confirms that the contents of this questionnaire are within my personal knowledge and are to the best of my belief both true and correct.

SIGNED ON BEHALF OF TENDERER: ________________________________

Tender
Part T2: Returnable Documents
Reference No: NRF/Themba LABS/2015 – 16:07
REPLACEMENT OF EXISTING CHILLERS IN PLANT ROOM AT ITHEMBA LABS, FAURE

SCHEDULE 2: SITE VISIT / CLARIFICATION MEETING CERTIFICATE

This is to certify that I/we, .................................................................................................................................

of (tenderer) ......................................................................................................................................................

........................................................................................................................................................................

of (address) .......................................................................................................................................................

........................................................................................................................................................................

........................................................................................................................................................................

telephone number .............................................................................................................................................

........................................................................................................................................................................

........................................................................................................................................................................

fax number .........................................................................................................................................................

........................................................................................................................................................................

........................................................................................................................................................................

on (date) ............................................................................................................................................................

........................................................................................................................................................................

have examined the Site of the Works and its surroundings for which I/we am/are submitting this Tender and have,
so far as is practicable, familiarized myself/ourselves with all the information, risks, contingencies and other
circumstances which may influence of affect my/our Tender.

SIGNED ON BEHALF OF TENDERER: ...............................................................................................................

SIGNED ON BEHALF OF ENGINEER’S REPRESENTATIVE: ...............................................................................

NRF - ITHEMBA LABS

BID NO: NRF/iThemba LABS/2015 – 16:07

REPLACEMENT OF EXISTING CHILLERS IN PLANT ROOM AT ITHEMBA LABS, FAURE

SCHEDULE 3: AUTHORITY OF SIGNATORY

Assurance shall be given at the time of submission of the tender that the tender has been signed by someone properly authorised thereto by resolution of the Directors, Members or Partners. Tenderers shall submit with their tenders the following information:

**Single Company, Close Corporation or Partnership**

Signatories for companies shall confirm their authority by attaching to this form a copy of the relevant resolution of the board of directors, duly signed and dated.

By resolution of the board of directors taken on \((\text{Date})\) ........................................................................................................................................

Mr/Ms \((\text{Print Name})\) ........................................................................................................................................

has been duly authorized to sign all documents in connection with this tender / contract on behalf of : ....

\((\text{Print Company Name})\) ........................................................................................................................................

Signed on behalf of Company : ........................................................................................................................................

In his/her capacity as : ........................................................................................................................................

Date : ........................................................................................................................................

**Joint Ventures**

We, the undersigned, are submitting this tender offer in joint venture and hereby authorize Mr/Ms .................

.............................................................., authorised signatory of the company, close corporation or partnership ..............

.............................................................., acting in the capacity of lead partner, to sign all documents in connection with the tender offer and any contract resulting from it on our behalf.

<table>
<thead>
<tr>
<th>NAME OF FIRM</th>
<th>ADDRESS</th>
<th>DULY AUTHORISED SIGNATORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead partner</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Signature...................</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Name...........................</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Designation..................</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Signature...................</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Name...........................</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Designation..................</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Signature...................</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Name...........................</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Designation..................</td>
</tr>
</tbody>
</table>

Note:

A copy of the Joint Venture Agreement showing clearly the percentage contribution of each partner to the Joint Venture shall be appended to this schedule.

**SIGNED ON BEHALF OF TENDERER: SIGNATURE OF SIGNATORY**
**NRF - ITHEMBA LABS**

**BID NO:** NRF/iThemba LABS/2015 – 16:07

**REPLACEMENT OF EXISTING CHILLERS IN PLANT ROOM AT ITHEMBA LABS, FAURE**

**SCHEDULE 4: SCHEDULE OF WORK EXPERIENCE**

The tenderer shall insert in the spaces provided below a list of similar completed contracts awarded to him and those currently being undertaken.

<table>
<thead>
<tr>
<th>COMPLETED CONTRACTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMPLOYER (NAME, TEL No. AND FAX No.)</td>
</tr>
<tr>
<td>----------------------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
### Current Contracts

<table>
<thead>
<tr>
<th>Employer (Name, Tel No. and Fax No.)</th>
<th>Consulting Engineer (Name, Tel No. and Fax No.)</th>
<th>Nature of Work</th>
<th>Value of Work (R(m))</th>
<th>Anticipated Completion Date</th>
</tr>
</thead>
</table>

Number of sheets, appended by the tenderer to this Schedule .................... (If nil, enter NIL).

Signed on behalf of tenderer: ..........................
NRF - ITHEMBA LABS

BID NO: NRF/iThemba LABS/2015 – 16:07

REPLACEMENT OF EXISTING CHILLERS IN PLANT ROOM AT ITHEMBA LABS, FAURE

SCHEDULE 5 : SCHEDULE OF CONSTRUCTION EQUIPMENT – NOT USED

The tenderer shall state below what construction equipment will be available for this Contract. The tenderer shall differentiate, if applicable, between construction equipment immediately available and construction equipment which will become available by virtue of outstanding orders, and indicate what further construction equipment will be acquired or hired for the work should he be awarded the Contract.

CONSTRUCTION EQUIPMENT IMMEDIATELY AVAILABLE

<table>
<thead>
<tr>
<th>DESCRIPTION, SIZE, CAPACITY</th>
<th>NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**CONSTRUCTION EQUIPMENT ON ORDER**

(State details of arrangements made, with delivery dates)

<table>
<thead>
<tr>
<th>DESCRIPTION, SIZE, CAPACITY</th>
<th>NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**CONSTRUCTION EQUIPMENT THAT WILL BE ACQUIRED OR HIRED**

(State details of delivery arrangements)

<table>
<thead>
<tr>
<th>DESCRIPTION, SIZE, CAPACITY</th>
<th>NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Number of sheets, appended by the tenderer to this Schedule ....................... (If nil, enter NIL).

**SIGNED ON BEHALF OF TENDERER:** .................................
SCHEDULE 6: PRELIMINARY PROGRAMME

The tenderer shall attach a preliminary programme, reflecting the proposed sequence and tempo of execution of the various activities comprising the work for the Contract, to this page.

This programme shall be in the form of a bar chart (Gantt chart) or similar acceptable time/activity form reflecting the proposed sequence and tempo of the various activities and the quantities that will be carried out every week under each of the elements, comprising the work for this contract. The programme shall also indicate the point where the tenderer intends to commence work operations and the direction in which the work will proceed. The working hours shall be indicated.

The tenderer shall also take into account the additional requirements stated in the Project Specifications when drawing up the programme.

Details of the preliminary programme shall be appended to this Schedule.

Number of sheets, appended by the tenderer to this Schedule ....................... (If nil, enter NIL).
SCHEDULE 7: SCHEDULE OF ESTIMATED MONTHLY EXPENDITURE – NOT USED

The tenderer shall state his estimated expenditure indicating the values of each monthly claim in terms of Clause 6.10 of the General Conditions of Contract, which he estimates will arise based on his preliminary programme and tendered rates, in the table below. The total of the monthly amounts shall be equal to the tender sum.

<table>
<thead>
<tr>
<th>MONTH</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>R</td>
</tr>
<tr>
<td>2.</td>
<td>R</td>
</tr>
<tr>
<td>3.</td>
<td>R</td>
</tr>
<tr>
<td>4.</td>
<td>R</td>
</tr>
<tr>
<td>5.</td>
<td>R</td>
</tr>
<tr>
<td>6.</td>
<td>R</td>
</tr>
<tr>
<td>7.</td>
<td>R</td>
</tr>
<tr>
<td>8.</td>
<td>R</td>
</tr>
<tr>
<td>9.</td>
<td>R</td>
</tr>
<tr>
<td>10.</td>
<td>R</td>
</tr>
<tr>
<td>11.</td>
<td>R</td>
</tr>
<tr>
<td>12.</td>
<td>R</td>
</tr>
<tr>
<td>13.</td>
<td>R</td>
</tr>
<tr>
<td>14.</td>
<td>R</td>
</tr>
</tbody>
</table>

SUBTOTAL: R

Contingencies: R

SUBTOTAL: R

VAT (14%): R

TOTAL: R (INCLUDING VAT @ 14%)

SIGNED ON BEHALF OF TENDERER: .................................................................
SCHEDULE 8: TAX CLEARANCE DECLARATION

1. Legal Name of tax payer/tenderer:

2. Trade name:

3. Identification number (if applicable):

4. Company/Close Corporation registration number:

5. Income tax reference number:

6. VAT registration number (if applicable):

7. PAYE employer’s registration number (if applicable):

An original valid Tax Clearance Certificate (valid at tender closing date) from the South African Revenue Services (SARS) shall be attached to this Schedule.

Each party to a Consortium/Joint Venture shall submit a separate Tax Clearance Certificate.

Number of sheets, appended by the tenderer to this Schedule ....................... (If nil, enter NIL).

SIGNED ON BEHALF OF TENDERER: ...........................................
SCHEDULE 9: SCHEDULE OF SUBCONTRACTORS

We notify you that it is our intention to employ the following Subcontractors for work in this contract.

Acceptance of this tender shall not be construed as approval of all or any of the listed subcontractors. Should any of the subcontractors not be approved subsequent to acceptance of the tender, this shall in no way invalidate this tender, and the tendered unit rates for the various items of work shall remain final and binding, even in the event of a subcontractor not listed below being approved by the Engineer.

<table>
<thead>
<tr>
<th>Category/type</th>
<th>Subcontractor Name/Address/Contact Person/Phone/Fax/Details Of Organisation/Firm Experience</th>
<th>Items of work (pay items) to be undertaken by the Subcontractor</th>
<th>Estimated Cost of Work (Rand)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TOTAL (Excluding VAT)

Number of sheets, appended by the tenderer to this Schedule ......................... (If nil, enter NIL).

**SIGNED ON BEHALF OF TENDERER:** .................................................................
NRF - ITHEMBA LABS

BID NO: NRF/iThemba LABS/2015 – 16:07

REPLACEMENT OF EXISTING CHILLERS IN PLANT ROOM AT ITHEMBA LABS, FAURE

SCHEDULE 10: DETAILS OF SITE AGENT’S AND GENERAL FOREMAN’S EXPERIENCE

Tenderers shall set out in the Schedule hereunder details of the Site Agent and General Foreman’s experience in work of a similar nature to that for which their Tender is submitted.

Failure to complete this Schedule may result in the Tender not being considered.

<table>
<thead>
<tr>
<th>SITE AGENT</th>
<th>NAME: ......................................................</th>
<th>NQF LEVEL .........</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTRACT &amp; CLIENT</td>
<td>NATURE OF WORK</td>
<td>POSITION HELD</td>
</tr>
<tr>
<td>GENERAL FOREMAN</td>
<td>NAME: ......................................................</td>
<td>NQF LEVEL .........</td>
</tr>
<tr>
<td>CONTRACT &amp; CLIENT</td>
<td>NATURE OF WORK</td>
<td>POSITION HELD</td>
</tr>
</tbody>
</table>

Number of sheets, appended by the tenderer to this Schedule ....................... (If nil, enter NIL).

SIGNED ON BEHALF OF THE TENDERER: ............................................
Tenderers are to note the requirements of the Occupational Health and Safety Act No. 85 of 1993 and the Construction Regulation 2014 issued in terms of Section 43 of the Act. The tenderer shall be deemed to have read and fully understood the requirements of the above Act and Regulations and to have allowed for all costs in compliance therewith.

In this regard the tenderer shall prepare and submit a generic Health and Safety Plan in respect of the Works in order to demonstrate the necessary competencies and resources to perform the construction work all in accordance with the Act and Regulations. Such Health and Safety Plan shall cover inter-alia the following details:

(1) Management Structure, Site Supervision and Responsible Persons including a succession plan.
(2) Contractor’s induction training programme for employees, sub-contractors and visitors to the Site.
(3) Health and safety precautions and procedures to be adhered to in order to ensure compliance with the Act, Regulations and Safety Specifications.
(4) Regular monitoring procedures to be performed.
(5) Regular liaison, consultation and review meetings with all parties.
(6) Site security, welfare facilities and first aid.
(7) Site rules and fire and emergency procedures.

Tenderers are to note that the Contractor is required to ensure that all sub-contractors or others engaged in the performance of the contract also comply with the above requirements.

The tenderer shall also take into account the additional requirements stated in the Scope of Work when drawing up the Health and Safety Plan for the contract.

Details of the Health and Safety Plan shall be appended to this Schedule.

Number of sheets, appended by the tenderer to this Schedule ....................... (If nil, enter NIL).

SIGNED ON BEHALF OF TENDERER: ...............................................................
SCHEDULE 12: SCHEDULE OF SPECIAL MATERIALS

Tenderers are referred to:

Clause 6.8.3: Variation in the cost of special materials – NOT APPLICABLE

<table>
<thead>
<tr>
<th>Special Material</th>
<th>Unit*</th>
<th>Rate or Price for the base month</th>
</tr>
</thead>
</table>

* Indicate whether the material will be delivered in bulk or in containers. When called upon to do so, the tenderer shall substantiate the above rates or prices with acceptable documentary evidence.

Number of sheets, appended by the tenderer to this Schedule ....................... (If nil, enter NIL).

SIGNED ON BEHALF OF TENDERER: .................................................................
NRF - ITHEMBA LABS

BID NO: NRF/iThemba LABS/2015 – 16:07

REPLACEMENT OF EXISTING CHILLERS IN PLANT ROOM AT ITHEMBA LABS, FAURE

SCHEDULE 13: SUPPLIER DUE DILIGENCE

a) DECLARATION OF INTEREST (STANDARD BIDDING DOCUMENT 4)

1. Any legal person, including persons employed by the state (see paragraph 20), or persons having a kinship with persons employed by the state, including a blood relationship, may make an offer or offers in terms of this invitation to bid (includes an advertised competitive bid, a limited bid, a proposal or written price quotation). In view of possible allegations of favouritism, should the resulting bid, or part thereof, be awarded to persons employed by the state, or to persons connected with or related to them, it is required that the bidder or his/her authorised representative declare his/her position in relation to the evaluating/adjudicating authority where:

   the bidder is employed by the state; and/or

   the legal person on whose behalf the bidding document is signed, has a relationship with persons/a person who are/is involved in the evaluation and or adjudication of the bid(s), or where it is known that such a relationship exists between the person or persons for or on whose behalf the declarant acts and persons who are involved with the evaluation and or adjudication of the bid.

2. In order to give effect to the above, the following questionnaire must be completed and submitted with this bid.

2.1 Full Name of bidder or his or her representative:

   ____________________________________________________________

2.2 Identity Number:

   ____________________________________________________________

2.3 Position occupied in the Company (director, trustee, shareholder (see paragraph 20), member):

   ____________________________________________________________

2.4 Registration number of company, enterprise, close corporation, partnership agreement or trust:

   ____________________________________________________________

2.5 Tax Reference Number:

   ____________________________________________________________
2.6 VAT Registration Number: 


2.6.1 The names of all directors/trustees/shareholders/members, their individual identity numbers, tax reference numbers and, if applicable, employee/PERSAL numbers must be indicated in paragraph 3 below.

2.7 Are you or any person connected with the bidder presently employed by the state? YES/NO

2.7.1 If so, furnish the following particulars in an attached schedule:

Name of person/director/trustee/shareholder/member:

Name of state institution at which you or the person connected to the bidder is employed

Position occupied in the state institution

Any other particulars:

2.7.2 If you are presently employed by the state, did you obtain the appropriate authority to undertake remunerative work outside employment in the public sector? YES/NO

2.7.2.1 If yes, did you attach proof of such authority to the bid document? YES/NO

(Note: Failure to submit proof of such authority, where applicable, may result in the disqualification of the bid.)

2.7.2.2 If no, furnish reasons for non-submission of such proof as an attached schedule

2.8 Did you or your spouse, or any of the company’s directors/trustees/shareholders/members or their spouses conduct business with the state in the previous twelve months? YES/NO

2.8.1 If so, furnish particulars as an attached schedule:

2.9 Do you, or any person connected with the bidder, have any relationship (family, friend, other) with a person employed by the state and who may be involved with the evaluation and or adjudication of this bid? YES/NO

2.9.1 If so, furnish particulars as an attached schedule.

2.10 Are you, or any person connected with the bidder, aware of any relationship (family, friend, other) between any other bidder and any person employed by the state who may be involved with the evaluation and or adjudication of this bid? YES/NO

2.10.1 If so, furnish particulars as an attached schedule:

2.11 Do you or any of the directors/trustees/shareholders/members of the company have any interest in any other related companies whether or not they are bidding for this contract? YES/NO

2.11.1 If so, furnish particulars as an attached schedule:

3. Full details of directors/trustees/members/shareholders.

<table>
<thead>
<tr>
<th>Full Name</th>
<th>Identity Number</th>
<th>Personal Income Tax Reference Number</th>
<th>State Employee Number/ Payroll (Personal) Number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Schedule attached with the above details for all directors / members / shareholders YES NO
## NRF - ITHEMBA LABS

**BID NO:** NRF/iThemba LABS/2015 – 16:07

**REPLACEMENT OF EXISTING CHILLERS IN PLANT ROOM AT ITHEMBA LABS, FAURE**

### SCHEDULE 14: DECLARATION OF BIDDER’S PAST SUPPLY CHAIN MANAGEMENT PRACTICES (STANDARD BIDDING DOCUMENT 8)

<table>
<thead>
<tr>
<th>Item</th>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Is the bidder or any of its directors listed on the National Treasury’s Database of Restricted Suppliers as companies or persons prohibited from doing business with the public sector?</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

The Database of Restricted Suppliers now resides on the National Treasury’s website ([www.treasury.gov.za](http://www.treasury.gov.za)) and can be accessed by clicking on its link at the bottom of the home page.

If so, furnish particulars as an attached schedule:

| 2.   | Is the bidder or any of its directors listed on the Register for Tender Defaulters in terms of section 29 of the Prevention and Combating of Corrupt Activities Act (No 12 of 2004)? | Yes | No |

The Register for Tender Defaulters can be accessed on the National Treasury’s website ([www.treasury.gov.za](http://www.treasury.gov.za)) by clicking on its link at the bottom of the home page.

If so, furnish particulars as an attached schedule:

| 3.   | Was the bidder or any of its directors convicted by a court of law (including a court outside of the Republic of South Africa) for fraud or corruption during the past five years? | Yes | No |

If so, furnish particulars as an attached schedule:

| 4.   | Was any contract between the bidder and any organ of state terminated during the past five years on account of failure to perform on or comply with the contract? | Yes | No |

If so, furnish particulars as an attached schedule:
NRF - ITHEMBA LABS

BID NO: NRF/iThemba LABS/2015 – 16:07

REPLACEMENT OF EXISTING CHILLERS IN PLANT ROOM AT ITHEMBA LABS, FAURE

SCHEDULE 15: CERTIFICATE OF INDEPENDENT BID DETERMINATION (STANDARD BIDDING DOCUMENT 9)

I, the undersigned, in submitting this bid in response to the invitation for the bid made by NATIONAL RESEARCH FOUNDATION do hereby make the following statements that I certify to be true and complete in every respect:

I certify, on behalf of:________________________________________________ (Name of Bidder) that:

1. I have read and I understand the contents of this Certificate;
2. I understand that the accompanying bid will be disqualified if this Certificate is found not to be true and complete in every respect;
3. I am authorized by the bidder to sign this Certificate, and to submit the accompanying bid, on behalf of the bidder;
4. Each person whose signature appears on the accompanying bid has been authorized by the bidder to determine the terms of, and to sign the bid, on behalf of the bidder;
5. For the purposes of this Certificate and the accompanying bid, I understand that the word “competitor” shall include any individual or organization, other than the bidder, whether or not affiliated with the bidder, who:
   (a) has been requested to submit a bid in response to this bid invitation;
   (b) could potentially submit a bid in response to this bid invitation, based on their qualifications, abilities or experience; and
   (c) provides the same goods and services as the bidder and/or is in the same line of business as the bidder
6. The bidder has arrived at the accompanying bid independently from, and without consultation, communication, agreement or arrangement with any competitor. However communication between partners in a joint venture or consortium³ will not be construed as collusive bidding.
   ³ Joint venture or Consortium means an association of persons for the purpose of combining their expertise, property, capital, efforts, skill and knowledge in an activity for the execution of a contract.
7. In particular, without limiting the generality of paragraphs 6 above, there has been no consultation, communication, agreement or arrangement with any competitor regarding:
   (a) prices;
   (b) geographical area where product or service will be rendered (market allocation);
   (c) methods, factors or formulas used to calculate prices;
   (d) the intention or decision to submit or not to submit, a bid;
   (e) the submission of a bid which does not meet the specifications and conditions of the bid; or
   (f) bidding with the intention not to win the bid.
8. In addition, there have been no consultations, communications, agreements or arrangements with any competitor regarding the quality, quantity, specifications and conditions or delivery particulars of the products or services to which this bid invitation relates.
9. The terms of the accompanying bid have not been, and will not be, disclosed by the bidder, directly or indirectly, to any competitor, prior to the date and time of the official bid opening or of the awarding of the contract.
10. I am aware that, in addition and without prejudice to any other remedy provided to combat any restrictive practices related to bids and contracts, bids that are suspicious will be reported to the Competition Commission for investigation and possible imposition of administrative penalties in terms of section 59 of the Competition Act No 89 of 1998 and or may be reported to the National Prosecuting Authority (NPA) for criminal investigation and or may be restricted from conducting business with the public sector for a period not exceeding ten (10) years in terms of the Prevention and Combating of Corrupt Activities Act No 12 of 2004 or any other applicable legislation.
PREFERENCE POINTS CLAIM FORM (STANDARD BIDDING DOCUMENT 6.1)

POINTS AWARDED FOR B-BBEE STATUS LEVEL OF CONTRIBUTION

In terms of Regulation 5 (2) and 6 (2) of the Preferential Procurement Regulations, preference points must be awarded to a bidder for attaining the B-BBEE status level of contribution in accordance with the table below:

<table>
<thead>
<tr>
<th>B-BBEE Status Level of Contributor</th>
<th>Number of points (90/10 system)</th>
<th>Number of points (80/20 system)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Non-compliant contributor</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

BID DECLARATION

Bidders who claim points in respect of B-BBEE Status Level of Contribution must complete below:

B-BBEE STATUS LEVEL OF CONTRIBUTION CLAIMED IN TERMS OF THE ABOVE TABLE

B-BBEE Status Level of Contribution: …………. = …………. (maximum of 10 or 20 points)
(Points claimed must be in accordance with the table reflected above and must be substantiated by means of a B-BBEE certificate issued by a Verification Agency accredited by SANAS or a Registered Auditor approved by IRBA or an Accounting Officer as contemplated in the CCA).

SUB-CONTRACTING

Will any portion of the contract be sub-contracted? YES / NO
If yes, indicate:
(i) what percentage of the contract will be subcontracted: …………………………….%
(ii) the name of the sub-contractor: ……………………………………………………………
(iii) the B-BBEE status level of the sub-contractor: …………..
(iv) whether the sub-contractor is an EME. YES / NO

DECLARATION WITH REGARD TO COMPANY/FIRM

Name of company/firm: …………………………………………………………………………………

VAT registration number: …………………………………………………………………………………

Company registration number: …………………………………………………………………………..

TYPE OF COMPANY/ FIRM

[Tick applicable box]

☐ Partnership/Joint Venture / Consortium
☐ One person business/sole propriety
☐ Close corporation
☐ Company
☐ (Pty) Limited

DESCRIBE PRINCIPAL BUSINESS ACTIVITIES

………………………………………………………………………………………………………………

COMPANY CLASSIFICATION

………………………………………………………………………………………………………………
I/we, the undersigned, who is/are duly authorised to do so on behalf of the company/firm, certify that the points claimed,

Total number of years the company/firm has been in business? …………………………………………………….…………

A person awarded a contract may not sub-

5. Definitions

"all applicable taxes" includes value-added tax, pay as you earn, income tax, unemployment insurance fund contributions and skills development levies;

"B-BBEE" means broad-based black economic empowerment as defined in section 1 of the Broad-Based Black Economic Empowerment Act;

"B-BBEE status level of contributor" means the B-BBEE status received by a measured entity based on its overall performance using the relevant scorecard contained in the Codes of Good Practice on Black Economic Empowerment, issued in terms of section 9(1) of the Broad-Based Black Economic Empowerment Act;

"bid" means a written offer in a prescribed or stipulated form in response to an invitation by an organ of state for the provision of services, works or goods, through price quotations, written price quotations, advertised competitive bidding processes or proposals;

"bid price" price offered by the bidder, including value added tax (VAT);

"Broad-Based Black Economic Empowerment Act" means the Broad-Based Black Economic Empowerment Act, 2003 (Act No. 53 of 2003);

"Closing time" means the date and hour specified in the bidding documents for the receipt of bids;

"Collusion" means Section 4 (1) (b) (iii) of the Competition Act No. 89 of 1998, as amended, prohibits an agreement between, or concerted practice by, firms, or a decision by an association of firms, if it is between parties in a horizontal relationship and if it involves collusive bidding (or bid rigging);

Collusive bidding is a per se prohibition meaning that it cannot be justified under any grounds. Bid rigging (or collusive bidding) occurs when businesses, that would otherwise be expected to compete, secretly conspire to raise prices or lower the quality of goods and/or services for purchasers who wish to acquire goods and/or services through a bidding process. Bid rigging is, therefore, an agreement between competitors not to compete;

"comparative price" means the price after the factors of comparative price

"consortium or joint venture" means an association of persons for the purpose of combining their expertise, property, capital, efforts, skill and knowledge in an activity for the execution of a contract;

"Contract" means the written agreement entered into between the purchaser and the supplier, as recorded in the contract form signed by the parties, including all attachments and appendices thereto and all documents incorporated by reference therein;
“Contract price” means the price payable to the supplier under the contract for the full and proper performance of his contractual obligations.

“Corrupt practice” means the offering, giving, receiving, or soliciting of anything of value to influence the action of a public official in the procurement process or in contract execution;

"Countervailing duties" are imposed in cases where an enterprise abroad is subsidised by its government and encouraged to market its products internationally;

“Country of origin” means the place where the goods were mined, grown or produced or from which the services are supplied. Goods are produced when, through manufacturing, processing or substantial and major assembly of components, a commercially recognised new product results that is substantially different in basic characteristics or in purpose or utility from its components;

“Day” means calendar day;

“Delivery” means delivery in compliance of the conditions of the contract or order;

“Delivery ex stock” means immediate delivery directly from stock actually on hand;

“Delivery into consignees store or to his site” means delivered and unloaded in the specified store or depot or on the specified site in compliance with the conditions of the contract or order, the supplier bearing all risks and charges involved until the supplies are so delivered and a valid receipt is obtained;

“designated sector” means a sector, sub-sector or industry that has been designated by the Department of Trade and Industry in line with national development and industrial policies for local production, where only locally produced services, works or goods or locally manufactured goods meet the stipulated minimum threshold for local production and content;

"duly sign" means a Declaration Certificate for Local Content that has been signed by the Chief Financial Officer or other legally responsible person nominated in writing by the Chief Executive, or senior member/person with management responsibility(close corporation, partnership or individual);

"Dumping" occurs when a private enterprise abroad market its goods on own initiative in the RSA at lower prices than that of the country of origin and which have the potential to harm the local industries in the RSA.

“EME” means any enterprise with annual total revenue of R5 million or less.

“Firm price” means the price that is only subject to adjustments in accordance with the actual increase or decrease resulting from the change, imposition, or abolition of customs or excise duty and any other duty, levy, or tax, which, in terms of the law or regulation, is binding on the contractor and demonstrably has an influence on the price of any supplies, or the rendering costs of any service, for the execution of the contract;

“Force majeure” means an event beyond the control of the supplier and not involving the supplier’s fault or negligence and not foreseeable. Such events may include, but is not restricted to, acts of the purchaser in its sovereign capacity, wars or revolutions, fires, floods, epidemics, quarantine restrictions and freight embargoes;

“Fraudulent practice” means a misrepresentation of facts in order to influence a procurement process or the execution of a contract to the detriment of any bidder, and includes collusive practice among bidders (prior to or after bid submission) designed to establish bid prices at artificial non-competitive levels and to deprive the bidder of the benefits of free and open competition.

“functionality” means the measurement according to predetermined norms, as set out in the bid documents, of a service or commodity that is designed to be practical and useful, working or operating, taking into account, among other factors, the quality, reliability, viability and durability of a service and the technical capacity and ability of a bidder;

“GCC” means the General Conditions of Contract;

“Goods” means all of the equipment, machinery, and/or other materials that the supplier is required to supply to the purchaser under the contract;

“Imported content” means that portion of the bidding price represented by the cost of components, parts or materials which have been or are still to be imported (whether by the supplier or his subcontractors) and which costs are inclusive of the costs abroad, plus freight and other direct importation costs such as landing costs, dock dues, import duty, sales duty or other similar tax or duty at the South African place of entry as well as transportation and handling charges to the factory in the Republic where the supplies covered by the bid will be manufactured;

“Local content” means that portion of the bidding price which is not included in the imported content provided that local manufacture does take place;

“Manufacture” means the production of products in a factory using labour, materials, components and machinery and includes other related value-adding activities;

“non-firm prices” means all prices other than “firm” prices;
“Order” means an official written order issued for the supply of goods or works or the rendering of a service;

“person” includes a juristic person;

“Project site,” where applicable, means the place indicated in bidding documents;

“Purchaser” means the organization purchasing the goods;

“rand value” means the total estimated value of a contract in South African currency, calculated at the time of bid invitations, and includes all applicable taxes and excise duties;

“Republic” means the Republic of South Africa;

“SCC” means the Special Conditions of Contract.

“Services” means those functional services ancillary to the supply of the goods, such as transportation and any other incidental services, such as installation, commissioning, provision of technical assistance, training, catering, gardening, security, maintenance and other such obligations of the supplier covered under the contract;

“Shareholder” means a person who owns shares in the company and is actively involved in the management of the enterprise or business and exercises control over the enterprise;

“State” means –
   (i) any national or provincial department, national or provincial public entity or constitutional institution within the meaning of the Public Finance Management Act, 1999 (Act No. 1 of 1999);
   (ii) any municipality or municipal entity;
   (iii) Provincial Legislature;
   (iv) National Assembly or the National Council of Provinces; or
   (v) Parliament.

“stipulated minimum threshold” means that portion of local production and content as determined by the Department of Trade and Industry;

“sub-contract” means the primary contractor’s assigning, leasing, making out work to, or employing, another person to support such primary contractor in the execution of part of a project in terms of the contract;

“total revenue” bears the same meaning assigned to this expression in the Codes of Good Practice on Black Economic Empowerment, issued in terms of section 9(1) of the Broad-Based Black Economic Empowerment Act and promulgated in the Government Gazette on 9 February 2007;

“trust” means the arrangement through which the property of one person is made over or bequeathed to a trustee to administer such property for the benefit of another person;

“trustee” means any person, including the founder of a trust, to whom property is bequeathed in order for such property to be administered for the benefit of another person;

“Written” or “in writing” means handwritten in ink or any form of electronic or mechanical writing.
SCHEDULE 16: ADDENDA / NOTICE(S) ISSUED TO TENDERERS

We confirm that the following communications / Addenda / Notice(s) to Tenderers received from the Employer before the submission of this tender offer, amending the tender documents, have been taken into account in this tender offer:

<table>
<thead>
<tr>
<th>ADDENDUM No</th>
<th>DATE</th>
<th>SUBJECT MATTER OF ADDENDUM / NOTICE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Documentary evidence of Addenda / Notices issued to Tenderers indicating proof of receipt shall accompany this Schedule.

Number of sheets, appended by the tenderer to this Schedule ...................... (If nil, enter NIL).

SIGNED ON BEHALF OF TENDERER: .................................................................
SCHEDULE 17: ALTERATIONS / AMENDMENTS BY TENDERER

The Tenderer should record any deviations or qualifications he may wish to make to the tender documents in this Returnable Schedule. Alternatively, a tenderer may state such deviations and qualifications in a covering letter attached to his tender and reference such letter in this schedule.

The Tenderer’s attention is drawn to clause F.3.8 of the Standard Conditions of Tender referenced in the Tender Data regarding the Employer’s handling of material deviations and qualifications.

If no deviations or modifications are desired, the schedule hereunder is to be marked NIL and signed by the Tenderer.

No alternative Tender will be considered unless a Tender free of qualifications and strictly on the basis of the Tender Documents is also submitted.

<table>
<thead>
<tr>
<th>PAGE / ITEM</th>
<th>CLAUSE / DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Number of sheets, appended by the tenderer to this Schedule .................... (If nil, enter NIL).

SIGNED ON BEHALF OF TENDERER: .............................................
Part C1: Agreements and Contract Data

Pages

C1.2 Contract Data .......................................................... 55 - 61
C1.3 Form of Guarantee .................................................. 62 - 63
C1.4 Occupational Health and Safety Agreement ...................... 64
C1.2 Contract Data

Part 1: Contract Data provided by the Employer

GENERAL CONDITIONS OF CONTRACT

The following standardised General Conditions of Contract:

General Conditions of Contract for Construction Works (Second Edition) 2010

prepared by the South African Institution of Civil Engineering (SAICE) shall apply to and from the General Conditions of Contract for this contract. Copies of these conditions of contract are obtainable from the South African Institution of Civil Engineering (SAICE), Private Bag X200, Halfway House 1685, Tel: (011) 805 5947, Fax: (011) 805 5971, e-mail: civilinfo@saice.org.za.

Copies of the General Conditions of Contract are available for inspection and scrutiny at the offices of the Employer’s Agent.

The Pro-formas bound with the General Conditions of Contract 2010, on pages 103 to 123 shall not apply to this Contract and shall be replaced with the documentation bound into this Contract Document.

The General Conditions of Contract make several references to the Contract Data for specific data, which together with these conditions collectively describe the risks, liabilities and obligations of the contracting parties and the procedures for the administration of the Contract. The Contract Data shall have precedence in the interpretation of any ambiguity or inconsistency between it and the general conditions of contract.

The General Conditions of Contract shall be read in conjunction with the variations, amendments and additions set out in the Contract Specific Data below. Each item of data given below is cross-referenced to the clause in the General Conditions of Contract to which it mainly applies.

The Contract Data and General Conditions of Contract shall have precedence over the Drawings, Scope of Work and Standardised Specifications in the interpretation of any ambiguity or inconsistency between these documents.

CONTRACT SPECIFIC DATA

The following contract specific data, referring to the General Conditions of Contract for Construction Works, Second Edition, 2010, are applicable to this Contract:

Clause 1.1.1.13:

The Defects Liability Period is 12 months.

Clause 1.1.1.14:

The time for achieving Practical Completion is 133 working days, inclusive of the 14 day period referred to in Clause 5.3.2 below if applicable, and exclusive of non-working days referred to in Clause 5.8.1 below, and special non-working days (Clause 5.8.1).

Please note: An alternative time for achieving practical completion can be offered in Part 2: Data Provided by Contractor, which will be evaluated as part of adjudication.

Clause 1.1.1.15:

The Employer is iThemba LABS a, represented by MR PAUL GARDINER and/or such other person or persons duly authorised thereto by the Employer in writing.

The name of the Employer is: THEMBA LABS and is referred to in this Contract Document by the terms “Employer”, or “NRF - ITHEMBA LABS” as the context provides.

Clause 1.1.1.26:
The Pricing Strategy is a Re-measurement Contract.

Add the following clauses after Clause 1.1.1.34:

1.1.1.35  “Drawings” means all drawings, calculations and technical information forming part of the Contract Documents and any modifications thereof or additions thereto from time to time approved in writing by the Engineer or delivered to the Contractor by the Engineer.

1.1.1.36  “Letter of Notification” means the letters of formal notification, signed by the Employer, of the decision of the Supply Chain Management Bid Adjudication Committee sent to all tenderers. The notification of the decision does not form part of the Employer’s Acceptance of the successful tenderer’s Offer and no rights shall accrue.

Clause 1.2.1.2:

The address of the Employer is: Old Faure Road
Faure
7129

Physical address:
Postal address: P O Box 722
SOMERSET WEST
7129

E-mail address: npietersen@tlabs.ac.za

Clause 1.1.1.16:

The Engineer, referred to in the documents, is the firm of BVi Consulting Engineers Western Cape (Pty) Ltd acting through a director, an associate or an official authorised thereto in writing.

The name of the Engineer is: BVi Consulting Engineers Western Cape (Pty) Ltd or their successors duly appointed by the Employer

Clause 1.2.1.2:

The address of the Engineer is:

Physical address: Block B2, Edison Square, c/o Edison Way & Century Avenue
CENTURY CITY
7441

Postal address: P O Box 86
CENTURY CITY
7446

E-mail address: alfredom@bviwc.co.za

Clause 3.1.3:

The Engineer shall obtain the specific approval of the Employer before executing any of his functions or duties according to the following Clauses of the General Conditions of Contract:

1. Clause 3.2.1 Nomination of Engineer’s Representative
2. Clause 3.2.4 Engineer’s authority to delegate
3. Clause 5.8.1 Non-working times
4. Clause 5.11.1 Suspension of the Works
5. Clause 5.12.4 Acceleration instead of extension of time
Clause 4.3:

Add the following clause after Clause 4.3.2.:

4.3.3 The Employer and the Contractor shall enter into an agreement to complete the work required for the construction of the works in terms of the provisions of Section 37(2) of the Occupational Health and Safety Act (Act 85 of 1993) and the Construction Regulations promulgated thereunder.

An agreement is included in the Contract Document (C1.4 of Contract Data) and shall be completed and submitted to the Employer together with a letter of good standing from the Compensation Commissioner (if not insured with a Licensed Compensation Insurer) within fourteen (14) days after the Commencement Date. The Contractor shall ensure that any letter of good standing shall be timeously renewed in order that it remains in full force for the duration of the Contract.

Clause 5.3.1:

The documentation required before commencement with Works execution is:

1. Health and Safety Plan (Refer to Clause 4.3)
2. Initial programme (Refer to Clause 5.6)
3. Security (Refer to Clause 6.2)
4. Insurance (Refer to Clause 8.6)
6. Letter of Good Standing from the Compensation Commissioner (if not insured with a Licensed Compensation Insurer)

Clause 5.3.2:

The time to submit the documentation required before commencement with Works execution is 14 days.

Clause 5.4.2:

Access to and possession of the site shall not be exclusive to the Contractor insofar as the provisions of Clause 4.8 apply, and where on-going use by the general public is required.

Add the following clause after Clause 5.4.3:

5.4.4 The Contractor shall bear all costs and charges for special and temporary rights of way required by him in connection with access to the Site.

Clause 5.8.1:

The non-working days are Sundays.

The special non-working days are:

1. All gazetted public holidays falling outside the year end break.
2. The year end break commencing on 15 December 2015 and ending on 8 January 2016 and similar dates on the following year end break.

Clause 5.12.2.2:

No extension of time will be granted in respect of any delays attributed to normal climatic conditions. Normal climatic conditions shall be deemed to include normal rainfall and associated wet conditions and materials, strong winds and extremes of temperature. However, in the event that delays to critical activities exceed the number of working days listed below for each month, then abnormal climatic conditions shall be deemed to exist, and an extension of time may be claimed in accordance with the provisions of Clause 5.12.

Clause 5.13.1:

The penalty for failing to complete the Works is R4 000 per calendar day.

Clause 5.16.3:

The latent defects period is 10 years

Clause 6.2.1:
The security to be provided by the Contractor shall be a performance guarantee of 10% of the Contract Sum. The performance guarantee shall contain the wording of the document included in C1.3.

**Clause 6.2.2:**

Delete Clause 6.2.2 in its entirety.

**Clause 6.2.3:**

Delete Clause 6.2.3 in its entirety and replace with the following:

The Contractor shall ensure that the performance guarantee remains valid and enforceable until the Certificate of Completion of the Works is issued.

**Clause 6.5.1.2.3:**

The percentage allowance to cover overhead charges is 10%.

**6.8.2:**

Add the following to Clause 6.8.2:

The Contract Price shall not be subject to contract price adjustment in accordance with Clause 6.8 of the General Conditions of Contract.

If special materials are specified in Part 2 of the Contract Data then the provisions of Clause 6.8.3 of the General Conditions of Contract shall apply to such special materials.

**Clause 6.8.4:**

Add the following to Clause 6.8.4:

Notwithstanding the above, in the event that a public holiday is proclaimed after 28 days before the closing date for tenders, no costs other than those that can be claimed under Clause 5.12.3 shall be added to the contract price.

**Clause 6.10.1.5:**

The percentage advance on materials not yet built into the Permanent Works is 0%.

**Clause 6.10.3:**

Add the following to Clause 6.10.3:

Notwithstanding the provision of a performance guarantee in terms of Clause 6.2.1, interim payments to the Contractors shall be subject to a retention by the Employer of an amount of 10% of the said amounts due to the Contractor, with no limit. The limit of retention money for the defect Liability Period shall be 5% of the Contract Price, including payment for contingencies and Contract Price Adjustment. A guarantee in lieu of retention is permitted.

**Clause 6.10.4:**

Add the following to clause 6.10.4:

Notwithstanding the above, the Engineer shall be empowered to withhold the delivery of the payment certificate until the Contractor has complied with his obligations to report in terms of Clause 4.10.2 and as described in the Scope of Work.

**Clause 8.6.1.1.2:**

The value of Plant and materials supplied by the Employer to be included in the insurance sum is R 0.00 (Nil).

**Clause 8.6.1.1.3:**

The amount to cover professional fees for repairing damage and loss to be included in the insurance sum is R0.00 (Nil).
Clause 8.6.1.3:

The limit of indemnity for liability insurance is R20 000 000.00 for any single claim – the number of claims to be unlimited during the construction and defects liability periods.

Clause 8.6.1.5:

In addition to the insurances required in terms of General Conditions of Contract Clauses 8.6.1.1 to 8.6.1.4 the following insurance is also required:

(a) Insurance of Construction Equipment (including tools, offices and other temporary structures and contents) and other things (except those intended for incorporation into the Works) brought onto the site for a sum sufficient to provide for their replacement.

(b) Insurance in terms of the provisions of the Compensation for Occupational injuries and Diseases Act No. 130 of 1993.

(c) Motor Vehicle Liability Insurance comprising (as a minimum) “Balance of Third Party” Risks including Passenger Liability Indemnity.

(d) Where the contract involves manufacturing and/or fabrication of the works or part thereof at premises other than the Site, the Contractor shall satisfy the Employer that all materials and equipment for incorporation in the works are adequately insured during manufacture and/or fabrication. In the event of the Employer having an insurable interest in such works during manufacture or fabrication then such interest shall be noted by endorsement to the Contractor’s Policies of Insurance.

Clause 8.6.6:

The evidence that the insurances have been effected in terms of Clause 8.6.1, shall be in the form of an insurance broker’s warranty worded precisely as given in part C1.6 Insurance Broker’s Warranty.

Clause 9.2.1:

Add the following to Clauses after Clause 9.2.1.3.7:

9.2.1.3.8 The Contractor committed a corrupt or fraudulent act during the procurement process or the execution of the contract.

9.2.1.3.9 An official or other role player committed any corrupt or fraudulent act during the procurement process or in the execution of the contract that benefitted the Contractor.

Clause 10.5.3:

The number of ad-hoc Adjudication Board Members to be appointed is 1(one).

ADDITIONAL CONDITIONS OF CONTRACT

Add the following clause after clause 10

Clause 11: Details to be confidential

The Contractor shall treat the details of the Works comprised in this Contract as private and confidential (save in so far as may be necessary for the purposes hereof) and shall not publish or disclose the same or any particulars thereof in any trade or technical paper elsewhere without the prior written consent of the Engineer.
Part 2: Data provided by the Contractor

Clause 1.1.1.9:
The name of the Contractor is ...........................................................................................................

Clause 1.2.1.2:
The address of the Contractor is

<table>
<thead>
<tr>
<th>Physical Address</th>
<th>Postal Address</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Telephone: .................................................. Fax: ..........................................................
email: ..........................................................

Alternative offer for Practical Completion: ................................................................. (weeks)
(Refer to clause 1.1.1.14, C1.2 contract data)
C1.3 Form of Guarantee

WHEREAS NRF - ITHEMBA LABS (hereinafter referred to as the Employer”) entered into, a Contract with:

(thereinafter called “the Contactor”) on the ........ day of ................... .20...... , for ................................................................. ................................................................. at ..............................

AND WHEREAS it is provided by such Contract that the Contractor shall provide the Employer with security by way of a guarantee for the due and faithful fulfilment of such Contract by the Contractor;

AND WHEREAS ................................................................. has / have at the request of the Contractor, agreed to give such guarantee;

NOW THEREFORE WE ................................................................. do hereby guarantee and bind ourselves jointly and severally as Guarantor and Co-principal Debtors to the Employer under renunciation of the benefits of division and excussion for the due and faithful performance by the Contractor of all the terms and conditions of the said Contract, subject to the following conditions:

1. The Employer shall, without reference and / or notice to us, have complete liberty of action to act in any manner authorized and/or contemplated by the terms of the said Contract, and/or to agree to any modifications, variations, alterations, directions or extensions of the completion date of the works under the said Contract, and that its rights under this guarantee shall in no way be prejudiced nor our liability hereunder be affected by reason of any steps which the Employer may take under such Contract, or of any modification, variation, alteration of the completion date which the Employer may make, give, concede or agree to under the said Contract.

2. This guarantee shall be limited to the payment of a sum of money.

3. The Employer shall be entitled, without reference to us, to release any guarantee held by it, and to give time to or compound or make any other arrangement with the Contractor.

4. This guarantee shall remain in full force and effect until the issue of the Certificate of Completion in terms of the Contract, unless we are advised in writing by the Employer before the issue of the said Certificate of his intention to institute claims, and the particulars thereof, in which event this guarantee shall remain in full force and effect until all such claims have been paid or liquidated.

5. Our total liability hereunder shall not exceed the Guaranteed Sum of ................................................................. Rand (in words); R ................................................................. (in figures)

6. The Guarantor reserves the right to withdraw from this guarantee by depositing the Guaranteed Sum with the beneficiary, whereupon our liability hereunder shall cease.

7. We hereby choose our address for the serving of all notices for all purposes arising here from as

.................................................................
IN WITNESS WHEREOF this guarantee has been executed by us at ........................................
on this ........ day of ........................................ 20 ........

Signature ........................................
Duly authorized to sign on behalf of ........................................
Address ........................................

As witnesses:
1 ........................................

2 ........................................

Guarantor’s seal or stamp
C1.4 Occupational Health and Safety Agreement

AGREEMENT MADE AND ENTERED INTO BETWEEN NRF - ITHEMBA LABS (HEREINAFTER CALLED THE “EMPLOYER”) AND

........................................................................................................ ,
(Contractor/Mandatary/Company/CC Name)

IN TERMS OF SECTION 37(2) OF THE OCCUPATIONAL HEALTH AND SAFETY ACT, ACT No. 85 OF 1993 AS AMENDED.

I, ........................................................................................................ , representing
........................................................................................................, as an employer
in its own right, do hereby undertake to ensure, as far as is reasonably practicable, that all work will be performed,
and all equipment, machinery or plant used in such a manner as to comply with the provisions of the Occupational
Health and Safety Act (OHSA) and the Regulations promulgated thereunder.

I furthermore confirm that I am/we are registered with the Compensation Commissioner and that all registration and
assessment monies due to the Compensation Commissioner have been fully paid or that I/We are insured with an
approved licensed compensation insurer.

COID ACT Registration Number:

OR Compensation Insurer: ........................................... Policy No.: ..............................................

I undertake to appoint, where required, suitable competent persons, in writing, in terms of the requirements of OHSA
and the Regulations and to charge him/them with the duty of ensuring that the provisions of OHSA and Regulations
as well as the Employer’s Special Conditions of Contract, Way Leave, Lock-Out and Work Permit Procedures are
adhered to as far as reasonably practicable.

I further undertake to ensure that any subcontractors employed by me will enter into an occupational health and safe
agreement separately, and that such subcontractors comply with the conditions set.

I hereby declare that I have read and understand the appended Occupational Health and Safety Conditions and
undertake to comply therewith at all times.

I hereby also undertake to comply with the Occupational Health and Safety Specification and Plan.

Signed at ..............................................on the.....................................day of............................20…

_______________________
Witness

_______________________
Mandatory

Signed at ..............................................on the.....................................day of............................20 ...

_______________________
Witness

for and on behalf of
NRF - ITHEMBA LABS
## Part C2: Pricing Data

### Pages

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>C2.1</td>
<td>Pricing data</td>
<td>66</td>
</tr>
<tr>
<td>1.</td>
<td>General Notes</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Layout and Structure of Bill of Quantities</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Please Note</td>
<td></td>
</tr>
<tr>
<td>C2.2</td>
<td>Bill of Quantities</td>
<td>67 - 75</td>
</tr>
<tr>
<td>1.</td>
<td>Preliminary &amp; General</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Demolition</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Equipment</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Piping</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Piping Insulation/Cladding</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Electrics and Controls</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>General/Miscellaneous</td>
<td></td>
</tr>
<tr>
<td>C2.3</td>
<td>Contract Rates</td>
<td>76</td>
</tr>
<tr>
<td>C2.4</td>
<td>Special Items</td>
<td>79</td>
</tr>
<tr>
<td>C2.5</td>
<td>Schedule of Equipment Offered</td>
<td>80</td>
</tr>
<tr>
<td>C2.6</td>
<td>Schedule of Imported Materials</td>
<td>81</td>
</tr>
</tbody>
</table>
C2.1 Pricing Data

1. GENERAL NOTES

- The Conditions of Contract and the application of the Contract Price Adjustment Provisions shall be as set out in Section 1: Preliminaries and General.
- The descriptions in these Bills of Quantities shall be read in conjunction with the specification and the attached drawings.
- The unit rate for each item in the Bills of Quantities shall include for all materials, labour profit, transport, etc. everything necessary for the execution and complete installation of the work in accordance with the description.
- The Bills of Quantities shall not be used for ordering purposes. The Contractor shall check the lengths of cables and overhead conductors on site before ordering any of the cables. Any allowance for off-cuts shall be made in the unit rates.
- The rates shall exclude Value-Added Tax and the total carried over to the final summary in Volume 1 (The main “Bill of Quantities” completed by the main contractor).
- All material covered by this Specification shall, wherever possible, be of South African manufacture.
- In the case of any error in the extensions of the unit rates, the unit rates will be accepted as correct, regardless of the extended total amounts entered in the Schedule of Prices. In their own interest Tenderers should make doubly sure about the correctness of their schedule rates (and the extension) and the tender price.
- A tender may be rejected if the unit rates or prices for some of the items in the Bill of Quantities are in the opinion of the Employer unreasonable or out of proportion, and the Tenderer fails, within a period of fourteen days after having been notified in writing by the Employer to adjust the unit rates or prices of such items, to make such adjustments.

2. LAYOUT AND STRUCTURE OF BILL OF QUANTITIES

The layout and structure of this “Bill of Quantities” is as illustrated below:

- BILL NUMBER 1: PRELIMINARY AND GENERAL
- BILL NUMBER 2: DEMOLITION
- BILL NUMBER 3: EQUIPMENT
- BILL NUMBER 4: PIPING
- BILL NUMBER 5: PIPING INSULATION, CLADDING
- BILL NUMBER 6: ELECTRICS AND CONTROLS
- BILL NUMBER 7: GENERAL/MISCELLANEOUS

3. PLEASE NOTE

Tenderers are to note that the Total Tender Price (which excludes VAT) must be carried over to the final summary, AND all fixed amounts shown in the price schedule must be included. No adjustments will be made for any failure by Tenderers to include the fixed amounts in the Total Tender Price for the complete Mechanical Installation.
# C2.2 Bill of Quantities

## CONTENTS

<table>
<thead>
<tr>
<th>BILL NUMBER</th>
<th>DESCRIPTION</th>
<th>PAGE(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PRELIMINARY AND GENERAL</td>
<td>70</td>
</tr>
<tr>
<td>2</td>
<td>DEMOLITION</td>
<td>71</td>
</tr>
<tr>
<td>3</td>
<td>EQUIPMENT</td>
<td>72</td>
</tr>
<tr>
<td>4</td>
<td>PIPING</td>
<td>73</td>
</tr>
<tr>
<td>5</td>
<td>PIPING INSULATION/CLADDING</td>
<td>74</td>
</tr>
<tr>
<td>6</td>
<td>ELECTRICS AND CONTROLS</td>
<td>75</td>
</tr>
<tr>
<td>7</td>
<td>GENERAL/MISCELLANEOUS</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td>SUMMARY OF BILL OF QUANTITIES</td>
<td>77</td>
</tr>
</tbody>
</table>
### BILL NUMBER 1

#### PRELIMINARY & GENERAL

<table>
<thead>
<tr>
<th>UNIT</th>
<th>QUANTITY</th>
<th>RATE</th>
<th>AMOUNT</th>
</tr>
</thead>
</table>

#### 1. PRELIMINARY & GENERAL CONDITIONS

**PREAMBLES**

All items in this Bill of Quantities (pages 1-8) must be read in conjunction with the Contract Documents, Technical Specifications, Standard Specifications, and Drawings, etc.

Special Preliminary and General Conditions pertaining to this Subcontract

1.1 Clearance of Rubbish
1.2 Site Establishment & Clearance
1.3 Scaffolding
1.4 Progress for Measurement - QS
1.5 Safety Officer / First Aider
1.6 Test and Inspections
1.7 12 Months Guarantee and Maintenance
1.8 Contract Drawings
1.9 Contract Management
1.10 Site Management
1.11 Office Administration
1.12 Rigging and Crane Hire
1.13 Spares as Specified
1.14 Equipment Labels
1.15 Extra over P&G for phasing of work.
1.16 Any additional items of preliminary nature that the Tenderer may wish to add to comply with requirements of the specification and/or bill of quantities (To be listed hereunder by the Tenderer)

#### SUBTOTAL

ADD Fixed Items
ADD Variable with time items

#### TOTAL CARRIED FORWARD TO SUMMARY PAGE

R
**BILL NUMBER 2**

### 2. DEMOLITION

<table>
<thead>
<tr>
<th>Unit</th>
<th>Quantity</th>
<th>Rate</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>REMOVAL OF REDUNDANT EQUIPMENT</strong> - (Disconnect, blank off, make safe)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1 De-commission chilled water plant, drain disconnect and make safe all equipment</td>
<td>Item 1</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>2.2 Recover/Remove all refrigerant</td>
<td>Item 1</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>2.3 Dispose R12 refrigerant legally</td>
<td>Item 1</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>2.4 Store on site all R134a refrigerant legally</td>
<td>Item 1</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>2.5 Dispose existing chillers and scrap</td>
<td>No 4</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>2.6 Remove primary chiller water pumps, valves and instrumentation</td>
<td>No 4</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>2.7 Remove secondary chiller water pumps, valves and instrumentation</td>
<td>No 4</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>2.8 Remove condenser water pumps, valves and instrumentation</td>
<td>No 4</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>2.9 Remove redundant controls, cabling, etc., only related to chillers and pumps.</td>
<td>Item 1</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>2.10 Remove redundant piping and fittings associated to pumps and chiller connections.</td>
<td>Item 1</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>2.11 Remove any other redundant equipment</td>
<td>Item 1</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>2.12 Saving/Credit for scrap value all redundant equipment.</td>
<td>Item 1</td>
<td>-R</td>
<td>-R</td>
</tr>
<tr>
<td>2.13 All Foxboro Control Equipment no longer required to be carefully removed and returned to the engineer</td>
<td>Item 1</td>
<td>-R</td>
<td>-R</td>
</tr>
<tr>
<td>2.14 Existing Mondicon PLC Equipment to be carefully removed and returned to the engineer</td>
<td>Item 1</td>
<td>-R</td>
<td>-R</td>
</tr>
</tbody>
</table>

**TOTAL CARRIED FORWARD TO SUMMARY PAGE**

|                        |        |      | R     |
### BILL NUMBER 3

#### 3. EQUIPMENT

<table>
<thead>
<tr>
<th>UNIT</th>
<th>QUANTITY</th>
<th>RATE</th>
<th>AMOUNT</th>
</tr>
</thead>
</table>

#### 3.1 CHILLERS

- **3.1.1** Dual Circuit Screw Chiller – Premium Efficiency with slide valve – 1 179 kW – refer to Equipment Schedule 18.1
  - No 2 R R

- **3.1.2** Dual Circuit Screw Chiller – Premium Efficiency with variable speed drive – Twin Screw – 1 250 kW – refer to Equipment Schedule 18.2
  - No 2 R R

- **3.1.3** Rigging and installation
  - No 4 R R

- **3.1.4** Spring anti-vibration mountings
  - Sets 4 R R

- **3.1.5** Chiller plant manager complete with BMS Interface
  - Item 1 R R

#### 3.2 PUMPS

- **3.2.1** Primary Chilled Water Pump End Suction Centrifugal Pump – refer to Equipment Schedule 18.3
  - No 4 R R

- **3.2.2** Condenser Water Pumps End Suction Centrifugal Pump – refer to Equipment Schedule 18.3
  - No 4 R R

- **3.2.3** Secondary Chilled Water Pumps End Suction Centrifugal Pump – refer to Equipment Schedule 18.3
  - No 4 R R

- **3.2.4** Rigging and installation
  - No 12 R R

- **3.2.5** Spring anti-vibration mountings
  - Sets 12 R R

- **3.2.6** Water flow switches
  - No 12 R R

**TOTAL CARRIED FORWARD TO SUMMARY PAGE**
### BILL NUMBER 4

<table>
<thead>
<tr>
<th>4. PIPING</th>
<th>UNIT</th>
<th>QUANTITY</th>
<th>RATE</th>
<th>AMOUNT</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1 CHILLED WATER PIPING</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(including valves, instrumentation, etc.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1.1 Chilled water piping for primary chilled water pumps</td>
<td>Sets</td>
<td>4</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>4.1.2 Chilled water piping for secondary chilled water pumps</td>
<td>Sets</td>
<td>4</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>4.1.3 Chilled water piping for chillers</td>
<td>Sets</td>
<td>4</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>4.1.4 Chilled water piping modifications in main plantroom</td>
<td>Item</td>
<td>1</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>4.1.5 Differential pressure sensor</td>
<td>No</td>
<td>8</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>4.1.6 Instrumentation (pressure gauges, thermometers, etc.)</td>
<td>Item</td>
<td>1</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>4.1.7 Valves, strainers, flexibles, etc.</td>
<td>Item</td>
<td>1</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>4.1.8 Energy/flow meter for chilled water de-couple bypass system</td>
<td>No</td>
<td>1</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>4.2 CONDENSER WATER PIPING</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(including valves, instrumentation, etc.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.2.1 Condenser water piping for pumps</td>
<td>No</td>
<td>4</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>4.2.2 Condenser water piping for chillers</td>
<td>No</td>
<td>4</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>4.2.3 Condenser water piping modifications in main plantroom</td>
<td>No</td>
<td>4</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>4.2.4 Cooling tower bypass valve and piping modifications</td>
<td>No</td>
<td>4</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>4.2.5 Instrumentation (pressure gauges, thermometers, etc.)</td>
<td>Item</td>
<td>1</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>4.2.6 Valves, strainers, flexibles, etc.</td>
<td>Item</td>
<td>1</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>4.3 DRAIN PIPING</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.3.1 Drain piping for all pumps.</td>
<td>Sets</td>
<td>12</td>
<td>R</td>
<td>R</td>
</tr>
</tbody>
</table>

**TOTAL CARRIED FORWARD TO SUMMARY PAGE**

| | | | R |
## BILL NUMBER 5

### 5. PIPING INSULATION/ PIPING CLADDING

<table>
<thead>
<tr>
<th>UNIT</th>
<th>QUANTITY</th>
<th>RATE</th>
<th>AMOUNT</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1 PIPING INSULATION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.1.1 Chilled water piping insulation for primary pumps</td>
<td>Sets</td>
<td>4</td>
<td>R</td>
</tr>
<tr>
<td>5.1.2 Chilled water piping insulation for secondary pumps</td>
<td>Sets</td>
<td>4</td>
<td>R</td>
</tr>
<tr>
<td>5.1.3 Chilled water piping insulation for chillers</td>
<td>Sets</td>
<td>4</td>
<td>R</td>
</tr>
<tr>
<td>5.1.4 Chilled water piping insulation for modifications in main plantroom</td>
<td>Item</td>
<td>1</td>
<td>R</td>
</tr>
<tr>
<td>5.2 PIPING CLADDING</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.2.1 Chilled water piping cladding for primary pumps</td>
<td>Sets</td>
<td>4</td>
<td>R</td>
</tr>
<tr>
<td>5.2.2 Chilled water piping cladding for secondary pumps</td>
<td>Sets</td>
<td>4</td>
<td>R</td>
</tr>
<tr>
<td>5.2.3 Chilled water piping cladding for chillers</td>
<td>Sets</td>
<td>4</td>
<td>R</td>
</tr>
<tr>
<td>5.2.4 Chilled water piping cladding for modifications in main plantroom</td>
<td>Item</td>
<td>1</td>
<td>R</td>
</tr>
</tbody>
</table>

**TOTAL CARRIED FORWARD TO SUMMARY PAGE**

R
### 6. ELECTRICS AND CONTROLS

<table>
<thead>
<tr>
<th>UNIT</th>
<th>QUANTITY</th>
<th>RATE</th>
<th>AMOUNT</th>
</tr>
</thead>
</table>

#### 6.1 ELECTRICS

- **6.1.1** Main AC distribution board modifications
  - Item: 1
  - Rate: R
- **6.1.2** Power supply to primary pumps
  - No: 4
  - Rate: R
- **6.1.3** Power supply to secondary pumps
  - No: 4
  - Rate: R
- **6.1.4** Variable speed drives to secondary pumps
  - No: 2
  - Rate: R
- **6.1.5** Power supply to condenser pumps
  - No: 4
  - Rate: R
- **6.1.6** Power supply to chillers
  - No: 4
  - Rate: R
- **6.1.7** Modifications to Cooling Tower Kiosk Board
  - Item: 1
  - Rate: R

#### 6.2 BMS/CONTROLS

- **6.2.1** BMS installation and chiller plant manager
  - Item: 1
  - Rate: R
- **6.2.2** Controls cabling
  - Item: 1
  - Rate: R
- **6.2.3** Field equipment for controls
  - Item: 1
  - Rate: R
- **6.2.4** PC amount for BMS interface with new PLC Controls
  - Item: 1
  - Rate: R 375 000
  - Amount: R 375 000

**TOTAL CARRIED FORWARD TO SUMMARY PAGE**

<table>
<thead>
<tr>
<th>UNIT</th>
<th>QUANTITY</th>
<th>RATE</th>
<th>AMOUNT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

|      |          |      |        |

---

Contract
Part C2: Pricing Data
Reference No: NRF/iThemba LABS/2015 – 16:07
### 7. GENERAL/MISCELLANEOUS

<table>
<thead>
<tr>
<th>UNIT</th>
<th>QUANTITY</th>
<th>RATE</th>
<th>AMOUNT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PREAMBLE**

Please note that the current Water Treatment Service Provider is PWM. No other Service Provider will be accepted on this site.

### 7.1 WATER TREATMENT

<table>
<thead>
<tr>
<th>UNIT</th>
<th>QUANTITY</th>
<th>RATE</th>
<th>AMOUNT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7.1.1 Drain and refill system - Exclude

7.1.2 Water treatment - open system - Exclude

7.1.3 Water treatment - closed system - Exclude

### 7.2 OTHER

<table>
<thead>
<tr>
<th>UNIT</th>
<th>QUANTITY</th>
<th>RATE</th>
<th>AMOUNT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7.2.1 Testing and commissioning

7.2.2 O+M Manuals and as built drawing (5 sets + CD)

7.2.3 Contingency amount for construction changes

TOTAL CARRIED FORWARD TO SUMMARY PAGE

<table>
<thead>
<tr>
<th>UNIT</th>
<th>QUANTITY</th>
<th>RATE</th>
<th>AMOUNT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
NRF - ITHEMBA LABS

BID NO: NRF/iThemba LABS/2015 – 16:07

REPLACEMENT OF EXISTING CHILLERS IN PLANT ROOM AT ITHEMBA LABS, FAURE

<table>
<thead>
<tr>
<th>BILL NUMBER</th>
<th>DESCRIPTION</th>
<th>AMOUNT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Preliminary &amp; General</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Demolition</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Equipment</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Piping</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Piping Insulation/Piping cladding</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Electrics and Controls</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>General/Miscellaneous</td>
<td></td>
</tr>
</tbody>
</table>

TOTAL OF PRICED ITEMS (EXCL. VAT)

SUB-TOTAL

PLUS 14% VAT

TOTAL CARRIED FORWARD TO TENDER FORM

TOTAL TENDER PRICE (IN WORDS):

COMPANY STAMP:

SIGNATURE OF TENDERER: ___________________ DATE: ___________________
C2.3 CONTRACT RATES

Any variations to the contract will be priced in accordance with the rates tabulated below. Rates are to include VAT.

Mark-up
Materials ........................................... %
Sub-Contractors ...................................... %
Other ...................................................... %

Labour
Commissioning Engineer R......................./hour
Site Supervisor R......................./hour
Site Team R......................./hour
Workshop Team R......................./hour
Labourer R......................./hour
Overtime rate for:
  Mon to Friday R......................./hour
  Saturday R......................./hour
  Sunday R......................./hour

Transport
Light Motor Vehicle R......................./km
Light Delivery Vehicle R......................./km
C2.4 SPECIAL ITEMS

Any item/s not covered by the above bill of quantities or rates, shall, if necessary, be entered here:

........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................

SIGNATURE OF TENDERER: ___________________________ DATE: ___________________________
C2.5 SCHEDULE OF EQUIPMENT OFFERED – REFER TO CLAUSE 22 IN THE TECHNICAL SPECIFICATION

The successful tenderer must submit complete technical information and performance specifications of all the items as listed below with the tender submission:

- Chillers
- Condenser water pumps
- Chilled water pumps
- Controls for chiller, cooling tower and pump controls.
- Valves
- BMS/PLC

The schedules will be scrutinised by the Representative/Agent and should any material offered not comply with the requirements contained in the specification, the Contractor will be required to supply material in accordance with the contract at no additional cost.

Failure to submit technical information and performance specifications will result in rejection of tender.

NB: Only one manufacturer’s name to be inserted for each item.

**NOTE:**

Tenderers are to note that under no circumstances may materials be installed other than that offered in the above material schedule, which has been approved and accepted by the Representative/Agent of the client.

Should the successful tenderer wish to supply materials other than that originally offered, prior written approval must be obtained from the Mechanical Engineer before any orders are placed.

SIGNATURE OF TENDERER: ____________________  DATE: ____________________
C2.6 SCHEDULE OF IMPORTED MATERIALS AND EQUIPMENT

The Contractor shall list imported items, materials and/or equipment which shall be excluded from the Contact Price Adjustment Provisions and shall be adjusted in terms of currency fluctuations only. Copies of the supplier’s quotations for the items, materials or equipment (not higher than the Contract rate as listed below) should be lodged with the Representative/Agent of the client within 60 (sixty) days from the date of acceptance of the tenders. No adjustment of the contractor’s profit, local VAT amount, discount, mark-up, handling costs, etc. shall be allowed.

<table>
<thead>
<tr>
<th>ITEMS</th>
<th>MATERIAL / EQUIPMENT</th>
<th>RAND (R) EXCLUDING VAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

FORMULA:

The net amount to be added to or deducted from the contract sum:

\[ A = V \times \left( \frac{Z}{Y} \right) \]

A = the amount (R) of adjustment

V = the net amount (R) (Supplier’s Quotation) of the imported item (Material or Equipment)

Y = exchange rate at the closing date of tender submission

Z = exchange rate on the date of payment

SIGNATURE OF TENDERER: ____________________  DATE: ________________
Part C3: Scope of Work

<table>
<thead>
<tr>
<th>Section</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>C3.1 Description of the Works</td>
<td>83 - 85</td>
</tr>
<tr>
<td>C3.2 Engineering</td>
<td>86</td>
</tr>
<tr>
<td>C3.3 Procurement</td>
<td>87</td>
</tr>
<tr>
<td>C3.4 Technical Specifications</td>
<td>88 - 116</td>
</tr>
<tr>
<td>C3.5 Annexes</td>
<td>117-198</td>
</tr>
</tbody>
</table>

**Status**

Should any requirement or provision in the parts of the Scope of Work conflict with any requirement of any Standardised Specification, particular specification or any drawings, the order of precedence, unless otherwise specified, is:

- Drawings
- Scope of Work (Parts C3.1, C3.3 and C3.4)
- SANS Standardised Specifications
C3.1 Description of the Works

1 SCOPE OF WORKS........................................................................................................... 84
2 INSTALLATION OF CHILLED WATER SYSTEM............................................................... 84
   2.1 Removal of Chillers and Water Pumps........................................................................ 84
   2.2 Installation of four new Chillers and Associated Water Pumps................................. 84
   2.3 Installation of chiller control panel - Chiller Plant Manager/BMS Installation........... 84
   2.4 Coordination and builders work.............................................................................. 85
3 SUBMISSIONS............................................................................................................... 85
1. SCOPE OF WORKS - GENERAL

The scope of works entails the replacement of the existing main chilled water generators 1-4, associated pumps, electrics and controls for Ithemba Labs. Chiller No 5, associated pumps, electrics and controls will remain:

- Replace chillers 1-4
- Replace condenser water pumps (CWP) 1-4 to suit new chillers
- Replace primary chilled water pumps (ChWP) 1-4 to suit new chillers
- Replace secondary chilled water pumps (PWP) 1-4
- Retain intermediate water pumps (IWP) including control methodology
- Retain cooling towers (FCT) 1-4 and incorporate in new design
- Retain fluid coolers (VXI) 1-3
- Replace existing modicon PLC with new chiller plant manager in the plantroom.
- Replace all existing instrumentation

The scope of work must be read in conjunction with the Technical and Standard specification documents and drawings. The scope of work herein provides an overview of the chiller installation to be executed in this project.

The scope of work also includes all manufacturing, conveying and delivering, unloading, storing, unpacking, hoisting, scaffolding, setting out, fitting and fixing in position, cutting, waste, patterns, plant, temporary works, commissioning, return of packing, establishment charges, protection and removal thereof on completion, cleaning down complete, profit and other obligations arising out of the conditions of contract.

2. INSTALLATION OF CHILLED WATER SYSTEMS

2.1 Removal of Chillers and Water Pumps

Four existing chillers, four condensor water pumps, four primary chilled water pumps, and four secondary chilled water pumps shall be removed from the chiller plant room and scrapped.

The scrap value of all the equipment must be disclosed in the tender Bill of Quantities as a credit.

NOTE: Existing chillers 1-2 operates on R134a refrigerant and chillers 3-4 operates on R12 refrigerant. The refrigerant must be removed/recovered and safely disposed of legally.

2.2 Installation of four new Chillers and Associated Water Pumps

Four new chillers, four new condensor water pumps, four new primary chilled water pumps and four new secondary pumps are to be installed in the plant room. The new chillers shall be connected to the existing chilled and condenser water piping. The installation shall be as indicated in the drawings.

2.3 Installation of chiller control panel – Chiller Plant Manager/BMS Installation

The works shall include 2 x control panels complete with chiller controls as per technical specification for operation of chilled water system at maximum efficiency.

The controls shall include for the following:
- Chiller controls and sequencing
- Cooling tower controls and sequencing
- Condenser water pumps controls and sequencing.
- Chilled water pumps controls and sequencing.
- Closed circuit cooler controls and sequencing.
- Intermediate water circuit pw controls and sequencing

Please note the BMS installation/Chiller Plant Manager must be able to be expanded into a full BMS installation to cater for the future incorporation of all the AHU’s and Intermediate circuit equipment.

Also note the current cooling tower controls fitted in the electrical kiosk next to the existing closed circuit coolers are of the Siemens type and must be incorporated into the new BMS installation/Chiller Plant Manager.
2.4 **Coordination and builders work**

The chiller installation is detailed in the attached drawings and the onus is on the Contractor to coordinate these drawings with the existing building layouts.

Minor builder’s work that is associated to the installation of the chiller equipment and the contractor shall be responsible for coordination thereof to ensure that all necessary openings, brackets, supports, waterproofing and plant rooms are provided timeously. All builders work requirements shall be by the Contractor.

3. **SUBMISSIONS**

Please note that the following documents must be submitted to the Engineer for approval prior to procurement of equipment and commencement of installations:

- Equipment schedule indicating the electrical power consumption, capacity/size, noise level, make/manufacturer and weight of the equipment.
- Workshop drawings indicating locations and sizes of the equipment.
- Any other equipment required for installation.
C3.2 Engineering

Drawings

The following drawings are applicable to the contract and are issued with this tender document and will form part of the Contract Documents as Volume 3.

Drawings not bound in Document:

<table>
<thead>
<tr>
<th>DRAWING NO.</th>
<th>SHORT DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>32075.00-740-01</td>
<td>SITE PLAN</td>
</tr>
<tr>
<td>32075.00-740-02</td>
<td>CHILLER PLANTROOM LAYOUT AND SECTION A-A</td>
</tr>
<tr>
<td>32075.00-740-03</td>
<td>SECTION B-B AND C-C</td>
</tr>
<tr>
<td>32075.00-740-04</td>
<td>CHILLER PLANTROOM LAYOUT AND SECTION A-A DEMOLITION</td>
</tr>
<tr>
<td>32075.00-740-05</td>
<td>SECTION B-B AND C-C</td>
</tr>
<tr>
<td>32075.00-740-06</td>
<td>SCHEMATIC LAYOUT</td>
</tr>
</tbody>
</table>

NOTES:

1. The drawings listed on the drawing index and included in the book of reduced drawings, comprise the tender drawings for:

   REPLACEMENT OF EXISTING CHILLERS IN PLANT ROOM AT ITHEMBA LABS, FAURE

2. The reduced drawings that form part of the tender documents shall be used for tender purposes only. However they will be included in the contract and form the basis for evaluating any significant changes.

3. The Contractor will be supplied with 3 unreduced paper prints of each of the drawings required for construction. These copies are issued free of charge and the Contractor shall make any additional copies he may require at his own cost.

4. Only figured dimensions shall be used and drawings shall not be scaled unless otherwise instructed.

5. The Contractor shall ensure that accurate as-built records are kept of all infrastructure installed or relocated during the contract. The position of pipe bends, junction boxes, duct ends and all other underground infrastructure shall be given by either co-ordinates, or stake value and offset. Where necessary, levels shall also be given. A marked-up set of drawings shall also be kept and updated by the Contractor. This information shall be supplied to the Engineer’s Representative on a regular basis.

6. Any information in the possession of the Contractor, which the Engineer requires to complete his record drawings shall be supplied to the Engineer’s Representative before a certificate of completion will be issued.

7. No CAD drawings will be e-mailed or supplied for tendering purposes. CAD drawings will be issued to the successful contractor after appointment.
C3.3 Procurement

<table>
<thead>
<tr>
<th>CONTENTS</th>
<th>PAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOT USED</td>
<td></td>
</tr>
</tbody>
</table>
C3.4 Technical Specifications

1 BASIS OF DESIGN........................................................................................................................................ 91
  1.1 Ambient conditions ................................................................................................................................. 91
  1.2 Air-conditioned indoor temperatures ...................................................................................................... 91
  1.3 Noise generation .................................................................................................................................... 91
  1.4 Chilled Water ......................................................................................................................................... 91

2 CHILLED WATER SYSTEM .................................................................................................................................. 91
  2.1 General .................................................................................................................................................... 91
  2.2 Pipe supports .......................................................................................................................................... 91
  2.3 Pressure testing ...................................................................................................................................... 92
  2.4 Piping insulation .................................................................................................................................... 92
  2.5 Chilled water pumps .............................................................................................................................. 92
  2.6 Valves .................................................................................................................................................... 92
  2.7 Isolating Valves ..................................................................................................................................... 92
  2.8 Regulating / Isolating Valves ................................................................................................................ 92

3 CHILLER INSTALLATION..................................................................................................................................... 92
  3.1 General .................................................................................................................................................... 92
  3.2 Combined performance summary .......................................................................................................... 93
  3.3 Quality assurance .................................................................................................................................... 93
  3.4 Compressor and Motor ........................................................................................................................... 93
  3.5 Evaporator .............................................................................................................................................. 93
  3.6 Condenser .............................................................................................................................................. 94
  3.7 Unit Controls .......................................................................................................................................... 94
  3.8 Human interface by Touchable Display ................................................................................................... 94
  3.9 Unit-Mounted Star-Delta Starter .............................................................................................................. 95
  3.10 Adaptive Frequency Drive .................................................................................................................... 95
  3.11 Harmonic Filter ..................................................................................................................................... 95
  3.12 Disconnect switch .................................................................................................................................. 95
  3.13 Holding charge ...................................................................................................................................... 95
  3.14 Insulation .............................................................................................................................................. 96
  3.15 Programmable Relays (Alarm and Status) ............................................................................................ 96
  3.16 External Base Loading .......................................................................................................................... 96
  3.17 Lon Talk Communication Interface ..................................................................................................... 96
  3.18 Modbus Communication Interface ....................................................................................................... 96
  3.19 External Chilled Water Setpoint ........................................................................................................... 96
  3.20 External Current Limit Setpoint ............................................................................................................ 96
3.21 Percent Condenser Pressure Output ................................................................. 96
3.22 Compressor Percent RLA Output ................................................................. 96

4 WATER COOLED CHILLER(S) SYSTEM CONTROL .................................................. 96
  4.1 General ............................................................................................................... 96
  4.2 Operator interface .......................................................................................... 97
  4.3 System Start/Stop .............................................................................................. 98
  4.4 Sequencing ....................................................................................................... 98
  4.5 System Soft Start .............................................................................................. 99
  4.6 Automatic rotation of chillers and pumps ......................................................... 99
  4.7 Diagnostics/Protection .................................................................................... 99
  4.8 Chiller Status Report ...................................................................................... 99

5 CONDENSER WATER SUPPLY .............................................................................. 100
  5.1 General ............................................................................................................ 100
  5.2 Cooling Towers ............................................................................................... 100
  5.3 Condenser water pumps .................................................................................. 100

6 COOLING TOWER SEQUENCING AND CONTROL .............................................. 100
  6.1 Cooling Tower Fan Control and BMS Installation ........................................... 100
  6.2 Chiller control panel and BMS Installation ....................................................... 100
  6.3 Points Schedule ............................................................................................... 101
  6.4 Requirements of New Chiller Plant PLC ......................................................... 101
  6.5 Existing Kiosk Siemens PLC ......................................................................... 102

7 CHILLED WATER AND CONDENSER WATER PUMPS ...................................... 102

8 CONDENSER AND CHILLED WATER PIPING ..................................................... 103

9 CHILLED WATER PIPE INSULATION .................................................................. 103

10 FIXING OF EQUIPMENT ..................................................................................... 103

11 VIBRATION ISOLATION ..................................................................................... 103

12 CORROSION PRECAUTIONS AND FINishes .................................................... 103

13 ASSOCIATED ELECTRICAL WORK .................................................................. 104
  13.1 General ........................................................................................................... 104

14 GENERAL ............................................................................................................. 104

15 STANDARDS AND REGULATIONS .................................................................. 105

16 COMMISSIONING .................................................................................................. 105
  16.1 Initial visual check .......................................................................................... 105
  16.2 Pre-switch on checks ..................................................................................... 106
  16.3 Post first switch on checks ............................................................................ 106
  16.4 Insulation ........................................................................................................ 106
  16.5 Electrics .......................................................................................................... 106
  16.6 General .......................................................................................................... 106

Contract  89  C3.4
Part C3: Scope of Work
Reference No: NRF/iThemba LABS/2015 – 16:07
Technical Specifications
Part C3: Scope of Work

Reference No: NRF/iThemba LABS/2015 – 16:07

17 AS-BUILT DRAWINGS .......................................................... 106

18 EQUIPMENT AND CAPACITIES REQUIRED ........................................... 107
18.1 Chilled Water Generators .......................................................... 107
18.2 Chilled Water Generators .......................................................... 108
18.3 Condenser Water Circulating Water Pumps ........................................ 109
18.4 PRIMARY CHILLED WATER CIRCULATING WATER PUMPS .................. 109
18.5 Secondary Chilled Water Circulating Water Pumps ................................. 110

19 MAINTENANCE ........................................................................ 110

20 OPERATING AND MAINTENANCE MANUALS .................................... 110
20.1 Introduction: ............................................................................. 110
20.2 Detailed description: ............................................................... 111
20.3 Schedules of data: ................................................................ 111
20.4 Schedules: ............................................................................. 111
20.5 Equipment details: ................................................................. 111
20.6 List of suppliers: .................................................................... 111
20.7 As-built drawings: ................................................................. 111

21 INSTRUCTION/TRAINING ........................................................ 111

22 SCHEDULES TO BE COMPLETED BY ALL TENDERERS ....................... 112
TECHNICAL SPECIFICATIONS

1 BASIS OF DESIGN

The criteria used for the design are as detailed hereunder. The completed work shall, where applicable, conform in all respects to these criteria and its operation shall be measured against these criteria during the practical and final completion inspections.

1.1 Ambient conditions

Altitude: 0 m
Summer: 32 °C dry bulb, 24 °C wet bulb
Winter: 2 °C dry bulb

1.2 Air-conditioned indoor temperatures

Typical requirement:
Summer: 22.5 °C DB; 50% RH-not controlled
Winter: 23 °C

1.3 Noise generation

Air-conditioned spaces: NC 35
Ventilated areas: NC 40

Sound levels inside the building shall be measured 1m from the noise source, whether that may be an item of equipment or any fluid (e.g. water, air, etc.) transfer piping, ducts, grilles, louvers, etc.

1.4 Chilled Water

Operating Conditions:
Evaporator In/Out water temperature: 14.5 °C/6°C
Condenser In/Out water temperature: 26.5 °C/32°C

2 CHILLED WATER SYSTEM

2.1 General

Existing air handling units and accelerator circuits are served by chilled water supply from chillers installed in the chiller plant room area.

The design and specification of the chiller and control systems on this document and drawings are based on a certain make and tenderers are required to follow the technical specification in order to price the correct equipment.

Note: 12 Pumps shall be installed, i.e. 4 for primary chilled water, 4 for secondary chilled water and 4 for condensor water.

All new chiller units and pumps shall be connected to the existing chilled water reticulation piping as indicated on the drawings. Chilled water supply connections including valves, strainers, flexibles, instrumentation, etc., to and from the chiller shall be new and as indicated on the drawings.

2.2 Pipe supports

All chilled water piping shall be adequately supported from galvanized channel supports as indicated on drawings.

All cable trays shall be supported from roof slab below with threaded rods. Support intervals shall not be greater than 1.5 m. All threaded rods shall be trimmed to not extend 20mm past installation nut.

All cable trays and metal pipe supports shall be thermally insulated by means of thermal breaks from the refrigerant piping to prevent heat loss or gain and to prevent condensation of moisture on the pipe supports.
2.3 Pressure testing

The chilled water circuits shall be tested to a pressure of at least 1.5x times working pressure for a duration of 4 hours. No static pressure loss shall be acceptable during the test period. All pressure tests shall be witnessed and certified by the Engineer.

2.4 Piping insulation

Insulated pipe work penetrating through masonry or concrete elements shall have its insulation extended right through the penetration to ensure the vapour proof integrity of the insulation. All penetrations shall be sealed and caulked to approval by the Contractor.

2.5 Chilled water pumps

Four secondary chilled water pumps shall be installed and be controlled for equal running time. Two of the four secondary chilled water pumps shall be supplied complete with variable speed drives for maximum operational efficiency.

Four differential pressure switches will be fitted. One in the Main Plantroom and three in remote AHU plantrooms. The pumps will sequence and operate to maintain a set pressure. The set pressure will be determined at commissioning stage. The controls shall be incorporated into the chiller control setup. Refer to site plan 32075.00 – 740-01 Rev 0 for approximate locations.

2.6 Valves

Valves shall be installed as indicated on the drawings and as may be required for the proper operation of the system. Each valve must be suitable for the working pressure of the system.

2.7 Isolating Valves

Isolating valves up to and including 50mm diameter shall be ball type of stainless steel body, stainless steel ball and Teflon seat. Valves are to have screwed ends. Above 50mm diameter wafer butterfly valves, of an approved type, may be used. Valve handles shall be epoxy coated.

2.8 Regulating / Isolating Valves

Regulating / isolating / measuring valves shall be 3-way fully modulating with proportional control.

3 CHILLER INSTALLATION

Four new chillers shall be installed in the chiller plant room on ground floor level. The four new chillers will replace four existing chillers. The installation shall include the removal of the existing chillers.

The chillers shall be a combination of four units of ±1200kW each, of which two will offer high efficiency and two high seasonal efficiency. The combination shall result in an increased overall efficiency of the system.

All associated commissioning and connection of the chiller shall be included in the tender price and installation.

3.1 General

Chilled water production will be made by a factory-assembled and tested, water-cooled liquid chiller which will be shipped with a full operating charge of R134A refrigerant and lubrication oil, screw compressor and electronic expansion valve.

Unit panels, frames and exposed steel surfaces shall be painted with an air-dry RAL 9002 prior to shipment. Moulded neoprene isolation pads shall be supplied for placement under all support points. Start-up and operator instructions by factory-trained service personnel are to be included.
3.2 Combined performance summary

The performance summary below is of the combination of two high efficiency and two high seasonal efficiency chillers.

Performance summary of 2 high efficiency chillers:
- Cooling capacity at full load: 2358 kW (both chillers)
- Unit power input at full load: 358 kW (both chillers)
- Operating conditions: Evaporator entering/leaving temperature: 14.5/6 °C.
- Condenser entering/leaving temperature: 26.5/32 °C.
- Energy efficiency at full load EER: 6.59 kW/kW
- Sound power: 81 dB (A)

Performance summary of 2 high seasonal efficiency chiller:
- Cooling capacity at full load: 2500 kW
- Unit power input at full load: 373.2 kW
- Operating conditions: Evaporator entering/leaving temperature: 14.5/6 °C.
- Condenser entering/leaving temperature: 26.5/32 °C.
- Energy efficiency at full load EER: 6.70 kW/kW
- Sound power: 83 dB (A)

3.3 Quality assurance

Chiller will be designed and manufactured under a quality assurance system and environmental management system certified in accordance with ISO 9001 and 14001 standards.

Chiller will be tested according to standard EN14511, hence certified Eurovent. All chillers will follow a production quality plan to ensure proper operation before being shipped to job site.

Unit construction will be in accordance with the following European directives:
- Pressure Equipment Directive (PED) 97/23/CE
- Machinery Directive (MD) 2006/42/CE
- Low Voltage Directive (LV) 2006/95/CE
- Electromagnetic Compatibility Directive (EMC) 2004/108/CE
- Electrical Machinery Safety Standard EN 60204-1
- Electromagnetic Emission and Immunity Standard EN 61800-3 category C3

3.4 Compressor and Motor

The unit shall have a semi-hermetic direct-drive rotary compressor driven by an Adaptive Frequency Drive to optimize performances at partial load on the version high seasonal efficiency. Unit shall also be equipped with a capacity control slide valve, oil sump heater and differential pressure refrigerant oil flow system.

Motor shall be a suction gas cooled, hermetically sealed, two poles, squirrel cage induction type, with four pressure lubricated rolling elements. Bearing groups shall support the rotating assembly. Motor bearings will be designed for the whole life of the chiller. Lubricant circuit shall be equipped with oil sump heater, differential pressure refrigerant oil flow system and filter with particles retention capacity of at least 5µm.

3.5 Evaporator

Chiller will fit a shell and tube evaporator which is manufactured, tested and stamped in accordance with PED 97/23/CE. Tubes will be cleanable with dismountable water boxes. Tubes will be copper, externally finned, internally enhanced seamless with lands at all tube sheet. Tube diameter of 25.4 mm, mechanically expanded into tube sheets and fastened to tube supports. Each tube shall be individually replaceable.

Evaporator will be designed for a water side working pressure of 10.5 bar (200 psi). Water boxes will be made of cast iron with Victaulic type connections.

Evaporator shell will be insulated with Armaflex II or equivalent of 19 mm (3/4 inches) thickness and K factor of 0.26. Evaporator will be supplied with drains and vents.
3.6 Condenser

Unit will fit a unique condenser, tube and shell type, manufactured, tested, and stamped in accordance with PED 97/23/CE. Tubes will be cleanable and individually replaceable with dismountable water boxes. Condenser tubes will be made of copper, externally finned of 19.05 mm in diameter, mechanically expanded into tube sheets and fastened to tube supports. Water boxes will be made of cast iron with drains and vents. Water connections will be made with Victaulic type connections.

3.7 Unit Controls

The microprocessor-based control panel shall be factory-installed and factory-tested. The control system shall be powered by a control power transformer, and will load and unload the chiller through adjustment of the compressor slide valve. An Adaptive Frequency Drive on the high seasonal efficiency model. Refer to controls section for details of chiller controls.

Microprocessor-based chilled water reset based on return water must be standard. The utilizing adaptive control microprocessor shall automatically take action to prevent unit shut down due to abnormal operating conditions associated with low evaporator refrigerant temperature, high condensing temperature and motor current overload.

If the abnormal operating condition continues and protective limit is reached, the machine must be able to shut down. Controller shall include machine protection shutdown requiring manual reset for:
- Low evaporator refrigerant temperature and pressure
- High condenser refrigerant pressure
- Low oil flow
- Critical sensor or detection circuit fault
- Motor current overload
- High compressor discharge temperature
- Communications lost between modules
- Electrical distribution faults: phase loss, phase imbalance, phase reversal
- External and local emergency stop
- Starter transition failure.

The panel shall include machine protection shutdown with automatic reset when the condition is corrected for:
- Momentary power loss
- Over / under voltage
- Loss of evaporator or condenser water flow.

Over 100 diagnostic checks shall be made and displayed when a fault is detected. The display shall indicate the fault, the type of reset required, the time and date the diagnostic occurred, the mode in which the machine was operating at the time of the diagnostic, and a help message. A diagnostic history shall display the last 20 diagnostics with the time and date of their occurrence. Alarms and diagnostic will be displayed in chronological order, with a colour/symbol code: red octagon for immediate shutdown, yellow triangle for normal shutdown and blue circle for warning.

3.8 Human interface by Touchable Display

Factory-mounted to the control panel door, the operator interface will have a touchable screen display for operator input and information output.

This interface will provide access from the main screen to:
- Chiller Status area, with a minimum of: chiller status button (running), alarm indicator button, manual override button, evaporator leaving water temperature target, setpoint source target, auto/stop buttons.
- Main display area / Home screen with minimum providing access to: Compressor running status and differential oil pressure, condenser entering/leaving temperature and flow status, evaporator entering/leaving temperature, current setpoint, and flow status. Motor average % in line current, customized reports and chiller tag.
- Main Menu area with minimum quick access to submenus of: Alarms, Reports, Graphics, Settings, Screen language setting up.

Evaporator report, condenser report, compressor report, operator settings, service settings, service tests, and diagnostics. All diagnostics and messages are to be displayed in “clear language.”
Data contained in available reports must include:

- Water and air temperatures
- Refrigerant levels and temperatures
- Oil pressure
- Flow switch status
- EXV position
- Head pressure control command
- Compressor starts and run-time
- Line phase percent RLA, amps, and volts

All necessary settings and setpoints shall be programmed into the microprocessor-based controller via the operator interface. The controller shall be capable of receiving signals contemporaneously from a variety of control sources, in any combination, and priority order of control sources can be programmed.

The control source with priority must be able to determine active setpoints via the signal it sends to the control panel.

Control sources:

- The local operator interface (standard)
- A 4-20 mA or 2-10 VDC signal from an external source (interface optional; control source not supplied)
- Trane Tracer EVO system via BACNET.
- Generic BAS (optional points; control source not supplied)
- LonTalk LCI-C (interface optional; control source not supplied)
- Modbus PIC (interface optional; control source not supplied)

3.9 Unit-Mounted Star-Delta Starter

The starter must be available in a Star-Delta configuration closed transition, factory-mounted and fully pre-wired to the compressor motor and control panel. Starter shall reduce 33% the RLA inrush current. A factory-installed, factory-wired 600VA control power transformer must provide all unit control power (120 VAC secondary) and module power (24 VAC secondary). Optional starter features to include circuit breaker, fused disconnect switch, non-fused disconnect switch. All the starter elements will be enclosed in an IP54 panel, with hinged door to allow customer power input connection.

3.10 Adaptive Frequency Drive

High seasonal efficiency chiller will fit an Adaptive Frequency Drive, factory mounted, tested and wired.

AFD enclosure must be IP54 as standard, with integrated air cooling system, consisting in a fan below the AFD frame, without no obstacle to the air circulation

3.11 Harmonic Filter

AFD to be equipped with a Harmonic Filter, sized by the manufacturer in accordance with the compressor size, with a minimum capability of 5% THD (Total Harmonic Distortion). Filter frame must have a minimum protection rate of IP23, and can be built-in on the AFD frame.

Filter must be in compliance with EMC standards EN 55011-1A.

The purpose of the harmonic filter will be to avoid incremental heat losses in the installation (transformers, cables), keeping harmonic currents at low level so as to avoid transformer overload and high cable temperature.

3.12 Disconnect switch

Optional starter features to include circuit breaker, fused disconnect switch, non-fused disconnect switch. The disconnect switch must also mechanically interlock to disconnect line power from the starter before the starter door is open.

3.13 Holding charge

Unit must be shipped with a holding R134a charge and full oil charge.
3.14 Insulation

All low temperature surfaces are to be covered with 19 mm of armaflex (K=0.26), including the evaporator and water boxes, suction line and motor housing.

3.15 Programmable Relays (Alarm and Status)

Controller shall provide a flexible alarm or chiller status indication to a remote location through a hard wired interface to a dry contact closure. Four relays are available for this function, and they are provided (generally with a Quad Relay Output LLID) as part of the Alarm Relay Output Option. The events/states that can be assigned to the programmable relays are to be listed in the chiller installation manual.

3.16 External Base Loading

Primarily for process control requirements, base loading must provide for immediate start and loading of a chiller up to an externally or remotely adjustable current limit setpoint without regard to differential to start or stop, or to leaving water temperature control. This shall allow the flexibility to prestart or preload a chiller in anticipation of a large load application. It must also keep a chiller on line between processes when leaving water temperature control would normally cycle the unit.

3.17 Lon Talk Communication Interface

Controller must provide an optional LonTalk Communication Interface (LCI-C) between the chiller and a Building Automation System (BAS). An LCI-C LLID shall be used to provide "gateway" functionality between the LonTalk protocol and the chiller.

3.18 Modbus Communication Interface

Controller must provide an optional Modbus Communication Interface (PIC) between the chiller and a Building Automation System (BAS). PIC board shall be used to provide "gateway" functionality between the Modbus protocol and the chiller.

3.19 External Chilled Water Setpoint

Controller shall accept either a 2-10 VDC or a 4-20mA input signal, to adjust the chilled water setpoint from a remote location.

3.20 External Current Limit Setpoint

Controller shall accept either a 2-10VDC or a 4-20mA input signal to adjust the current limit setpoint from a remote location.

3.21 Percent Condenser Pressure Output

Controller must provide a 2-10 VDC analog output to indicate percent High Pressure Cutout (HPC) condenser pressure. Percent HPC = (Condenser Pressure/High Pressure Cut-out Setpoint)*100.

3.22 Compressor Percent RLA Output

Controller must provide a 2-10 Vdc analog output to indicate %RLA of compressor starter average phase current. 2 to 10 Vdc corresponds to 0 to 120%RLA.

4 WATER COOLED CHILLER(S) SYSTEM CONTROL

4.1 General

The chiller plant control system shall monitor and control the chilled water system including the chiller(s), pump(s), cooling tower(s), and variable speed drive(s) as appropriate.

The chiller plant control system shall have a fully editable user interface set-up via point and click on a standard windows screen. It shall not require special software tools or a building automation system technician to operate.
The chiller plant control system shall include the following features:

1. Operator interface
2. System Start/Stop
3. System soft start
4. Chiller and pump sequencing
5. Automatic rotation of chillers and pumps
6. Failure recovery diagnostics/protection
7. Energy optimization routines
8. System and chiller status reports
9. Demand limiting
10. Cooling tower sequencing and control

4.2 Operator interface

The chiller plant control system shall include the following operator interface elements:

a. Operational status screen to include:
   - Chiller System Status (Off/Soft Start/Normal/Ambient Lockout/Shutdown in Progress)
   - Chiller Plant Supply Water Setpoint
   - Chilled Water System Supply Water Temperature
   - Chilled Water System Return Water Temperature
   - Predictive of chiller addition / subtraction status messages (i.e. “Next Chiller will be added if the system supply water temp 6°C exceeds 7°C for 10 minutes.” Or “Next Chiller will be subtracted if there is no add request and the actual system Delta T 8.5°C is less than 6.5°C for 10 minutes.”)
   - Individual Chiller Failure Reset (Push Button)
   - All Chiller Failure Reset (Push Button)
   - System Pump Failure Reset (Push Button)
   - Manual Addition of Chiller (Push Button)
   - Manual Subtraction of Chiller (Push Button)
   - Manual Rotation of Chiller Sequence (Push Button)

b. Screen that allows editing of the following data (to be performed without entering program code editor):
   - Supply Water Setpoint
   - System Soft Loading Parameters
   - Ambient Lockout Parameters
   - Chiller Addition Parameters
   - Chiller Subtraction Parameters
   - Auto Rotation Parameters
   - Alarm Handling Setup
   - Security Setup

c. Individual Chiller Graphic(s) to include all data listed on the supplementary Chiller System Point List, including:
   - Chiller Name
   - Chiller Operating Mode
   - Chilled Water Setpoint
   - Chiller RLA %
   - Entering Chiller Water Temperature
   - Leaving Chilled Water Temperature
   - Evaporator Flow Status
   - Condenser Flow Status
4.3 System Start/Stop

The chilled water system shall start in response to a need for chilled water from any system load, with the option to use outside ambient temperature lockout.

Upon the start of the chilled water system the chiller plant control system shall automatically start Trend Log Reports to include:

Hourly logging of system shall include the following points:
- Outside Air Dry Bulb
- Outside Air Wet Bulb
- System Chilled Water Setpoint
- System Chilled Water Supply
- System Chilled Water Return Temperature
- System Condenser Water Supply Temperature
- System Condenser Water Return Temperature
- Operating Status of each chiller
- Operating Status of each pump

4.4 Sequencing

The chiller plant control system will start and stop the chilled water pumps and chillers based upon system load.

1. When the chilled water system is enabled the chiller plant control system shall:
   a. Start the lead system secondary chilled water pump in sequence.
   b. The secondary chilled water pump shall be controlled to maintain the design pressure setpoint for the system.
   c. Upon confirmation of system chilled water flow, an enable signal shall be sent to the lead chiller.
   d. Upon receiving the enable signal the chiller shall enable its primary chilled water pump.
   e. Upon confirmation of evaporator water flow the chiller shall enable the chiller condenser isolation valve and call for the lead condenser pump operation.
   f. Upon confirmation of condenser water flow the chiller shall continue its pre-start sequence and start its compressor(s).
   g. Upon the start of each chiller the Chiller Plant Control system shall automatically start chiller specific Trend Log Reports to include:
      i. Hourly logging of chiller
         - Unit Chilled Water Setpoint
         - Compressor(s) RLA
         - Evaporator Entering Water Temp
         - Evaporator Leaving Water Temp
         - Evaporator Flow Rate (if chiller so equipped)
         - Evaporator Approach Temp
         - Condenser Entering Water Temp
         - Condenser Leaving Water Temp
         - Condenser Approach Temp
      ii. Five-minute logging of chiller:
         - Unit Chilled Water Setpoint
         - Compressor(s) RLA
         - Evaporator Entering Water Temp
         - Evaporator Leaving Water Temp
         - Evaporator Flow Rate (if chiller so equipped)
         - Condenser Entering Water Temp
         - Condenser Leaving Water Temp

2. The chiller plant control system shall initiate the start of the next system secondary chilled water pump when the pressure setpoint is not met for 5 minutes.
   a. The active pumps shall run at the same speed.

3. The chiller plant control system shall initiate the shutdown of the next system secondary chilled water pump whenever excess pump capacity exists as determined by the pump speed, the system pressure, and the number of pumps running.
4. The chiller plant control system shall initiate the start of the next chiller in the sequence whenever insufficient chilled water capacity exists continuously, as indicated by supply water temperature deviation from system chilled water temperature setpoint, for 10 minutes.
   a. The chiller plant control system will unload operating chillers to an operator editable current limit prior to starting a lag chiller.
   b. Lag chillers shall start in a similar manner to the lead chiller start sequence.

Note: System Temperature Based Chiller Subtract is accurate, simple, and reliable for most decoupled system with no more than four chillers.

5. The chiller plant control system shall initiate the shutdown of the next chiller in the sequence whenever excess chilled water capacity exists continuously, as determined by the system supply and chiller return water temperatures, for 20 minutes.
   a. The chiller shall shut down its pump when the chiller determines it is safe to do so.

6. Upon sensing a chiller failure the chiller plant control system shall shut down the failed chiller immediately and initiate the start of the next chiller in the rotation sequence.

7. The chiller plant control system shall control individual chiller setpoints to maintain the system supply water temperature at setpoint.

8. The design system chilled water setpoint shall be 6°C and editable by the operator.

4.5 System Soft Start

The chiller plant control system will initiate a “soft start” mode whenever the system chilled water temperature exceeds the specified chilled water system setpoint by ±11°C at system start-up. The chiller plant control application will add cooling capacity during soft start mode only if return water temperature is not declining at a rate of at least 0.5°C per minute. This prevents the unnecessary operation of chillers and limits system electrical demand during chilled water loop pull down.

4.6 Automatic rotation of chillers and pumps

1. Chiller rotation shall be initiated based on an operator entered day interval or by the cycling of a binary point. The method of sequence shall be operator selectable.
2. Chiller cycling caused by normal system load fluctuations shall cause the chillers to change rotation sequence or at the operator’s option chillers may be forced into the new rotation sequence at the time of sequence change.
3. Pump rotation shall be initiated by a schedule or by the cycling of a binary point.

4.7 Diagnostics/Protection

The Building Automation System shall be able to alarm from all sensed points and diagnostic alarms monitored by the chiller controller.

4.8 Chiller Status Report

Provide an operating status report for each chiller. The report(s) shall provide the present status for the following information to provide the operator with critical chiller operating data.

- Compressor On/Off Status
- Compressor Starts/Run Hours
- Compressor Phase 1/2/3 Percent Rated Load Amps - separate for each compressor
- Compressor Current Draw – Rated Load Amps Percent
- Active Chiller Diagnostics or Alarms
- Leaving Chilled Water Temperature
- Entering Chilled Water Temperature
- Evaporator Flow Rate (if chiller so equipped)
- Condenser Water Entering/Leaving Temperatures
- Chilled Water Setpoint
- Refrigerant Temperature Evaporator/Condenser - Separate for each circuit
- Operating Mode
- Chiller Model and Serial Number
- Outside Air Dry Bulb
- Outside Air Wet Bulb
5 CONDENSER WATER SUPPLY

5.1 General

The chillers will be connected to four existing cooling towers via existing condenser water reticulation piping. Four new condenser water pumps will be installed to replace the 4 existing pumps. The pumps will be controlled from the chillers control panel as described in controls section of the specification.

5.2 Cooling Towers

The four existing BAC cooling towers are in good condition and will be re-used. The controls of the towers will be changed to be run from the chillers control panel, and set up for maximum efficiency. All associated commissioning and connection of the cooling towers will be included.

5.3 Condenser water pumps

Four condenser water pumps shall be installed and be controlled for equal running time.

The controls are described in further detail under the controls section of the specification. The controls shall be incorporated into the chiller control setup.

6 COOLING TOWER SEQUENCING AND CONTROL

The Building Automation System shall monitor the leaving water temperature for each chiller's evaporator and condenser. The Building Automation System shall control the chiller condenser pump VSD and cooling tower bypass valve to maintain no less than the minimum temperature differential specified by the chiller manufacturer.

6.1 Cooling Tower Fan Control and BMS Installation

For cooling towers fans with VSD drives, when a chiller is operating and the cooling tower basin temperature rises to 2 degrees C above the current tower leaving water setpoint, the cooling tower lead tower fan shall be turned on at minimum speed and the control loop shall be enabled.

   a. The cooling tower fan speed shall be modulated to maintain the desired cooling tower leaving water temperature.
   b. When the operating fan(s) are operating at 50 percent speed an additional fan shall be enabled and controlled at the same speed as the operating fans until all active cooling tower cell fans are enabled.
   c. When operating fans are running at minimum speed and the tower supply water temperature is 5 degrees C below the current tower leaving water leaving water setpoint, the most lag tower fan shall be turned off.
   d. Cooling tower fans shall have 5 minute minimum on and off time delays.
   e. Cooling tower fan sequence shall be rotated on a 7 day basis to equalize fan run time.

In addition to the above 4 off condenser water bypass valves will be fitted between the pump suction pipes and the cooling tower return lines to raise the cooling tower water temperature above the minimum chiller entering condenser water setpoint.

The intermediate circuit will remain physically unchanged. However, the control and sequencing of the closed circuit coolers will be incorporated into the new BMS Installation/Chiller Plant Manager via a return water temperature sensor fitted before the existing mixing loop.

6.2 Chiller control panel and BMS Installation

All controls for the automatic control of the chilled water system shall be of the electronic type. The control system shall be an integrated component of the chiller equipment and shall be installed and maintained as part of this contract.

All sensors and controllers etc. shall be types suitable for maintaining conditions within the limits as elsewhere specified. The whole of the installation shall automatically restart on restoration of power after a power failure.

Control panel position shall be as per design drawings.
6.3 Points Schedule

<table>
<thead>
<tr>
<th>Inputs &amp; Outputs</th>
<th>DO</th>
<th>DI</th>
<th>A0</th>
<th>AI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chiller Management</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secondary CHW High Pressure</td>
<td></td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Secondary CHW Low Pressure</td>
<td></td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Sec CHW Supply Temp</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Sec CHW Return Temp</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>CHW Bypass Temp</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Common Pri CHW Supply Temp</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Common Pri CHW Return Temp</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>OA Temp</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>OA RH</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Bypass Chilled Water Flow Positive</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Bypass Chilled Water Flow Negative</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Tower Fan Control</td>
<td></td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Tower Fan Run Status</td>
<td></td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Tower Fan Condition Trip</td>
<td></td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Cooling Tower Valve Control</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Cooling Tower Valve Status</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Sec CHW Pump Control</td>
<td></td>
<td></td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Sec CHW Pump Flow Switch</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Sec CHW Pump Status Run/Trip</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Tower Bypass Damper Control</td>
<td></td>
<td></td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Intermediate Circuit Return water</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Closed Circuit Cooler Fan Control</td>
<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Closed Circuit Cooler Pump Control</td>
<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Closed Circuit Cooler Fan Status</td>
<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Closed Circuit Cooler Pump Status</td>
<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Closed Circuit Cooler Fan Trip</td>
<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Closed Circuit Cooler Pump Trip</td>
<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Condenser Water Pump Control</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Condenser Water Pump Status</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Condenser Water Pump Trip</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Condenser Water Pump Flow Switch</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Primary Chilled Water Pump Control</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Primary Chilled Water Pump Status</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Primary Chilled Water Pump Trip</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Primary Chilled Water Pump Flow Switch</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Dosing System Low Level Alarm</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Dosing System Solenoid Valve</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Air Compressor - Run Status/Pressure Switch</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Flow Meters</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td>25</td>
<td>53</td>
<td>11</td>
<td>21</td>
</tr>
</tbody>
</table>

Plus all data available via the chiller interface to 4 x chillers.

6.4 Requirements of New Chiller Plant PLC:

PLC should be latest Siemens standard or equivalent.

PLC memory must be backed up by button cell that can be replaced if necessary with mains present without affecting the running program.

PLC must be Programmable through interface with PC.

PLC must allow online program changes via a programmer without affecting the running operation of the PLC, i.e. watchdogs are not interrupted.

Programming preference is Ladder Logic.
Program edited through programmer must have features which allow for proper information to be displayed at each rung where the programmer can add a note of the rung’s functionality. Each instruction must contain a unique name “Mnemonic” which can be easily identified.

Program must be easily printable via the programmer and appear in a well layed out format.

In the event of a communications failure on any of its serial inks, the PLC will continue to maintain operations based on the last correct communicated Data it received.

All Motors started by the PLC must return, Running Status is not presently wired in the existing system and therefore an extra wire will be required to each motor cubicle. (In total 1 x DO + 3 x DI) not included in 6.3.

The contractor shall complete programs necessary for the plant PLC as well as BMS system configuration. He shall give representation and explanation of the logic flow used for the control of the plant to the Engineer and technical staff at least a month prior to commencement of the chiller installations e.g. before 1 June 2016.

The Contractor must also at this time be able to present the completed BMS software configured for the plant to the point where GUI’s and operator accessible functions can be viewed.

The Contractor shall also present the Engineer at this time with a bound hard copy of the logic statements used for the PLC (New Chiller Plant PLC as well as Kiosk PLC). These must in the case of the New Chiller Plant PLC show adequate comments explaining each rung function. The logic entities e.g. “Mnemonic” used must also be suitably labelled.

Prior to final commissioning of the Chiller plant the contractor shall provide the Engineer with the Programming software used, connecting cable, latest update of PLC program on CD as well as bound paper copy of Ladder logic written for the Chiller Plant to be supplied to Engineer prior to commissioning.

### 6.5 Existing Kiosk Siemens PLC:

- The Kiosk PLC is to be connected via serial interface to the New Plant PLC.

The control relays at the Kiosk PLC previously hardwired to the Modicon PLC for the control and status information of the cooling towers, these need to be altered as follows: (this might require a larger PLC unit to be fitted) at the kiosk.

1. The Kiosk PLC’s outputs need to drive relays in the Kiosk that start various fans and pumps. (this might mean changing relay voltages to suit PLC).
2. The Kiosk PLC’s inputs need to sense the status of control relay contacts providing status information of the Fans and pumps.
3. The Kiosk PLC Inputs need to be wired to verify “Running” status of all motors fed from the Kiosk building.
4. The Kiosk PLC must communicate all data relating to Temperatures, Fan operation, VSD settings available to the New Chiller PLC which will relay this to the BMS system.
5. In the event of a communications failure to the New Chiller PLC or any other communications link fails the Kiosk PLC will continue to maintain operations based on the last correct communicated Data it received.

### 7 CHILLED WATER AND CONDENSER WATER PUMPS

Chilled water and condenser water pumps shall be of the direct drive centrifugal type incorporating mechanical seals, stainless steel shafts and bronze impellers.

The maximum operating speed is to be 1450 RPM.

Impellers shall be not more than 80% of the maximum diameter for the particular size pump.

Pump assemblies are to be installed on spring anti-vibration mounts.

Tenderers are to base their main offers on the use of **KSB series E.T.A. pumps or equivalent.**

Motors shall be premium efficiency type.

The two large secondary chilled water pumps shall be speed control by YASKAWA or equivalent frequency converters and pump motors used are to be compatible with this type of speed controller.
8 CONDENSER AND CHILLED WATER PIPING

Chilled water reticulation shall be carried out in Schedule 40 black pipe, welded down to 65mm diameter and screwed below this size.

Condenser water reticulation shall be carried out in Schedule 40 medium hot dipped galvanised black pipe welded down to 65 mm diameter.

9 CHILLED WATER PIPE INSULATION

Piping insulation inside Building:

Chilled water piping shall be insulated with polyisocyanurate (PIC) foam insulation (35 kg/m³ density) with vapour barrier.

The insulation thickness and finishes shall be as follows:

15 – 50 mm – 25 mm thick
65 – 450 mm – 50 mm thick

All chilled water piping shall further be covered/cladded with 0.5 mm thick aluminium sheet metal secured with metal strapping, so as not to damage or tear the vapour barrier. No pop rivets are to be used. The quality of the cladding shall be to match the existing.

10 FIXING OF EQUIPMENT

The Contractor shall identify the location of hangers and/or other support points of all equipment with a mass in excess of 25 kg to the Engineer. Approval of the proposed hanging and fixing shall be obtained from the Engineer, prior to carrying out the work.

All lightweight fixing to brick or concrete shall be made with steel screws and "Fischer" or other approved plugs. Holes of the required size for the plugs, which shall suit the screws used, are to be neatly drilled in the concrete or brickwork (not in the joints between bricks) to a depth excluding plaster or soft wall finish equal to at least the length of the plugs. The plug lengths shall be such that all the threaded length of the screws are in the plugs.

All heavy weight fixings to brick or concrete shall be by means of appropriately sized grouted galvanised bolts or by one of the various types of suitable expanding bolt fixings.

After erection of equipment all exposed metalwork of fixings shall be treated with two coats of paint to match the finish of the equipment. Bolts shall in all instances be secured by means of a washer on the bolt head side and a lock washer on the nut side of the items being bolted.

Where the Contractor is in any way uncertain of the method of fixing of any plant or material, the proposed fixing and loading involved shall be cleared with the Engineer prior to carrying out the work on site.

11 VIBRATION ISOLATION

Unless otherwise noted on the equipment schedules hereafter, all mechanical equipment, i.e. chillers, pumps, machinery, piping, ducting, etc., shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure.

12 CORROSION PRECAUTIONS AND FINISHES

All materials such as brackets, hangers, etc., shall be shot blasted, pre painted, galvanised or treated against corrosion prior to their delivery to site. Any work that will require site cutting, etc., i.e. exposure of the bare steel to the atmosphere, shall immediately be treated by cold galvanising, painting, etc.

The method of treatment for the above shall depend on the particular environment and type of surface to be coated. The surface preparation, primer coats, finishing coats, etc. shall therefore be in accordance with those specified by reputable paint manufacturers such as Plascon, Dulux, etc.
All black steel piping, support brackets, hangers, etc., installed inside the building shall be treated with two coats of corrosion inhibitor paint prior to installation. The first coat shall be allowed to dry completely before the next coat is applied.

A further coat of corrosion inhibitor shall be applied after installation and allowed to dry completely. Two coats of enamel paint, to the Architect or Engineers specification, shall finally be applied. The first coat shall be allowed to dry completely before the next coat is applied.

All black steel piping, support brackets, hangers, etc., exposed to the weather shall be hot dipped galvanised.

All duct, supports, equipment and materials exposed to view (i.e. not in shafts, false ceiling, bulkheads, etc.) shall be cleaned, primed and then finished with two coats of enamel paint to the Architect or Engineer’s specification. Each application shall be allowed to dry completely before the next coat is applied. The only exception to these stipulations shall be in the case of subcontracts, where the Contractor shall only apply the primer coats and the Principal Contractor the finishing coats.

Colour coding shall follow the coding currently used on site. If no colour coding is in use, or in the case of new installations, the latest SANS 10173 (clause 6) and SANS 10140 Standards shall be used.

Plant and equipment, pre painted or pre primed at the factory shall be examined to ensure that the paint finishes are in a good condition. If not satisfactory, priming paint or finishing coats shall be removed where necessary, the surface cleaned to remove rust, and all such surfaces re primed and finished in two coats of high quality paintwork to match the original.

The contractor shall fix black on white ivorine labels to all items of equipment (machinery, fans, pumps, electric heater batteries, humidifiers, air handling units, outdoor condensers, etc.), as well as to all active valves (motorised and solenoid) and major isolating valves.

The lettering shall not be less than 10 mm in height and the wording shall be approved by the Engineer. The wording and tag numbers shall be the same as those used in this specification and indicated on the drawings.

13 ASSOCIATED ELECTRICAL WORK

13.1 General

All electrical switchgear and wiring required for the proper operation of the works shall be provided by the Contractor.

The existing switchboard and switchgear will be re-used where possible.

The switchgear for secondary pumps PW-P1 and PW-P2 will be removed and VSD’s will be fitted.

The power supply cables from the boards to the chillers and pumps will also be re-used where possible.

Tenderers shall indicate whether the above power supplies are sufficient or not and whether additional plug points, conduits and draw boxes are required. All costs arising from the failure to comply with this instruction will be for the Contractors account.

The contractor shall provide all necessary assistance, information (such circuit breaker type and overload protection required), etc., to ensure that the correct power supplies are provided to the HVAC equipment. The contractor shall ensure that the power supply to the equipment is installed correctly and that, once switched on, it will not damage the equipment.

All costs arising from the failure to comply with the above instructions will be for the contractors account.

14 GENERAL

The contractor shall supply and install all equipment and materials necessary for the complete and correct electrical operation of the mechanical services under normal operation, fire mode and emergency power mode.

All items of equipment shall be of good quality with regard to design and manufacture and shall be completely satisfactory for operation, control, safety and maintenance under all conditions of service.
Uniformity of type and manufacture of switchgear, control gear, fittings and accessories shall be preserved throughout the whole of the installation.

15 STANDARDS AND REGULATIONS

All electrical work shall be carried out strictly in accordance with the following SANS 10142-1 - The Wiring Code and Regulations of the Supply Authority.

The contractor will provide supply adjacent to the mechanical equipment as indicated on drawings. The contractor shall supply and connect the supply isolator, and do all work on the load side of this point of connection as necessary for the complete installation and operation of equipment. Prior to any work being carried out, this contractor shall confirm by means of a detailed spreadsheet the size and type of supplies required for the equipment.

Provide COC for all electrical works. Certificate of Compliance

16 COMMISSIONING

Commissioning of the works shall form part of the Contract. All equipment shall be commissioned by the equipment supplier.

The Contractor shall prepare detailed commissioning schedules well in advance of the programmed practical completion inspection date.

The schedules shall make allowance for all measurements that will be required, checking of operational and safety set-points, test results, etc., and shall be submitted to the Engineer for approval prior to the start of commissioning.

The Contractor shall submit the completed schedules to the Engineer for checking after commissioning has been completed, and prior to the practical completion inspection.

The Contractor is forewarned that the Engineer will under absolutely no circumstances deviate from the above procedure. The Engineer furthermore reserves the right to refuse to carry out the practical completion inspection until the Contractor has complied with the above stipulations. The Contractor shall accept this reserved right by the act of tendering.

Each task in these schedules shall be countersigned by the Contractors Commissioning Engineer to ensure that any discrepancies between site and commissioning conditions/data can be clarified.

The minimum commissioning requirements are:

16.1 Initial visual check

- Correct models, types, etc. provided.
- Equipment located in correct positions and parallel to building lines unless otherwise specified.
- Shipping fasteners, clamps, etc. removed or released.
- Joints tight and correctly fitted.
- All fasteners in position and tight.
- Coil piping correct configuration. (Counter flow, IN at the bottom, OUT at the top, etc.).
- Existence of sufficient and where applicable correctly fitted bleed off, vent valves, drains, etc., as specified. (Both at components and in pipework.)
- Thermal expansion and contraction allowances.
- Access panels provided and are hinged complete with handles, patches, locks, etc.
- Natural free movement of rotary/moving equipment.
- Proper isolation of rotary/moving equipment (check canvas collars anti vibration mounts, flexible couplings/rubber mounts, etc.).
- Soundness and alignment of general supports.
- Grommets provided against chaffing at all pipe cables, etc. penetrations through housings, etc.
- Installation workmanship and finish.
16.2 Pre-switch on checks
- Megger all electrical circuits for correct continuity, etc.
- Check oil levels and lubricate where applicable.
- Run fan impellers by hand to see that they are free of obstructions.

16.3 Post first switch on checks
- Listen for strange noises from equipment items.
- Check for unbalanced rotary items.
- Vibration transmitted to fixed elements, such as ducts, structure, pipework, etc. (Anti vibration mountings, flexible canvas collars, to be checked for isolation.)
- Moving/rotary equipment smooth operation, i.e. free of excessive vibration, drumming, rumbling, etc.
- Excessive air and other fluid leaks (prime suspects: Evaporator units’ joints and canvas collars).

16.4 Insulation
- Securement.
- Type and thickness.
- Soundness/integrity of joints.
- Vapour barrier, where applicable.
- Wooden rings, or other approved thermal break, at supports.

16.5 Electrics
- Check motor sizes.
- Check motor types.
- Check amperage against motor nameplate ratings.
- Motor direction of rotation.
- Electrical wiring, etc.
- Starters overloads settings, etc.
- Interlocks.
- Check soundness of all wiring connections (particularly ammeters.).

16.6 General
- Lubrication.
- General noises (record unusual levels).
- Colour coding provision.
- Space cleanliness.
- Spare parts/operating manuals handed over.

It is hereby recorded that the checking, testing, adjusting, measuring, setting, confirming, reporting, etc., of the foregoing items are the minimum requirements. Additional tasks which are necessary for the proper commissioning of the works shall be conducted by the Contractor as required.

17 AS-BUILT DRAWINGS

As-built drawings shall be prepared by the Contractor. These drawings shall be submitted to the Engineer for approval 1 week prior to the programmed date for the practical completion inspection of the last section of the works.
### 18.1 Chilled Water Generators

<table>
<thead>
<tr>
<th>Unit Numbers</th>
<th>CH1 – CH2</th>
</tr>
</thead>
<tbody>
<tr>
<td>To Serve</td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td>Chiller Plantroom</td>
</tr>
<tr>
<td>Make</td>
<td>Carrier or equivalent</td>
</tr>
<tr>
<td>Series/Range</td>
<td>30 XW 1152P</td>
</tr>
<tr>
<td>Number Off</td>
<td>2</td>
</tr>
<tr>
<td>Total Cooling Capacity Each</td>
<td>1179</td>
</tr>
<tr>
<td>Capacity Control Steps</td>
<td>Screw</td>
</tr>
<tr>
<td>Compressor Type</td>
<td></td>
</tr>
<tr>
<td>Compressor Rotor Speed</td>
<td></td>
</tr>
<tr>
<td>Evaporator:</td>
<td></td>
</tr>
<tr>
<td>Number Off</td>
<td>1</td>
</tr>
<tr>
<td>Type</td>
<td>Shell &amp; Tube</td>
</tr>
<tr>
<td>Chilled Water Flow Rate</td>
<td>l/s each</td>
</tr>
<tr>
<td>Chilled Water temperature Entering</td>
<td>°C</td>
</tr>
<tr>
<td>Chilled Water temperature Leaving</td>
<td>°C</td>
</tr>
<tr>
<td>Water Pressure Drop</td>
<td>kPa</td>
</tr>
<tr>
<td>Number of Refrigerant Circuits</td>
<td>2</td>
</tr>
<tr>
<td>Number of Passes</td>
<td>2</td>
</tr>
<tr>
<td>Fouling Factor</td>
<td>m²°C/kW</td>
</tr>
<tr>
<td>Water Connections Type/Size</td>
<td></td>
</tr>
<tr>
<td>Maximum Working Pressure</td>
<td>kPa</td>
</tr>
<tr>
<td>Condenser:</td>
<td></td>
</tr>
<tr>
<td>Number Off</td>
<td>1</td>
</tr>
<tr>
<td>Type</td>
<td>Shell &amp; Tube</td>
</tr>
<tr>
<td>Condenser Water Flow Rate</td>
<td>l/s each</td>
</tr>
<tr>
<td>Condenser Water Temperature Entering</td>
<td>°C</td>
</tr>
<tr>
<td>Condenser Water Temperature Leaving</td>
<td>°C</td>
</tr>
<tr>
<td>Water Pressure Drop</td>
<td>kPa</td>
</tr>
<tr>
<td>Number of Passes</td>
<td>2</td>
</tr>
<tr>
<td>Fouling Factor</td>
<td>m²°C/kW</td>
</tr>
<tr>
<td>Water Connections Type/Size</td>
<td></td>
</tr>
<tr>
<td>Maximum Working Pressure</td>
<td>kPa</td>
</tr>
<tr>
<td>Motor:</td>
<td></td>
</tr>
<tr>
<td>Rating</td>
<td>kW</td>
</tr>
<tr>
<td>Full load Amps max.</td>
<td></td>
</tr>
<tr>
<td>Type of Starting</td>
<td></td>
</tr>
<tr>
<td>Maximum Starting Current</td>
<td>Amps</td>
</tr>
<tr>
<td>Power Supply</td>
<td>400/3/50</td>
</tr>
<tr>
<td>Motor Speed</td>
<td></td>
</tr>
<tr>
<td>Refrigerant:</td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td>R134a</td>
</tr>
<tr>
<td>Operating Charge</td>
<td>kg</td>
</tr>
<tr>
<td>Operating Weight of Unit</td>
<td>kg</td>
</tr>
<tr>
<td>Type of Mounting</td>
<td></td>
</tr>
<tr>
<td>Physical Dimensions</td>
<td></td>
</tr>
<tr>
<td>W x L x H</td>
<td>1070 x 4694 x 1918</td>
</tr>
</tbody>
</table>
### Chilled Water Generators

#### Unit Numbers

<table>
<thead>
<tr>
<th>CH3 – CH4</th>
</tr>
</thead>
<tbody>
<tr>
<td>To Serve</td>
</tr>
<tr>
<td>Location</td>
</tr>
<tr>
<td>Make</td>
</tr>
<tr>
<td>Series/Range</td>
</tr>
<tr>
<td>Number Off</td>
</tr>
<tr>
<td>Total Cooling Capacity Each</td>
</tr>
<tr>
<td>Capacity Control Steps</td>
</tr>
<tr>
<td>Compressor Type</td>
</tr>
<tr>
<td>Compressor Rotor Speed</td>
</tr>
<tr>
<td>Evaporator:</td>
</tr>
<tr>
<td>Number Off</td>
</tr>
<tr>
<td>Type</td>
</tr>
<tr>
<td>Chilled Water Flow Rate</td>
</tr>
<tr>
<td>°C</td>
</tr>
<tr>
<td>Chilled Water temperature Leaving</td>
</tr>
<tr>
<td>Water Pressure Drop</td>
</tr>
<tr>
<td>Number of Refrigerant Circuits</td>
</tr>
<tr>
<td>Number of Passes</td>
</tr>
<tr>
<td>Fouling Factor</td>
</tr>
<tr>
<td>Water Connections Type/Size</td>
</tr>
<tr>
<td>Maximum Working Pressure</td>
</tr>
<tr>
<td>Condenser:</td>
</tr>
<tr>
<td>Number Off</td>
</tr>
<tr>
<td>Type</td>
</tr>
<tr>
<td>Condenser Water Flow Rate</td>
</tr>
<tr>
<td>°C</td>
</tr>
<tr>
<td>Condenser Water Temperature Leaving</td>
</tr>
<tr>
<td>Water Pressure Drop</td>
</tr>
<tr>
<td>Number of Passes</td>
</tr>
<tr>
<td>Fouling Factor</td>
</tr>
<tr>
<td>Water Connections Type/Size</td>
</tr>
<tr>
<td>Maximum Working Pressure</td>
</tr>
<tr>
<td>Motor:</td>
</tr>
<tr>
<td>Rating</td>
</tr>
<tr>
<td>Input above Capacity</td>
</tr>
<tr>
<td>Full load Amps max.</td>
</tr>
<tr>
<td>Type of Starting</td>
</tr>
<tr>
<td>Maximum Starting Current</td>
</tr>
<tr>
<td>Power Supply</td>
</tr>
<tr>
<td>Motor Speed</td>
</tr>
<tr>
<td>Refrigerant:</td>
</tr>
<tr>
<td>Operating Charge</td>
</tr>
<tr>
<td>Operating Weight of Unit</td>
</tr>
<tr>
<td>Type of Mounting</td>
</tr>
<tr>
<td>Physical Dimensions</td>
</tr>
<tr>
<td>W x L x H</td>
</tr>
</tbody>
</table>
### 18.3 Condenser Water Circulating Water Pumps

<table>
<thead>
<tr>
<th>Unit Numbers</th>
<th>CW P1 – CW P4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>CHW Plantroom</td>
</tr>
<tr>
<td>Number Off</td>
<td>4</td>
</tr>
<tr>
<td>Type</td>
<td>End Suction Centrifugal</td>
</tr>
<tr>
<td>Capacity</td>
<td>/s</td>
</tr>
<tr>
<td>Total Head</td>
<td>kPa</td>
</tr>
<tr>
<td>Maximum Discharge Pressure</td>
<td>kPa</td>
</tr>
<tr>
<td>Selected Impeller Diameter</td>
<td>mm</td>
</tr>
<tr>
<td>Maximum Impeller Diameter</td>
<td>mm</td>
</tr>
<tr>
<td>Pump Speed</td>
<td>rpm</td>
</tr>
<tr>
<td>Efficiency</td>
<td>Operating %</td>
</tr>
<tr>
<td>Maximum Efficiency for Impeller Diameter</td>
<td>%</td>
</tr>
<tr>
<td>Power Absorbed</td>
<td>kW</td>
</tr>
<tr>
<td>Motor Nameplate Rating</td>
<td>kW</td>
</tr>
<tr>
<td>NPSH Required</td>
<td>kPa</td>
</tr>
<tr>
<td>Type of Coupling</td>
<td>Flexible</td>
</tr>
<tr>
<td>Seal Type</td>
<td>Mechanical</td>
</tr>
<tr>
<td>Mounting</td>
<td>Vibration isolating base on springs</td>
</tr>
<tr>
<td>Power Supply</td>
<td>400/3/5</td>
</tr>
</tbody>
</table>

**NOTE:**
Motors shall be premium efficiency motors.

### 18.4 PRIMARY CHILLED WATER CIRCULATING WATER PUMPS

<table>
<thead>
<tr>
<th>Unit Numbers</th>
<th>CHWP1 – CHWP4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>CHW Plantroom</td>
</tr>
<tr>
<td>Number Off</td>
<td>4</td>
</tr>
<tr>
<td>Type</td>
<td>End Suction Centrifugal</td>
</tr>
<tr>
<td>Capacity</td>
<td>/s</td>
</tr>
<tr>
<td>Total Head</td>
<td>kPa</td>
</tr>
<tr>
<td>Maximum Discharge Pressure</td>
<td>kPa</td>
</tr>
<tr>
<td>Selected Impeller Diameter</td>
<td>mm</td>
</tr>
<tr>
<td>Maximum Impeller Diameter</td>
<td>mm</td>
</tr>
<tr>
<td>Pump Speed</td>
<td>rpm</td>
</tr>
<tr>
<td>Efficiency</td>
<td>Operating %</td>
</tr>
<tr>
<td>Maximum Efficiency for Impeller Diameter</td>
<td>%</td>
</tr>
<tr>
<td>Power Absorbed</td>
<td>kW</td>
</tr>
<tr>
<td>Motor Nameplate Rating</td>
<td>kW</td>
</tr>
<tr>
<td>NPSH Required</td>
<td>kPa</td>
</tr>
<tr>
<td>Type of Coupling</td>
<td>Flexible</td>
</tr>
<tr>
<td>Seal Type</td>
<td>Mechanical</td>
</tr>
<tr>
<td>Mounting</td>
<td>Vibration isolating base on springs</td>
</tr>
<tr>
<td>Power Supply</td>
<td>400/3/5</td>
</tr>
</tbody>
</table>

**NOTE:**
Motors shall be premium efficiency motors.
18.5 Secondary Chilled Water Circulating Water Pumps

<table>
<thead>
<tr>
<th>Unit Numbers</th>
<th>PW-P1 – PW-P4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>CHW Plantroom</td>
</tr>
<tr>
<td>Number Off</td>
<td>4</td>
</tr>
<tr>
<td>Type</td>
<td></td>
</tr>
<tr>
<td>Capacity</td>
<td>m3/s</td>
</tr>
<tr>
<td>Total Head</td>
<td>kPa</td>
</tr>
<tr>
<td>Maximum Discharge Pressure</td>
<td>kPa</td>
</tr>
<tr>
<td>Selected Impeller Diameter</td>
<td>mm</td>
</tr>
<tr>
<td>Maximum Impeller Diameter</td>
<td>mm</td>
</tr>
<tr>
<td>Pump Speed</td>
<td>rpm</td>
</tr>
<tr>
<td>Efficiency</td>
<td>Operating %</td>
</tr>
<tr>
<td>Maximum Efficiency for Impeller Diameter</td>
<td>%</td>
</tr>
<tr>
<td>Power Absorbed</td>
<td>kW</td>
</tr>
<tr>
<td>Motor Nameplate Rating</td>
<td>kW</td>
</tr>
<tr>
<td>NPSH Required</td>
<td>kPa</td>
</tr>
<tr>
<td>Type of Coupling</td>
<td>Flexible</td>
</tr>
<tr>
<td>Seal Type</td>
<td>Mechanical</td>
</tr>
<tr>
<td>Mounting</td>
<td>Vibration isolating base on springs</td>
</tr>
<tr>
<td>Power Supply</td>
<td>400/3/5</td>
</tr>
</tbody>
</table>

**NOTE:**

Motors shall be premium efficiency motors.
2 Off pumps fitted with VSD’s.

19 MAINTENANCE

The Contractor shall prepare detailed weekly, monthly, 6-monthly and annual maintenance and service schedules, as required, for the complete works. These schedules shall be included in the Operating & Maintenance Manuals and will be submitted to the Engineer for approval.

The tenderers shall allow for six (6), equally spaced, service visits to be carried out during the warranty period. A detailed service report together with a copy of the completed maintenance and service schedules shall be passed on to the Engineer on completion of each service visit.

The Contractor shall provide a logbook, which shall be stored in an approved location on site. A short description and any relevant comments relating to the service visits or defect repairs, and all pressures, power draws etc., shall be noted in the logbook at the end of each visit.

Each entry shall be signed and dated by the serviceman, as well as counter signed by the Employers representative. A new logbook shall be provided by the Contractor when required and the old book passed on to the Employer via the Engineer.

20 OPERATING AND MAINTENANCE MANUALS

Three sets of operating and maintenance manuals shall be prepared by the Contractor. These manuals shall be submitted to the Engineer for approval 2 weeks prior to the programmed date for the practical completion inspection.

Tenderers are to note that the said practical completion inspection shall not be carried out prior to the approval of these operating and maintenance manuals.

The manuals shall be properly bound and titled. Each set shall consist of 4 sections. Each section shall have the following sub-sections:

Section 1 – Operation

20.1 Introduction:
Short description of the complete system to familiarise laymen with the system lay-out and operation.
20.2 **Detailed description:**
A detailed description of each system and its equipment, complete with schematic drawings. The purpose of this system is to explain the intended operation of each system and item of equipment to technical personnel. Detailed descriptions of the operation, set-points, adjustments, etc., are thus to be included.

Section 2 - Commissioning data

20.3 **Schedules of data:**
Detailed schedules of commissioning data of all the systems shall be included in this section for future reference. These schedules shall include, amongst others, air flow rates, major equipment power draws, pressure drops, etc.

Section 3 - Maintenance

20.4 **Schedules:**
This section shall contain detailed maintenance and service schedules for the complete installation.

20.5 **Equipment details:**
This section shall contain manufacturers’ brochures, spare parts lists, etc., of all the items of equipment.

20.6 **List of suppliers:**
The list of suppliers (complete with addresses and telephone numbers) for each item of equipment shall be included in this section.

Section 4 - Drawings

20.7 **As-built drawings:**
A complete set of as-built drawings shall be enclosed in this section.

In addition to the above, one operating and maintenance instruction booklet per air-conditioning unit installed shall be provided by the contractor prior to the practical completion inspection.

It is to be noted that under no conditions will the practical completion inspections be carried out unless these instruction booklets have been handed over to the Engineer.

It shall be the contractor's responsibility to advise the air-conditioning units' suppliers of this requirement at tender stage and to ensure that any associated costs are allowed for in the tendered subcontract sum.

21 **INSTRUCTION/TRAINING**

The Tenderers shall allow a period for instructing/training of the Employers representatives and the Engineer on the operation, maintenance and adjustment of the systems.

Instruction shall take place during the warranty period on dates and times to be identified by the Engineer.
## 22. SCHEDULES
### TO BE COMPLETED BY ALL TENDERERS

22.1. Chilled Water Generators:

<table>
<thead>
<tr>
<th>Unit Numbers</th>
<th>CH1 – CH2</th>
</tr>
</thead>
<tbody>
<tr>
<td>To Serve</td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td></td>
</tr>
<tr>
<td>Make</td>
<td></td>
</tr>
<tr>
<td>Series/Range</td>
<td></td>
</tr>
<tr>
<td>Number Off</td>
<td></td>
</tr>
<tr>
<td>Total Cooling Capacity Each</td>
<td></td>
</tr>
<tr>
<td>Capacity Control Steps</td>
<td></td>
</tr>
<tr>
<td>Compressor Type</td>
<td></td>
</tr>
<tr>
<td>Compressor Rotor Speed</td>
<td></td>
</tr>
<tr>
<td>Evaporator:</td>
<td></td>
</tr>
<tr>
<td>Number Off</td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td></td>
</tr>
<tr>
<td>Chilled Water Flow Rate  l/s each</td>
<td></td>
</tr>
<tr>
<td>Chilled Water temperature Entering  °C</td>
<td></td>
</tr>
<tr>
<td>Chilled Water temperature Leaving  °C</td>
<td></td>
</tr>
<tr>
<td>Water Pressure Drop  kPa</td>
<td></td>
</tr>
<tr>
<td>Number of Refrigerant Circuits</td>
<td></td>
</tr>
<tr>
<td>Number of Passes</td>
<td></td>
</tr>
<tr>
<td>Fouling Factor  m²°C/kW</td>
<td></td>
</tr>
<tr>
<td>Water Connections Type/Size</td>
<td></td>
</tr>
<tr>
<td>Maximum Working Pressure  kPa</td>
<td></td>
</tr>
<tr>
<td>Condenser:</td>
<td></td>
</tr>
<tr>
<td>Number Off</td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td></td>
</tr>
<tr>
<td>Condenser Water Flow Rate  l/s each</td>
<td></td>
</tr>
<tr>
<td>Condenser Water Temperature Entering  °C</td>
<td></td>
</tr>
<tr>
<td>Condenser Water Temperature Leaving  °C</td>
<td></td>
</tr>
<tr>
<td>Water Pressure Drop  kPa</td>
<td></td>
</tr>
<tr>
<td>Number of Passes</td>
<td></td>
</tr>
<tr>
<td>Fouling Factor  m²°C/kW</td>
<td></td>
</tr>
<tr>
<td>Water Connections Type/Size</td>
<td></td>
</tr>
<tr>
<td>Maximum Working Pressure  kPa</td>
<td></td>
</tr>
<tr>
<td>Motor:</td>
<td></td>
</tr>
<tr>
<td>Rating</td>
<td></td>
</tr>
<tr>
<td>Input above Capacity  kW</td>
<td></td>
</tr>
<tr>
<td>Full load Amps max.</td>
<td></td>
</tr>
<tr>
<td>Type of Starting</td>
<td></td>
</tr>
<tr>
<td>Maximum Starting Current  Amps</td>
<td></td>
</tr>
<tr>
<td>Power Supply</td>
<td></td>
</tr>
<tr>
<td>Motor Speed</td>
<td></td>
</tr>
<tr>
<td>Refrigerant:</td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td></td>
</tr>
<tr>
<td>Operating Charge  kg</td>
<td></td>
</tr>
<tr>
<td>Operating Weight of Unit  kg</td>
<td></td>
</tr>
<tr>
<td>Type of Mounting</td>
<td></td>
</tr>
<tr>
<td>Physical Dimensions</td>
<td></td>
</tr>
<tr>
<td>W x L x H</td>
<td></td>
</tr>
</tbody>
</table>
### Chilled Water Generators:

<table>
<thead>
<tr>
<th><strong>Unit Numbers</strong></th>
<th>CH3 – CH4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>To Serve</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Location</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Make</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Series/Range</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Number Off</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Total Cooling Capacity Each</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Capacity Control Steps</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Compressor Type</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Compressor Rotor Speed</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Evaporator:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Number Off</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td></td>
</tr>
<tr>
<td>Chilled Water Flow Rate</td>
<td>l/s each</td>
</tr>
<tr>
<td>Chilled Water temperature Entering</td>
<td>ºC</td>
</tr>
<tr>
<td>Chilled Water temperature Leaving</td>
<td>ºC</td>
</tr>
<tr>
<td>Water Pressure Drop</td>
<td>kPa</td>
</tr>
<tr>
<td>Number of Refrigerant Circuits</td>
<td></td>
</tr>
<tr>
<td>Number of Passes</td>
<td></td>
</tr>
<tr>
<td>Fouling Factor</td>
<td>m²ºC/kW</td>
</tr>
<tr>
<td>Water Connections Type/Size</td>
<td></td>
</tr>
<tr>
<td>Maximum Working Pressure</td>
<td>kPa</td>
</tr>
<tr>
<td><strong>Condenser:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Number Off</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td></td>
</tr>
<tr>
<td>Condenser Water Flow Rate</td>
<td>l/s each</td>
</tr>
<tr>
<td>Condenser Water Temperature Entering</td>
<td>ºC</td>
</tr>
<tr>
<td>Condenser Water Temperature Leaving</td>
<td>ºC</td>
</tr>
<tr>
<td>Water Pressure Drop</td>
<td>kPa</td>
</tr>
<tr>
<td>Number of Passes</td>
<td></td>
</tr>
<tr>
<td>Fouling Factor</td>
<td>m²ºC/kW</td>
</tr>
<tr>
<td>Water Connections Type/Size</td>
<td></td>
</tr>
<tr>
<td>Maximum Working Pressure</td>
<td>kPa</td>
</tr>
<tr>
<td><strong>Motor:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Rating</strong></td>
<td></td>
</tr>
<tr>
<td>Input above Capacity</td>
<td>kW</td>
</tr>
<tr>
<td>Full load Amps max.</td>
<td></td>
</tr>
<tr>
<td>Type of Starting</td>
<td></td>
</tr>
<tr>
<td>Maximum Starting Current</td>
<td>Amps</td>
</tr>
<tr>
<td>Power Supply</td>
<td></td>
</tr>
<tr>
<td>Motor Speed</td>
<td></td>
</tr>
<tr>
<td><strong>Refrigerant:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td></td>
</tr>
<tr>
<td>Operating Charge</td>
<td>kg</td>
</tr>
<tr>
<td>Operating Weight of Unit</td>
<td>kg</td>
</tr>
<tr>
<td>Type of Mounting</td>
<td></td>
</tr>
<tr>
<td><strong>Physical Dimensions</strong></td>
<td></td>
</tr>
<tr>
<td>W x L x H</td>
<td></td>
</tr>
</tbody>
</table>
## 22.3. Condenser Water Circulating Water Pumps

<table>
<thead>
<tr>
<th>Unit Numbers</th>
<th>CW P1 – CW P4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td></td>
</tr>
<tr>
<td>Number Off</td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td></td>
</tr>
<tr>
<td>Capacity</td>
<td>/s</td>
</tr>
<tr>
<td>Total Head</td>
<td>kPa</td>
</tr>
<tr>
<td>Maximum Discharge Pressure</td>
<td>kPa</td>
</tr>
<tr>
<td>Selected Impeller Diameter</td>
<td>mm</td>
</tr>
<tr>
<td>Maximum Impeller Diameter</td>
<td>mm</td>
</tr>
<tr>
<td>Pump Speed</td>
<td>rpm</td>
</tr>
<tr>
<td>Efficiency</td>
<td></td>
</tr>
<tr>
<td>Maximum Efficiency for Impeller Diameter</td>
<td>%</td>
</tr>
<tr>
<td>Power Absorbed</td>
<td>kW</td>
</tr>
<tr>
<td>Motor Nameplate Rating</td>
<td>kW</td>
</tr>
<tr>
<td>NPSH Required</td>
<td>kPa</td>
</tr>
<tr>
<td>Type of Coupling</td>
<td></td>
</tr>
<tr>
<td>Seal Type</td>
<td></td>
</tr>
<tr>
<td>Mounting</td>
<td></td>
</tr>
<tr>
<td>Power Supply</td>
<td></td>
</tr>
</tbody>
</table>

### NOTE:

Motors shall be premium efficiency motors.

## 22.4. Primary Chilled Water Circulating Water Pumps

<table>
<thead>
<tr>
<th>Unit Numbers</th>
<th>CHWP1 – CHWP4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td></td>
</tr>
<tr>
<td>Number Off</td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td></td>
</tr>
<tr>
<td>Capacity</td>
<td>/s</td>
</tr>
<tr>
<td>Total Head</td>
<td>kPa</td>
</tr>
<tr>
<td>Maximum Discharge Pressure</td>
<td>kPa</td>
</tr>
<tr>
<td>Selected Impeller Diameter</td>
<td>mm</td>
</tr>
<tr>
<td>Maximum Impeller Diameter</td>
<td>mm</td>
</tr>
<tr>
<td>Pump Speed</td>
<td>rpm</td>
</tr>
<tr>
<td>Efficiency</td>
<td></td>
</tr>
<tr>
<td>Maximum Efficiency for Impeller Diameter</td>
<td>%</td>
</tr>
<tr>
<td>Power Absorbed</td>
<td>kW</td>
</tr>
<tr>
<td>Motor Nameplate Rating</td>
<td>kW</td>
</tr>
<tr>
<td>NPSH Required</td>
<td>kPa</td>
</tr>
<tr>
<td>Type of Coupling</td>
<td></td>
</tr>
<tr>
<td>Seal Type</td>
<td></td>
</tr>
<tr>
<td>Mounting</td>
<td></td>
</tr>
<tr>
<td>Power Supply</td>
<td></td>
</tr>
</tbody>
</table>

### NOTE:

Motors shall be premium efficiency motors.
22.5. Secondary Chilled Water Circulating Water Pumps:

<table>
<thead>
<tr>
<th>Unit Numbers</th>
<th>PW-P1 – PW-P4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td></td>
</tr>
<tr>
<td>Number Off</td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td></td>
</tr>
<tr>
<td>Capacity</td>
<td>l/s</td>
</tr>
<tr>
<td>Total Head</td>
<td>kPa</td>
</tr>
<tr>
<td>Maximum Discharge Pressure</td>
<td>kPa</td>
</tr>
<tr>
<td>Selected Impeller Diameter</td>
<td>mm</td>
</tr>
<tr>
<td>Maximum Impeller Diameter</td>
<td>mm</td>
</tr>
<tr>
<td>Pump Speed</td>
<td>rpm</td>
</tr>
<tr>
<td>Efficiency</td>
<td></td>
</tr>
<tr>
<td>Maximum Efficiency for Impeller Diameter</td>
<td>%</td>
</tr>
<tr>
<td>Power Absorbed</td>
<td>kW</td>
</tr>
<tr>
<td>Motor Nameplate Rating</td>
<td>kW</td>
</tr>
<tr>
<td>NPSH Required</td>
<td>kPa</td>
</tr>
<tr>
<td>Type of Coupling</td>
<td></td>
</tr>
<tr>
<td>Seal Type</td>
<td></td>
</tr>
<tr>
<td>Mounting</td>
<td></td>
</tr>
<tr>
<td>Power Supply</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:**

Motors shall be premium efficiency motors.

2 Off pumps fitted with VSD’s.

22.6. Automatic Controls:

<table>
<thead>
<tr>
<th>Thermostats</th>
<th>Room Type</th>
<th>Make and Model Number:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Room Type</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reheater</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Safety-Overheat</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fire</td>
<td></td>
</tr>
<tr>
<td>Air Pressure Differential Switch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Damper Motors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step Controller</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage Monitors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time Switches</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure Reducing Dampers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable Speed Drives</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

22.7. Switchpanels and Control Boards:

<table>
<thead>
<tr>
<th>Name of Manufacturer</th>
<th>Make of</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Isolators</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Circuit Breakers</td>
<td></td>
</tr>
<tr>
<td>Contactors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor Starters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relays</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time Delay Relays</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time Switches</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotary Switches</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instruments</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
22.8. **Subcontract Work – where applicable:**

Tenderers to list any work or service which they intend to subcontract and name the firm to whom they propose subletting the work.

<table>
<thead>
<tr>
<th>SERVICE</th>
<th>NAME OF FIRM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
NRF - ITHEMBA LABS

BID NO. TBC

REPLACEMENT OF EXISTING CHILLERS IN PLANT ROOM AT ITHEMBA LABS, FAURE

C3.5 Annexes

<table>
<thead>
<tr>
<th>CONTENTS</th>
<th>PAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annexure 1: Health and Safety Specification</td>
<td>118-131</td>
</tr>
<tr>
<td>Annexure 2: General Standard Specifications</td>
<td>132-198</td>
</tr>
</tbody>
</table>
ANNEXURE 1

HEALTH & SAFETY SPECIFICATION
## CONTENTS

1 INTRODUCTION ................................................................. 121  
   1.1 Purpose ........................................................................ 121  
   1.2 Project Health & Safety Aims ........................................ 121  
   1.3 Definitions ................................................................. 121  
2 PROJECT DETAILS .......................................................... 122  
   2.1 Responsibilities ......................................................... 122  
3 OCCUPATIONAL HEALTH & SAFETY MANAGEMENT SYSTEM .......... 122  
   3.1 Health & Safety Plan .................................................... 122  
   3.2 Site Health & Safety File. ............................................. 122  
   3.3 Notification of Construction Work ................................. 123  
   3.4 Compensation for Occupational Injuries and Diseases .......... 123  
   3.5 Health & Safety Policy ................................................ 123  
   3.6 Company Structure .................................................... 123  
   3.7 Competence of appointed persons ................................ 123  
   3.8 Legal Appointments .................................................... 123  
   3.9 Contractor Management ............................................. 124  
   3.10 Health & Safety Training ............................................ 124  
      3.10.1 Inductions .......................................................... 124  
      3.10.2 Competency ...................................................... 124  
      3.10.3 Awareness ........................................................ 124  
   3.11 Risk Assessment ........................................................ 124  
   3.12 Fall Protection .......................................................... 125  
      3.12.1 Fall Protection Plan ............................................. 125  
      3.12.2 Scaffold Work .................................................... 125  
      3.12.3 Ladders ............................................................ 125  
      3.12.4 Fall Protection Equipment ................................... 126  
   3.13 Demolition Work ........................................................ 126  
   3.14 Lifting Machines & Equipment ...................................... 126  
   3.15 Support Work ........................................................... 126  
   3.16 Construction Vehicles & Mobile Plant ........................... 126  
   3.17 Hired Plant & Machinery ............................................ 126  
   3.18 Electrical Installation & Equipment .............................. 126  
   3.19 Existing Services ..................................................... 127  
   3.20 Stacking & Storage .................................................... 127  
   3.21 Public Safety ........................................................... 128  
   3.22 Occupational Health & Safety Signage ........................... 128  
   3.23 Hot Works .............................................................. 128  
   3.24 Medical Certificates of Fitness ..................................... 128  
   3.25 Personal Protective Equipment .................................... 128  
   3.26 Hazardous Chemical Substances ................................ 128  
   3.27 Emergency Procedures ............................................. 129
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.28</td>
<td>First Aid</td>
<td>129</td>
</tr>
<tr>
<td>3.29</td>
<td>Accident / Incident Reporting and Investigation</td>
<td>129</td>
</tr>
<tr>
<td>3.30</td>
<td>Fire Fighting</td>
<td>129</td>
</tr>
<tr>
<td>3.31</td>
<td>Health &amp; Safety Representatives and Committee</td>
<td>129</td>
</tr>
<tr>
<td>3.32</td>
<td>Housekeeping</td>
<td>129</td>
</tr>
<tr>
<td>3.33</td>
<td>Health and Safety Notice Board</td>
<td>130</td>
</tr>
<tr>
<td>3.34</td>
<td>Occupational Health</td>
<td>130</td>
</tr>
<tr>
<td>3.34.1</td>
<td>Occupational Hygiene</td>
<td>130</td>
</tr>
<tr>
<td>3.34.2</td>
<td>Welfare Facilities</td>
<td>130</td>
</tr>
<tr>
<td>3.34.3</td>
<td>Alcohol and other Drugs</td>
<td>130</td>
</tr>
<tr>
<td>3.35</td>
<td>Penalties</td>
<td>130</td>
</tr>
<tr>
<td>3.36</td>
<td>Checklists and Registers</td>
<td>131</td>
</tr>
</tbody>
</table>
1. INTRODUCTION

1.1 PURPOSE

This health and safety specification has been developed to assist any Contractor making a bid for the REPLACEMENT OF EXISTING CHILLERS IN PLANT ROOM AT ITHEMBA LABS, FAURE at iThemba labs in Faure, in achieving compliance with the Occupational Health and Safety Act (Act 85 of 1993) and the Regulations promulgated thereunder, as well as to ensure that the Client (iThemba Labs) meets his/her legal obligations in terms of Construction Regulation 5, 2014.

The level of compliance achieved by all Contractors will be measured against this specification and the relevant occupational health and safety legislation. Any contractor that is appointed for this contract is required to use this specification as a guide when preparing their project specific health and safety plan and must forward the relevant sections to their Contractors so that they can in turn prepare health and safety plans addressing the requirements of their portion of the operations.

1.2 PROJECT HEALTH AND SAFETY AIMS

The aim of the health and safety specification is to ensure that:

i. Health and safety management is planned into the work activities undertaken by the appointed Contractor;
ii. No injuries or illnesses occur during the project;
iii. All potential risks to safety, health, property and environment are identified and mitigated;
iv. The commitments made by the appointed Contractor in their own health and safety plans are put into practical effect;
v. Continuous improvement in meeting the health and safety targets and objectives is achieved by the appointed Contractor;
vi. A high level of co-operation is achieved between the appointed Contractor and all members of the professional team.

1.3 DEFINITIONS

The definitions in the Occupational Health & Safety Act and the Regulations promulgated thereunder, shall apply to these specifications. Special note should be taken of the following definitions:

“Client” means any person (IThemba Labs) for whom construction work is performed.
“Contractors” means an employer, as defined in Section 1 of the Act, who performs construction work and includes Principal Contractors.
“Designer” means any of the following persons –
(i) a person who prepares a design;
(ii) a person who checks and approves a design;
(iii) a person who arranges for any person at work under his control (including an employee of his, where he is the employer) to prepare a design, as well as;
(iv) an architect or engineer contributing to, or having overall responsibility for the design;
(v) building services engineer designing details for fixed plant;
(vi) surveyor specifying articles or drawing up specifications;
(vii) contractor carrying out design work as part of a design and build project;
(viii) temporary works engineer designing formwork and false work; and
(ix) interior designer, shop-fitter and landscape architect.
“Principal Contractor” means an employer, as defined in Section 1 of the Act who performs construction work and is appointed by the client IThemba Labs to be in overall control and management of a part of or the whole of the construction site.
“Construction Work” means any work in connection with –
– the erection, maintenance, alteration, renovation, repair, demolition or dismantling of or any addition to a building or any similar structure;
– the installation, erection, dismantling or maintenance of a fixed plant where such work includes the risk of a person falling;
– the construction, maintenance, demolition or dismantling of any bridge, dam, canal, runway, sewer or water reticulation system or any similar civil engineering structure; or
– the moving of earth, clearing of land, the making of an excavation, piling, or any similar type of work;
“Competent Person” means any person having the knowledge, training, experience and qualifications specific to the work or task being performed: Provided that where appropriate qualifications and training are registered in terms of the provisions of the South African Qualifications Authority Act, 1995 (Act No. 58 of 1995), these qualifications and training shall be deemed to be the required qualifications and training.

CLIENT REPRESENTATIVE: BVI Engineering
2. PROJECT DETAILS

CLIENT: iThemba Labs.
CLIENT REPRESENTATIVE: BVI Engineering
PROJECT NAME: "REPLACEMENT OF EXISTING CHILLERS IN PLANT ROOM AT ITHEMBA LABS, FAURE"
COMPRENEMENT DATE: 07 January 2016
PRACTICAL COMPLETION DATE: 24 August 2016 (8 months duration)
PROJECT ADDRESS: iThemba Labs in Old Faure Road, Faure, Cape Town, 7131
CONTRACT DURATION: 8 months
PROJECT TYPE: REPLACEMENT OF EXISTING CHILLERS IN PLANT ROOM AT ITHEMBA LABS, FAURE

2.1 RESPONSIBILITIES

PROFESSIONAL TEAM
The professional team will be responsible for:
• identifying health and safety risks associated with the electrical upgrade and maintenance of the design and designing them out;
• identifying any states of structural instability during the construction stage;
• making suggestions, where applicable, regarding methods or sequence of construction;
• Co-ordinating on-going design work and communicating potential risks in design changes to the appointed Contractors;
• specifying, where possible, materials or substances with reduced risks to health and safety;
• conducting regular inspections throughout the construction stage;
• conducting a final inspection and issuing a certificate of successful completion.

3. OCCUPATIONAL HEALTH & SAFETY MANAGEMENT SYSTEM

3.1 HEALTH AND SAFETY PLAN
The appointed contractor will develop a health and safety plan, based on this specification, for approval by NRF-iThemba Labs safety officer.

The health and safety plan will clearly define the appointed contractor’s management system for managing health and safety during the contract in accordance with the health and safety requirements set out in this specification, as well as with the project baseline risk assessment and all relevant health and safety legislation.

The health and safety plan will be kept up to date by the appointed contractor and to include other Contractors’ risk management information.

The health and safety plan must contain the risk assessments for the project, before works starts on site.

Further risk assessments must be carried out where the works change, due to design changes.

The health and safety plan should also include a map of the site detailing the following:

vii. The positioning of emergency routes, assembly points and emergency equipment that must remain unobstructed.

viii. The positioning of the site access and egress points to ensure that any nuisance or risk to members of the public, college staff and students is minimized and controlled.

ix. The location of temporary site facilities to ensure that members of the public, college staff and students are not subjected to any nuisance arising from the use of the facilities.

x. The location of loading / offloading areas and storage areas to minimize excessive manual handling of materials required for the ventilation upgrade, damage to adjacent property, disruption to the flow of pedestrian and vehicular traffic and the security of equipment and materials.

xi. The planning of traffic and pedestrian routes, inside and outside the site, to ensure adequate protection for employees, members of the public, college staff, students and road users. The use of suitable barriers, signs and the appointment of vehicle flagmen should be adopted to provide the required level of protection.
3.2 SITE HEALTH AND SAFETY FILE

Once the appointed contractor’s health and safety plan has been approved for implementation by iThemba Labs Safety Officer; the appointed contractor must maintain a well referenced health and safety file on site. The health and safety file must contain all the legal documentation required to be made available for inspection by the Occupational Health & Safety Act and its Regulations and by this specification.

3.3 NOTIFICATION OF CONSTRUCTION WORK

Not applicable for this project.

3.4 COMPENSATION FOR OCCUPATIONAL INJURIES AND DISEASES

A copy of the appointed contractor’s letter of good standing with the Compensation Commissioner or FEM, valid for the duration of the contract, must be included in the health and safety file. The appointed contractor must ensure that all Contractors are at all times in good standing whilst performing work on site. If not covered by any form of compensation as described above, no work will be allowed to commence.

3.5 HEALTH AND SAFETY POLICY

A health and safety policy must be prepared by the appointed Contractor, stating their commitment to the effective management of health and safety on site, and a commitment to continuous improvement. The health and safety policy must be signed by the Chief Executive Officer or Managing Director of each company and must be included in their site health and safety file. The appointed contractor must display their policy on the site health and safety notice board only if establishing a site office.

3.6 COMPANY STRUCTURE

An organogram detailing the site health and safety management structure must be included in the health and safety file and displayed on the health and safety notice board. The organogram must detail the name and position of each person, as well as the reporting structure.

3.7 COMPETENCE OF APPOINTED PERSONS

The appointed competent personnel for the various risk management appointments shall fulfill the criteria as stipulated under the definition of “competent person” in accordance with the Construction Regulations (2014), see section 1.3 of these specifications. Proof of competency must be filed with the relevant appointments in the site health and safety file.

3.8 LEGAL APPOINTMENTS

The relevant appointments from the list highlighted below must be made in writing and included in the health and safety file:

OHS ACT

<table>
<thead>
<tr>
<th>Reference</th>
<th>Appointment</th>
<th>Tick if Applicable</th>
<th>NAME OF APPOINTEE</th>
</tr>
</thead>
<tbody>
<tr>
<td>OHS Act 16(1)</td>
<td>CEO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OHS Act 16(2)</td>
<td>Contracts Manager</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CR 8(7)</td>
<td>Construction Supervisor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CR 8(8)</td>
<td>Assistant Construction Supervisor(s)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CR 8(5)</td>
<td>Health &amp; Safety Officer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CR 9(1)</td>
<td>Risk Assessor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CR 10(1)</td>
<td>Fall Protection Plan Coordinator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CR 16(2)</td>
<td>Scaffold Erector</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CR 16(1)</td>
<td>Scaffold Supervisor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CR 16(3)</td>
<td>Scaffold Inspector</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CR 21(2)</td>
<td>Explosive Powered Tools Inspector</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CR 23(1)</td>
<td>Mobile Plant Inspector</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CR 24(1)</td>
<td>EMR9 Electrical Installation and Machinery Inspector</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CR 28(1)</td>
<td>Stacking and Storage Supervisor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CR 29(1)</td>
<td>Fire Equipment Inspector</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GSR 3(4)</td>
<td>First Aiders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GAR 9(2)</td>
<td>Incident Investigator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GSR 3</td>
<td>Emergency Coordinator</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
GSR 13A Ladder Inspector
Sect 8.2 Hand tool inspector
CR 24 Electrical tool inspector

Abbreviations
CR Construction Regulations
GSR General Safety Regulations
GAR General Administrative Regulations
EMR Electrical Machinery Regulations
DMR Driven Machinery Regulations
HCSR Hazardous Chemical Substances Regulations

3.9 CONTRACTOR MANAGEMENT

Each sub-contractor will be required to co-operate with the appointed contractor and provide information on risk assessments, safe work procedures, etc. For inclusion in the health and safety plan prepared by the appointed contractor. In addition, each sub-contractor will comply with the site rules and any reasonable instructions formulated by appointed contractor, or any member of the professional team, in accordance with current relevant health and safety legislation.

The following requirements must be attended to by the appointed contractor for all their sub-contractors:

xii. Evaluate the sub-contractors’ provisions for the cost of health and safety in their tenders as well as their competencies and resources.

xiv. Appoint sub-contractors in writing in terms of Construction Regulation 7.3.

xvi. Complete 37(2) Mandatory Agreements with sub-contractors detailing the arrangements made between parties to ensure compliance to the OHS Act and Regulations.

xvii. Maintain a list of all sub-contractors on site detailing the type of work being done.

The appointed contractor will be responsible for conducting health and safety inductions for all employees, sub-contractors, professional team members and visitors. Health and safety inductions must be conducted before employees or sub-contractors begin work on site or before visitors enter the site.

Proof of induction must be carried by all persons on site and a copy of the proof of induction must be kept in the site health and safety file.

3.10 HEALTH AND SAFETY TRAINING

3.10.1 Inductions

3.10.2 Competency

Proof of specialized health and safety training will be required for appointed contractor’s risk management team i.e. Health and Safety Officer, Risk Assessor, Fall Protection Plan Coordinator, Emergency Coordinator, Incident Investigator, Fire Fighters, First Aiders etc. (see section 3.8 of these specifications). Where certain work activities require employees to be competent, copies of training certificates and qualifications must be available (See Construction Regulations definition of “competent person”).

3.10.3 Awareness

Ongoing training in the form of Daily Safe Task Instructions (DSTI), must be conducted by the appointed contractor. DSTI attendance registers must be kept as proof of training for all employees and contractors.

3.11 RISK ASSESSMENT

Risk assessments must be developed and maintained by each contractor. Each contractor must appoint a competent person in writing as the site Risk Assessor who’s task will be to facilitate the development, review and revision of the risk assessments. The participation of a representative group of employees in the development and review of the risk assessments is essential. The risk assessments must be developed in compliance with the requirements of Construction Regulation 9.
All site staff must be trained on the contents of the risk assessments and made aware of all potential hazards and risks to themselves, to others, to the campus property and to the environment, as well as the mitigation measures to be implemented. This information must be documented in the form of safe work procedures and method statements. Proof must be included in the site health and safety file that all employees have been trained on the relevant risk assessments, safe work procedures and method statements, before commencing the tasks they address.

The effectiveness of the risk assessments must be monitored and reviewed on an ongoing basis and a formal monitoring and review plan must be drawn up. The monitoring and review plan must identify how the risk assessments are to be monitored, when they are to be reviewed and who will review them.

3.12 FALL PROTECTION (Only if working above 2m)

3.12.1 Fall Protection Plan

The appointed contractor must develop and maintain a fall protection plan in accordance with the requirements of Construction Regulation 10. The fall protection plan must include the following details:

xxi. A risk assessment of all work carried out from an elevated position, which shall include the procedures and methods used to address all the risks identified per location. Particular attention must be given to:
   1. stripping of old chillers and removal thereof
   2. erecting, use and dismantling of scaffolding;
   3. use of ladders;
   4. selection of appropriate fall protection equipment and anchor points.

xxii. Medical certificates of fitness for all persons performing work from an elevated position. The medical certificates must be issued by a registered Occupational Health Practitioner and must state that the medical evaluations include an assessment of the fitness to work at heights.

xxiii. The programme for the training of employees working from elevated positions and records thereof. Training certificates for the use of fall protection equipment must be issued by accredited training providers.

xxiv. The procedure addressing the inspection, testing and maintenance of all fall protection equipment.

The fall protection plan must be developed by a competent person appointed in writing and must be available on site at all times for inspection and reference.

The appointed contractor must ensure that any sub-contractors performing work at height also develop similar fall protection plans where required which must be incorporated into the appointed contractor’s fall protection plan. The appointed contractor will be responsible to assess, approve and enforce the content of the sub-contractors’ fall protection plans.

The appointed contractor will be responsible to ensure that any roof work activities are included in the risk assessments and that method statements are developed in accordance with the requirements of Construction Regulation 10.

3.12.2 Scaffold

Access and mobile scaffolds must be erected, inspected and used in accordance with the requirements of Construction Regulation 16 and the SANS 10085: 2004 code of practice. If scaffolding does not comply with these legal requirements, all work on and around the scaffolding will be immediately suspended until the scaffolding is fully compliant and safe for use. Particular attention must be given to the type of bracing used for any specific application.

All scaffold platforms must be fully boarded and be complete with double guardrails around all sides and toe boards. Safe and convenient access must be provided to all working platforms via internal ladders or stairs.

The Client reserves the right to appoint a specialist scaffolding contractor to erect and inspect scaffolding, at the cost of the appointed Contractor, if scaffolding erected by the appointed Contractor consistently does not meet the legal requirements.

3.12.3 Ladders

The appointed contractor and their sub-contractors must ensure that all ladders are used, inspected and maintained in accordance with the requirements of General Safety Regulation 13A. All ladders must be in good working condition, the correct height for the task, extend at least 1m above any landing, fastened / secured or held during use, and used at safe inclinations. Where applicable, ladders must be fitted with non-slip rubber feet. Records of regular ladder inspections must be kept in a register on site.
3.12.4 Fall Protection Equipment

In work areas where it is not possible for the appointed contractor to eliminate falling hazards by erecting secure barricading or hoarding, or during the installation and dismantling of temporary structures, the appropriate fall protection equipment must be used. The process of selection of the appropriate type of fall protection equipment for the tasks to be performed must form part of the fall protection plan i.e. an equipment needs analysis per task.

The fall protection equipment must be SANS approved and must be routinely inspected by a competent person appointed in writing. All inspection results must be recorded on a register and signed off by the competent person. All fall protection equipment, including life-lines, must be attached to secure anchor points capable of taking the anticipated shock load.

3.13 DEMOLITION WORK (Includes removal of old Chillers, pumps and piping)

Demolition work must be conducted in compliance with Construction Regulation 14 and must be under the supervision of a competent person appointed in writing. A demolition method statement must be prepared by the appointed contractor and approved by the Structural Engineer for the demolition of any structural elements of the building. The demolition of non-structural elements, such as the removal of old ventilation ducting, must also be included in the method statement. The Demolition Work Supervisor and the Structural Engineer must check the structural integrity of the structure being demolished at intervals determined in the method statement.

3.14 LIFTING MACHINES AND EQUIPMENT (Only applicable if used on site) (If used on site)

The appointed contractor and their sub-contractors must ensure that all lifting machinery plant comply with the requirements of Construction Regulation 23. Procedure and process of lifting machines shall be documented in the Safety plan.

3.15 SUPPORT WORK (Only if done on this project)

All support work operations, should they be required during the removal and installation of any elevated structural work etc, must be conducted in compliance with the requirements of Construction Regulation 12 and must be under the supervision of a competent person appointed in writing. The Support work Supervisor must inspect all the equipment before use and must certify it as safe to use. The Support work Supervisor must then inspect the completed installation before loading. All inspections must be recorded, signed off by the Support work Supervisor and be available on site in the health and safety file.

The support work must be designed by a professional engineer and must be assembled as per the drawings issued. The appointed contractor must submit a method statement to detail how they will safely install and dismantle the support work.

3.16 MOBILE PLANT (If used on site)

The appointed contractor and their sub-contractors must ensure that all mobile plant comply with the requirements of Construction Regulation 23. The appointed contractor and their sub-contractors must conduct daily pre-ignition inspections of the construction plant used on site and keep records of inspections. The appointed contractor and their sub-contractors must ensure that all plant operators are competent and that copies of their training certificates and medical certificates of fitness are kept on site in the health and safety file.

A map of the planned vehicle access routes, flagmen positions, fencing / hoarding, parking areas and loading / offloading points must be included in the method statement addressing the control of construction vehicles and mobile plant.

3.17 HIRED PLANT AND MACHINERY (If used on site)

The appointed contractor shall ensure that any hired plant and machinery used on site is safe for use (including where applicable load test certificates, road worthy certificates, inspection registers). The necessary requirements as stipulated by Construction Regulation 23 shall apply. The appointed contractor and their sub-contractors shall ensure that operators hired with machinery are competent and that training certificates and medical certificates of fitness are kept on site in the health and safety file.

The appointed contractor and not the hiring company will be held responsible for any incidents involving faulty hired machinery.
3.18 **ELECTRICAL INSTALLATIONS AND EQUIPMENT**

The appointed contractor must ensure that the use of the temporary electrical installation and all portable electrical tools is conducted in compliance with Construction Regulation 24, the Electrical Machinery Regulations and the Electrical Installation Regulations.

The appointed contractor must ensure that the location of all existing services is determined before commencing with any work that may affect those services. Close coordination with the professional team will be required to ensure that no services are accidentally damaged which could result in harm to site personnel, college staff, students, visitors or members of the public. Where the location or status of existing services is unknown or unclear, the appointed contractor must stop work in that location and consult with the professional team before continuing with the work.

The appointed contractor must ensure that the location of all existing services is determined before commencing with any work that may affect those services. Close coordination with the professional team will be required to ensure that no services are accidentally damaged which could result in harm to site personnel, college staff, students, visitors or members of the public. Where the location or status of existing services is unknown or unclear, the appointed contractor must stop work in that location and consult with the professional team before continuing with the work.

The appointed contractor must ensure that the location of all existing services is determined before commencing with any work that may affect those services. Close coordination with the professional team will be required to ensure that no services are accidentally damaged which could result in harm to site personnel, college staff, students, visitors or members of the public. Where the location or status of existing services is unknown or unclear, the appointed contractor must stop work in that location and consult with the professional team before continuing with the work.

Electrical Installation Regulations. The appointed contractor must ensure that all electrical tools, electrical distribution boards, extension leads, and plugs are correctly wired and maintained in safe working condition. Cables must be protected from damage on site and armoured cable must be used for the cables feeding the temporary distribution boards.

Regular toolbox talks must be conducted and recorded to make workers aware of the dangers and control measures to be implemented.

The appointed contractor must comply and enforce compliance by their sub-contractors with the following:

- xxv. A competent person must conduct and record weekly inspections of the temporary electrical installation;
- xxvi. Electrical machinery, including portable electrical tools, must be inspected daily by an appointed competent person and the inspection results must be recorded on a register at least monthly;
- xxvii. Only authorized trained personnel may use electrical equipment. Proof of training will be required.
- xxviii. Awareness training is carried out and compliance is enforced at all times;
- xxix. Personal protective equipment and clothing is provided and maintained for the use of portable electrical tools.

3.19 **EXISTING SERVICES**

The appointed contractor must ensure that the location of all existing services is determined before commencing with any work that may affect those services. Close coordination with the professional team will be required to ensure that no services are accidentally damaged which could result in harm to site personnel, college staff, students, visitors or members of the public. Where the location or status of existing services is unknown or unclear, the appointed contractor must stop work in that location and consult with the professional team before continuing with the work.

3.20 **STACKING AND STORAGE**

The appointed contractor and other relevant sub-contractors shall ensure that there are sufficient appointed Storage Supervisors and that all materials and equipment are stacked and stored safely in planned, designated areas. Double handling of material should be avoided.
3.21 PUBLIC SAFETY

The appointed contractor shall ensure that every person working on or visiting the site, as well as the college staff, students and public in general, is made aware of the dangers likely to arise from the site activities, including the precautions to be taken to avoid or minimize those dangers. The appointed contractor has a duty to do all that is reasonably practicable to prevent college staff, students, and members of the public and site visitors from being adversely affected by their construction activities. The site must be enclosed by fencing or hoarding and the appropriate health and safety warning notices and signs must be displayed on the hoarding and at all entrances to the site. Site visitors must be inducted upon arrival to site on the risks that they may be exposed to and what measures must be taken to control these risks. A record of the visitor inductions must be kept on site in accordance with Construction Regulation 9. The site office must be strategically located so that site visitors are not exposed to site risks prior to reporting at the office. Visitors not wearing the prescribed protective equipment must not be permitted onto site.

3.22 OCCUPATIONAL HEALTH AND SAFETY SIGNAGE

The appointed contractor must provide appropriate site health and safety signage, including but not limited to: ‘No Unauthorized Entry’, ‘Visitors Report to Site Office’, ‘Beware of Overhead Work’, ‘Hard Hat Area’, ‘First Aid’, ‘Fire Extinguishers’, all relevant PPE pictograms etc. Signage shall be posted up at all entrances to the site as well as in strategic locations on site e.g. access routes, stairways, entrances to structures and buildings, scaffolding, and other potential risk areas/operations. Emergency evacuation routes and assembly points must be sign posted accordingly.

3.23 HOT WORKS (Where required)

Hot work operations must be conducted in compliance with the requirements of General Safety Regulation 9. A competent supervisor must be appointed in writing that will be responsible for ensuring that all welding, flame cutting, brazing or soldering equipment is kept in safe working condition and used in a safe manner. Firefighting equipment must be available on stand-by at all hot work locations. The appointed contractor will be required to issue hot work permits to sub-contractors performing hot works (welding, flame cutting, brazing or soldering). The hot work permits may only be issued once the appointed Contractor is satisfied that the area where the work is to be conducted is safe to operate in and that the equipment to be used has been inspected and is safe for use. The appointed contractor must ensure that the hot work is effectively screened off, where applicable, and cannot adversely affect other site personnel, tenants, visitors or members of the public.

3.24 MEDICAL CERTIFICATES OF FITNESS

Medical certificates of fitness must be available in the health and safety file for employees:

- xxx. working at elevated heights.
- xxxi. working with equipment producing noise in excess of 85dB, e.g. use of grinders, circular saws etc.
- xxxii. operating construction vehicles and mobile plant

3.25 PERSONAL PROTECTIVE EQUIPMENT (PPE)

The appointed contractor must ensure that the appropriate PPE to be used on site is identified and issued to all site personnel, including sub-contractors and visitors. A PPE needs analysis must be conducted per task to identify the PPE required. A PPE issue register must be kept and the use of PPE must be enforced by the Construction Supervisor. A regular inspection of the PPE must be conducted by an appointed person and the PPE must be maintained in good working condition. All PPE must be provided free of charge and replaced if damaged.

3.26 HAZARDOUS CHEMICAL SUBSTANCES (Not Applicable )

The appointed contractor must compile a list of all hazardous chemical substances (HCS) to be used during the project. Material Safety Data Sheets (MSDS) must be available on site for all HCS. All affected personnel must be trained on the content of the MSDS and the training recorded on a register. The training must address the safe use, transport, storage and disposal of HCS. HCS include: cement, cementitious products, epoxies, paint, thinners etc. The appointed contractor must ensure that the use, transport, storage and disposal of HCS is carried out as prescribed by the HCS Regulations and the National Environmental Management: Waste Act, No.59 of 2008.

The First Aiders must be made aware of the first aid requirements contained in the MSDS and how to treat HCS incidents appropriately.
The storage and issuing of HCS must be strictly controlled by the appointed Storage Supervisor.

3.27 EMERGENCY PROCEDURES

The appointed Contractor must prepare a site specific emergency response plan and it must fall in line with the campus emergency procedures, prior to commencement on site, detailing the following key elements:

- xxxiii. List of key competent emergency site personnel;
- xxxiv. Contact details of emergency services;
- xxxv. Actions to be taken and by whom, in the event of different types of emergencies;
- xxxvi. Evacuation map detailing evacuation routes, assembly points and location of firefighting equipment;
- xxxvii. Information on hazardous materials or situations.

The appointed contractor must advise IThemba Labs Safety Officer immediately, of any emergency situation, together with a record of action taken. The emergency response plan and the contact list, of all emergency service providers (Fire Department, Ambulance, Police, Medical and Hospital, etc.) must be displayed prominently on site.

All persons on site must be informed of the emergency procedures to be followed and a register must be kept as proof that the information was communicated.

3.28 FIRST AID

A first aid box must be available on site at all times and must be under the control of a certified First Aider appointed in writing if there are 10 or more employees on site. The name of the First Aider and location of the first aid box must be prominently displayed. The contents of the first aid box must be in compliance with the Annexure of the General Safety Regulations.

3.29 ACCIDENT / INCIDENT REPORTING AND INVESTIGATION

The appointed contractor must have a documented incident reporting procedure in place that must be communicated to all site personnel.

All incidents, including near miss incidents, must be investigated by the appointed Incident Investigator and a comprehensive report compiled for each incident, which must include a full description of the incident and the remedial actions to be implemented to prevent its reoccurrence. All incidents must be immediately verbally reported to IThemba Labs Safety Officer. Written incident reports must be forwarded to IThemba Labs Safety Officer upon completion.

The appointed contractor must maintain an incident register to log the occurrence of all incidents. In the event of a reportable incident occurring (see section 24 of the OHS Act), the appointed contractor will notify the Department of Labour in writing within 7 days using the Annexure 1 form of the General Administrative Regulations.

3.30 FIRE FIGHTING

The appointed contractor must provide sufficient fire extinguishers to adequately protect the site (Unless otherwise arranged with the campus head to use their equipment on site). The fire extinguishers must be checked monthly by a competent person appointed in writing. The fire extinguishers must be in service date (annual service) and kept in good working condition. The location of firefighting equipment must be clearly signposted and must remain unobstructed at all times. A team of fire fighters, competent in the use and inspection of the firefighting equipment must be trained.

3.31 HEALTH & SAFETY REPRESENTATIVES AND COMMITTEE

Due to the nature of this project the expected staff compliment of the appointed contractor should not exceed 10 Staff members.

3.32 HOUSEKEEPING

Good housekeeping and stacking practices are imperative as the uncontrolled accumulation of waste materials and equipment can cause serious accidents by obstructing access on and around the site. The appointed contractor must prepare a written refuse removal plan and must ensure that the site is kept tidy at all times.
3.33 HEALTH AND SAFETY NOTICE BOARD (Only if a site office is established on site)

The appointed contractor will erect a health and safety notice board in a suitable and prominent place where all relevant health and safety notices must be displayed. The notices and documents to be displayed must include, but will not be limited to:

xxxviii. Health and safety organogram;
xxxix. Site layout map;
xl. Emergency procedures and contact numbers for emergency services and emergency site staff;
xli. Evacuation route maps;
xlii. Current DSTI;
xliii. Current risk assessments and safe work procedures;
xliv. Induction information;
xlv. Awareness posters e.g. HIV / AIDS, use of tools etc.
xlvi. The relevant standards incorporated into the act

3.34 OCCUPATIONAL HEALTH

3.34.1 Occupational Hygiene

The appointed contractor must ensure that adequate health and hygiene measures are put in place to prevent exposure to health hazards such as concrete dust, noise, vibrations from machinery, lifting heavy loads and exposure to chemicals. Particular emphasis must be placed on the mitigation of the risk of silicosis caused by the creation of concrete dust during the demolition process or cutting into walls for fixing points of the ventilation systems to be installed.

3.34.2 Welfare Facilities

The appointed contractor must supply a sufficient number of clean, hygienic toilets (at least 1 toilet per 15 workers), changing facilities, hand washing facilities, soap, toilet paper, and hand drying material. Waste bins must be strategically placed and emptied regularly. Safe, clean storage areas must be provided for workers to store personal belongings and personal protective equipment. Workers should not be exposed to hazardous materials/substances while eating and must be provided with sheltered eating areas as the loitering by workers on the campus is not allowed at all. Adequate potable water must be provided.

3.34.3 Alcohol and other Drugs

No alcohol and other drugs will be allowed on site. No person may be under the influence of alcohol or any other drugs while on the construction site. The appointed contractor must provide means for testing personnel suspected of being under the influence of alcohol.

Any person suffering from a chronic illness or taking prescription medication with known side effects must report this to site Health and Safety Officer/ Site supervisor. This will enable faster treatment should that person be involved in an accident.

Any person suspected of being under the influence of alcohol or other drugs must be sent home immediately, to report back the next day for a preliminary inquiry. A comprehensive disciplinary procedure must be followed and a copy of the disciplinary action must be included in the site health and safety file.

3.35 PENALTIES (Only if required by the client: iThemba Labs)

A fine or cease works order will be imposed on the appointed contractor for each non-compliance with the following legislation and documents:

xlvii. The Occupational Health and Safety Act, No.85 of 1993 and the regulations promulgated thereunder;
xlviii. The relevant standards incorporated into the act;
xlix. The project health and safety specification;
lix. The appointed contractor’s health and safety plan and supporting documentation;
lxi. The sub-contractors’ health and safety plans and supporting documentation.

Where the non-compliances are not immediately rectified or rectified within the agreed time limits, the fines or cease works order will recur daily until the non-compliances are rectified to the satisfaction of the Health and Safety Agent and professional team.
3.36 **CHECKLISTS AND REGISTERS**

Checklists and registers must be regularly completed *(frequency varies depending on the activity, equipment or materials)* and kept in the H&S File on site. A sample of the checklists and registers required to be kept include:

**REGISTERS & CHECKLISTS**

**EQUIPMENT & MATERIALS FREQUENCY OF INSPECTION**
- Mobile Plant Checklist Daily
- Electrical Installations Checklist Weekly
- Electrical Machinery Checklist (includes Portable Electric Tools) Daily
- Explosive Power Tool Issuing & Collection Register As utilized
- Fall Prevention & Protection Equipment Checklist (To be identified in the Fall Protection Plan)
- Fire Fighting Equipment Checklist Monthly
- First Aid Box Contents Checklist Monthly
- First Aid Treatment Register As utilized
- Hand Tool Checklist Weekly
- Hazardous Chemical Substances Register, including MSDS’s As utilized
- Ladder Checklist Monthly
- PPE and Protective Clothing Issuing Register As Issued
- PPE and Protective Clothing Inspection Checklist Weekly
- Scaffold Checklist Weekly, after alterations or inclement weather
- Stacking & Storage Checklist Weekly
- Welding, Flame Cutting & Soldering Checklist Weekly

**TRAINING REGISTERS**
- H&S Induction Register (Including Contractors & Visitors) before beginning work or entering the site
- Safe Work Procedure Training Register Before beginning of specific tasks
- MSDS Training Register Before use of chemicals
- Medical Certificate of Fitness Register Before beginning work
- Daily Safe Task Instruction (DSTI) Daily
ANNEXURE 2

GENERAL TECHNICAL SPECIFICATION

FOR

AIR CONDITIONING INSTALLATIONS

REV 1 – MAY 2009

CONSULTING ENGINEERS
BVI CONSULTING ENGINEERS INCORPORATING BASIL NAIＲ & ASSOCIATES
P O Box 86, CENTURY CITY, 7446
Telephone: (021) 527 7000 CAPE TOWN
cpl@bviwc.co.za
www.basilnair.co.za

REFERENCE IV-01
# GENERAL TECHNICAL SPECIFICATION
## FOR
### AIR CONDITIONING INSTALLATIONS

<table>
<thead>
<tr>
<th>Clause</th>
<th>Page Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Index</td>
<td>133</td>
</tr>
<tr>
<td>4.1 Scope</td>
<td>134</td>
</tr>
<tr>
<td>4.2 General</td>
<td>134</td>
</tr>
<tr>
<td>4.3 Chilled Water Generators</td>
<td>135</td>
</tr>
<tr>
<td>4.4 Packaged Air Conditioning Units - Air Cooled and Evaporative Condenser Cooled</td>
<td>138</td>
</tr>
<tr>
<td>4.5 Air Handling Units</td>
<td>141</td>
</tr>
<tr>
<td>4.6 Refrigeration Condensing Units - Air Cooled</td>
<td>143</td>
</tr>
<tr>
<td>4.7 Refrigeration Pipework</td>
<td>145</td>
</tr>
<tr>
<td>4.8 Refrigeration Charge</td>
<td>146</td>
</tr>
<tr>
<td>4.9 Packaged Air Conditioning Units - Water Cooled</td>
<td>147</td>
</tr>
<tr>
<td>4.10 Cooling Towers</td>
<td>149</td>
</tr>
<tr>
<td>4.11 Closed Circuit Coolers</td>
<td>150</td>
</tr>
<tr>
<td>4.12 Water Treatment</td>
<td>151</td>
</tr>
<tr>
<td>4.13 Water Pumps</td>
<td>153</td>
</tr>
<tr>
<td>4.14 Water Pipework</td>
<td>154</td>
</tr>
<tr>
<td>4.15 Chilled Water Pipework Insulation</td>
<td>157</td>
</tr>
<tr>
<td>4.16 Ductwork</td>
<td>159</td>
</tr>
<tr>
<td>4.17 Ductwork Insulation</td>
<td>161</td>
</tr>
<tr>
<td>4.18 Diffusers, Grilles and Louvres</td>
<td>162</td>
</tr>
<tr>
<td>4.19 Dampers</td>
<td>163</td>
</tr>
<tr>
<td>4.20 Sound Attenuators</td>
<td>164</td>
</tr>
<tr>
<td>4.21 Air Filters</td>
<td>165</td>
</tr>
<tr>
<td>4.22 Propeller Fans</td>
<td>166</td>
</tr>
<tr>
<td>4.23 Axial Flow Fans</td>
<td>167</td>
</tr>
<tr>
<td>4.24 Centrifugal Fans</td>
<td>168</td>
</tr>
<tr>
<td>4.25 Electric Motors</td>
<td>169</td>
</tr>
<tr>
<td>4.26 Machinery Drives</td>
<td>170</td>
</tr>
<tr>
<td>4.27 Electric Heater Batteries</td>
<td>171</td>
</tr>
<tr>
<td>4.28 Electrode Humidifiers</td>
<td>172</td>
</tr>
<tr>
<td>4.29 Automatic Controls</td>
<td>173</td>
</tr>
<tr>
<td>4.30 Switchpanels and Control Boards</td>
<td>175</td>
</tr>
<tr>
<td>4.31 Electric Wiring</td>
<td>180</td>
</tr>
<tr>
<td>4.32 Instruments</td>
<td>182</td>
</tr>
<tr>
<td>4.33 Equipment Bases</td>
<td>183</td>
</tr>
<tr>
<td>4.34 Equipment Supports</td>
<td>185</td>
</tr>
<tr>
<td>4.35 Noise and Vibration</td>
<td>186</td>
</tr>
<tr>
<td>4.36 Painting and Cleaning</td>
<td>187</td>
</tr>
<tr>
<td>4.37 Labelling and Identification</td>
<td>189</td>
</tr>
<tr>
<td>4.38 Commissioning and Testing</td>
<td>190</td>
</tr>
<tr>
<td>4.39 Operating and Maintenance Instructions</td>
<td>193</td>
</tr>
<tr>
<td>4.40 Spare Parts</td>
<td>195</td>
</tr>
<tr>
<td>4.41 Maintenance</td>
<td>196</td>
</tr>
<tr>
<td>4.42 Drains</td>
<td>197</td>
</tr>
<tr>
<td>4.43 Exclusions</td>
<td>198</td>
</tr>
</tbody>
</table>
4.1 SCOPE

4.1.1 This General Specification describes the usual material required for Air Conditioning installations and the general methods of constructing and installing the various components and equipment associated therewith.

4.1.2 This General Specification forms a supplement to the drawings and specifications for a particular subcontract. Where the detailed Specification of Part V and/or the drawings differ from this General Specification, the Detailed Specification and Drawings shall take precedence.

4.2 GENERAL

4.2.1 All workmanship and materials used in the installation shall be of the highest quality and, where not fully covered by this Specification, shall conform with best modern practice, as determined by the Engineer.

4.2.2 The entire installation shall comply fully with all relevant requirements of governmental and local authorities and the equipment provided for the installation shall comply in all respects with the Occupational Health and Safety Act of 1993 as amended.

4.2.3 All electrical work associated with the installation shall comply with the requirements of the Municipal Authorities and shall be carried out in accordance with the latest edition of the "Standard Regulations for the Wiring of Premises".

4.2.4 Alternative equipment, materials or apparatus from those that are noted or required on the drawings and/or in the Specifications, may only be offered and supplied on the written approval of such equipment, material or apparatus by the Engineer.

4.2.5 All things being equal, preference will be given to South African manufactured equipment, material or apparatus. In cases where all the necessary information is not supplied by the tenderer, then the Engineer's decision shall be final.
4.3 CHILLED WATER GENERATORS

4.3.1 DESIGN, MATERIALS AND FINISH

4.3.1.1 Chillers shall be of standard, factory assembled packaged type and the design, material and finish shall be equivalent to a well known make approved by the Engineer.

4.3.1.2 The refrigerant to be used shall be R134a unless otherwise specified in Part V.

4.3.2 CAPACITY

4.3.2.1 The cooling capacity as specified in Part V shall be delivered in accordance with the relevant ARI specification.

4.3.2.2 The fouling factors used when selecting chillers shall not be less than the following:

- Condenser tubes: 0.088 m² K/kW
- Chiller tubes: 0.044 m² K/kW

4.3.2.3 The maximum permissible saturated condensing temperature is 40.6°C.

4.3.2.4 The minimum permissible saturated suction temperature is 1°C.

4.3.2.5 The minimum permissible sub-cooling of the refrigerant is 6°C at full load.

4.3.3 COMPONENTS

The chiller shall comprise the following:

- One or more reciprocating or screw compressor;
- One or more evaporator;
- One or more water cooled condenser;
- All necessary refrigeration pipework;
- Accessories as listed;
- Control equipment as listed;
- Frame; and
- Compressor motor drive

4.3.4 COMPRESSOR(S)

The compressor(s) shall be of the screw type or of the open or semi-hermetic reciprocating type with built-in cylinder head by-pass controlled by either suction pressure or external signal in a number of steps as specified in Part V. The compressor shall be fitted with suction and discharge valves and crankcase heater. The compressor shall be direct driven at a speed not exceeding that of a four pole motor. A sight glass for checking oil level shall be fitted in the crankcase.
4.3.5 WATER COOLED CONDENSER

4.3.5.1 The condenser(s) shall be of the multi-pass shell and tube type constructed in accordance with the relevant ASME code. The condenser(s) shall be equipped with a pressure relief device and liquid line isolating valve.

4.3.5.2 The condenser(s) shall be circuited to give the sub-cooling specified and shall be fitted with a device with which the liquid level within the condenser can be readily and reliably checked whilst the machine is on load.

4.3.5.3 The condenser shell shall be fitted with either a marine type water box or shall be connected to external piping in such a way that the water box covers can be easily removed.

4.3.5.4 The maximum permissible velocity of water in the tubes is 3 m/s.

4.3.6 EVAPORATOR

The evaporator shall be of direct expansion type with refrigerant flowing in the tubes and water in the shell. The shell shall be lagged with a minimum of 25mm non-combustible insulation, vapour sealed and finished with a durable outer protection.

4.3.7 REFRIGERANT CIRCUIT(S)

Each circuit shall include the following components:

- Refrigeration pipework in accordance with Part IV Clause 7.
- Expansion Valve
- Liquid line solenoid valve
- Filter driers with replaceable core.
- Sight glass situated above the operating level of the liquid in the condenser.
- Liquid line shut-off valve.
- Hot gas muffler.

4.3.8 INSTRUMENTATION

The unit shall be fitted with gauges to indicate suction pressure, discharge pressure and oil pressure for each compressor.

4.3.9 CONTROL AND ACCESSORIES

The unit shall be wired with all necessary controls in a separate enclosure. The following components shall be included:

4.3.9.1 Crankcase heater control to operate when compressor stops.

4.3.9.2 Non-recycling pump down relay.

4.3.9.3 Timer to prevent compressor cycling in less than five minutes. (Units above 40kW refrigeration capacity only).

4.3.9.4 Transformer if controls are to operate at less than mains voltage.

4.3.9.5 High and low pressure cut out, the former with manual reset.
4.3.9.6 Oil pressure cut out with manual reset.

4.3.9.7 Unloaders to bypass cylinder heads on start up.

4.3.9.8 Low water temperature safety protection.

4.3.9.9 Chilled water leaving temperature control set to operate with a minimum of four steps in units above 200 kW refrigeration capacity, and in two steps in units above 100 kW refrigeration capacity.

4.3.10 **MOTOR**

The compressor(s) shall be driven by a three phase squirrel cage induction motor(s). The motor(s) shall have sufficient power and torque for all operating conditions on the compressor(s).

The motor(s) shall have four or six poles. Where open compressor(s) are used, standard protected drip proof or totally enclosed fan cooled motor(s) shall be fitted.

4.3.11 **DRIVE**

Where open compressor(s) are used the motor(s) shall be direct coupled to the compressor(s) by a flexible drive. A protective coupling guard shall be fitted to each drive.

4.3.12 **FRAME**

Components shall be mounted on a rigid frame such that any major component can be readily removed without removing other components. The base holding the motor-compressor shall be sufficiently rigid to prevent any torsional or lateral vibration or misalignment between the motor and compressor shafts.

Anti-vibration mounting shall be in compliance with Part IV Clause 35.
4.4 **PACKAGED AIR CONDITIONING UNITS - AIR COOLED AND EVAPORATIVE CONDENSER COOLED**

4.4.1 The packaged air conditioning units shall be suitable in all respects for outdoor location and shall be equal to GÜNTER Roof Mounted Packaged Air Conditioners.

4.4.2 Units shall comprise the following components all housed within, or forming part of, their cabinet:

- Refrigeration Compressors
- Air Cooled Condensing coils
- Condenser Fans and Motors
- Refrigeration pipework and controls
- Refrigerant gas charge
- Direct Expansion Cooling coils
- Centrifugal Supply Air Fans with Motor and Belt Drive
- Electric Heater Elements
- Cleanable air filters
- Mixing plenum with Economy Cycle Dampers
- Electric Switchpanel
- Internal electrical wiring.

4.4.3 Unit casings shall be constructed of not less than 1.2mm thick mild steel panels suitably braced and framed so as to prevent drumming, whilst at the same time being arranged in easily removable panels to facilitate access to any portion of the internal components. Casing panels shall be attached to a sub-frame of welded mild steel sections, which framework shall also hold all internal equipment in position. The casing panels shall be internally lined with "sonic liner" or equivalent non-combustible material, such insulation being adequately secured to the internal surfaces with non-combustible adhesive and mechanical fasteners. All mild steel casing panels and framework shall be thoroughly degreased and then painted with a suitable rustproofing primer prior to the application of two finishing coats of good quality enamel or lacquer in the standard colour of the manufacturer.

4.4.4 Tenderers are to note that the unit casing specification above is the minimum required, and that preference will be given to units having double skin panel construction. Further, preference will be given to units having an outer skin of anodised aluminium, or fibreglass construction.

4.4.5 Units shall contain a minimum of two refrigeration compressors. These shall be of the hermetic or the accessible hermetic type, direct driven by integral suction gas cooled squirrel cage motors, at a rotational speed not exceeding 1500 r.p.m. The compressor shall be complete with positive displacement reversible force-feed lubrication systems, and shall have low oil pressure protection, and shall contain crankcase oil heaters to ensure boil-off of dissolved refrigerant from lubricating oil when the compressors are stationary. Each compressor shall have at least one stage of capacity modulation other than full load and shall be arranged to start unloaded.

Each compressor shall have at least one stage of capacity modulation other than full load and shall be arranged to start unloaded.

4.4.6 Condenser coils shall consist of copper tubes with mechanically bonded aluminium plate fins, all housed in a robust galvanised steel frame and protected with a suitable galvanised wire mesh screen. Suitable space shall be provided at the coil ends in order that tube bends are easily accessible in the event of possible refrigerant leaks.

4.4.7 Condenser fans shall be of the slow-running propeller type, direct driven by squirrel cage electric motors. The units shall be provided with a minimum of two propeller fans, which shall be arranged, preferably for vertical discharge through suitable weatherproofed protective wire guards. The fan and motor bearings shall be of the permanently lubricated sealed type, and the motor shall be resiliently mounted so as not to transmit vibration to the unit casing.

4.4.8 Condenser air intake and discharge arrangements shall be such that no short-circuited discharge air can be drawn back into the air intake.

4.4.9 Refrigeration pipework shall be carried out in seamless, refrigeration quality copper tubing, suitable provision being made to ensure that the piping is not subjected to any stresses from vibration of the
compressors. The refrigeration system shall be split into at least two stages on the liquid side for adequate capacity control. Refrigerant circuits shall incorporate replaceable core type filter-driers, sight glasses, thermostatic expansion valves and vapour proof insulation on the suction lines. The systems shall be factory charged with Refrigerant 22.

4.4.10 Automatic safety controls within the unit shall include a dual pressure switch with manual reset on the high pressure side, and an oil pressure switch with manual reset. Provision shall be made for pressure relief of the high side refrigerant piping in accordance with government regulations. Provision shall also be made for cycling the condenser fans so that the units may be capable of operating down to an ambient temperature of 10ºC db.

4.4.11 Direct expansion cooling coils shall consist of at least two separate refrigerant circuits and shall comprise of copper tubes with mechanically bonded aluminium fins. The coils shall be encased in a heavy gauge grade 304 stainless steel casing fitted with a 1.2mm thick grade 304 stainless steel condensate pan so sized and located as to prevent entrainment of moisture into the air stream, whilst also ensuring positive drainage of condensate.

Cooling coil sizes shall be selected so that the face velocity does not exceed 2.5 m/s.

4.4.12 Supply air fans shall be of the double inlet, forward curved centrifugal type with impellers running in sealed, permanently lubricated ball-bearings incorporating pillow blocks located in the suction eye on both sides of each fan. Fan impellers shall be statically and dynamically balanced, and shall run well below critical speed. Fan assemblies shall be so mounted within the packaged air conditioning unit that they do not transmit any vibration. Where units having more than one fan are offered, these shall all be driven by a common motor.

4.4.13 Tenderers are to note that the supply air fan specification above is the minimum required and that preference will be given to units having a single, backward curved centrifugal fan mounted on anti-vibration mounts, and complete with a ventilated removable guard on the V-belt drive.

4.4.14 Supply air fan motors shall be three phase squirrel cage type, rated not less that 25% above the power input absorbed by the fans, and shall run at a rotational speed not exceeding 1500 r.p.m. The motor shall drive the fans by means of a V-belt drive having not less than two V-belts.

4.4.15 Heater elements shall be of the factory-bent, incaloy type, rated for still air, and fitted into the unit in such a manner as to ensure full air flow over each element.

The heater elements shall be fitted into a withdrawable fabricated galvanised channel frame. The side on which the terminals are located shall be fitted with a terminal base of sufficient size to contain all necessary electrical wiring. The terminal box shall be fitted with a removable weather proofed cover so fastened that no screw shall project into the actual terminal box. The electrical wiring within the terminal box shall be effected in insulated wiring capable of withstanding the temperatures encountered without breakdown of the insulation.

4.4.16 Air filters shall be equal to FIBATRON WP77, minimum 50mm thick, high performance washable, pleated panel type, housed in adequate holding frames, and fitted with gaskets to ensure a positive airtight seal around them.

4.4.17 The return air and fresh air mixing plenum shall be factory installed and shall be of similar construction to the rest of the cabinet. The mixing plenum shall be complete with return air and maximum fresh air volume control dampers equal to those specified later herein.

4.4.18 Because of the use of an economy cycle, and the resultant possible low "on coil" dry bulb temperature in the intermediate season, the compressors shall be protected by low limit thermostats positioned in the mixing plenum, and set to prevent the compressors from operating at a mixed temperature below 18ºC.
4.4.19 A weatherproof electrical switchpanel shall be incorporated to form part of the unit, and shall house all the necessary switchgear and controls required to operate the various components within the units. The switch panel shall comply with best modern practice, and shall incorporate all necessary protection against overload or short-circuit. The switchpanel shall be fitted with a suitably sized main isolator backed up by High Rupturing Capacity fuses with a minimum capacity to suit the system fault level. In addition phase failure relays shall be incorporated to protect against low voltage or phase failure. The switchgear shall be fully interlocked so that cooling and heating cannot operate simultaneously, and so that the compressors cannot operate unless the condenser fans and supply air fans are operational. A run down timer shall be incorporated so that the supply air fans shall continue to run for three minutes after the unit is switched off. The switchpanels shall be fully labelled with engraved black ivorine labels having 6mm high white lettering. The labels shall be rivetted to chassis plates to identify all switchgear, relays, instruments and controls inside the switchpanel.

4.4.20 Wiring within the switchpanel and the unit shall comply with wiring regulations as relevant, and shall be neatly grouped in horizontal and vertical runs in P.V.C. trunking. All wiring shall be colour-coded in the colours red, yellow and blue for the relevant phases, and black for neutral, the busbars being similarly marked. Busbars shall be copper of adequate cross sectional area, suitably spaced and mounted on stand-off type porcelain insulators. All exposed current carrying parts must be fully insulated with P.V.C. tape of the colours mentioned above. Every wire inside, and outside the switchpanel, shall be fitted with ferrules and shall be labelled with identical numbers at both ends. All outgoing leads shall be connected to a clearly marked terminal strip.

4.4.21 All equipment stored or installed on site shall be adequately protected at all times, until the final overall acceptance of the entire installation by the engineer.
4.5 AIR HANDLING UNITS

4.5.1 Units shall comprise the following components all housed within, or forming part of, their steel cabinets:

- Direct Expansion Cooling Coil
- Refrigeration or Chilled Water Pipework and Controls
- Centrifugal Supply Air Fans with Motor and Belt Drive
- Cleanable Air Filters
- Internal Electrical Wiring

4.5.2 Unit Casings shall be constructed of not less than 1.2mm thick mild steel panels suitably braced and framed so as to prevent drumming, while at the same time being arranged in easily removable panels to facilitate access to any portion of the internal components. Casing panels shall be attached to a sub-frame of welded mild steel sections, which framework shall also hold all internal equipment in position. The casing panels shall be internally lined with “sonic liner” or equivalent non-combustible material, such insulation being adequately secured to the internal surfaces with non-combustible adhesive and mechanical fasteners. All mild steel casing panels and framework shall be thoroughly degreased and then painted with a suitable rustproofing primer prior to the application of two finishing coats of good quality enamel or lacquer in the standard colour of the manufacturer.

Coastal unit casings shall be of galvanised construction throughout and generally in accordance with the above.

4.5.3 Tenderers are to note that the unit casing specification above is the minimum required, and that preference will be given to units having double skin panel construction.

4.5.4 Direct expansion cooling coils shall consist of at least two separate refrigerant circuits.

Cooling coils shall comprise copper tubes with mechanically bonded aluminium fins. The coils shall be encased in a heavy gauge grade 304 stainless steel casing fitted with a 1.2 mm thick grade 304 stainless steel condensate pan, so sized and located to prevent entrainment of moisture into the air stream, whilst also ensuring positive drainage of condensate.

Cooling coil sizes shall be selected so that the face velocity does not exceed 2.5 m/s.

The chilled water flow through the cooling coil shall be counter flow to the airflow across the cooling coil. The chilled water connections shall be supply at the bottom, and return at the top.

4.5.5 Refrigeration pipework shall be carried out in seamless refrigeration quality copper tubing. The refrigeration system shall be split into at least two stages on the liquid side for adequate capacity control. Refrigerant circuits shall incorporate replaceable core type filter-driers, sight glasses, thermostatic expansion valves and vapour proof insulation on the suction lines.

4.5.6 Supply air fans shall be of the double inlet, forward curved centrifugal type, with impellers running in sealed, permanently lubricated ball-bearings incorporating pillow blocks located in the suction eye on both sides of each fan.

Fan impellers shall be statically and dynamically balanced and run well below critical speed. Fan assemblies shall be so mounted within the air handling unit that they do not transmit any vibration. Where units having more than one fan are offered, these shall all be driven by a common motor.

4.5.7 Supply air fan motors shall be three phase, squirrel cage type, rated not less than 25% above the power input absorbed by the fans, and run at a rotational speed not exceeding 1500 r.p.m. The motor shall drive the fans by means of a V-belt drive having not less than two V-belts.

4.5.8 Air filters shall be equal to FIBATRON WP77, minimum 50mm thick, high performance washable, pleated panel type, housed in adequate holding frames, and fitted with gaskets to ensure a positive airtight seal around them.
4.5.9 Internal electrical wiring shall comply fully with wiring regulations as relevant, and shall be adequately secured. Adequate earthing shall be allowed.

4.5.10 Air handling units shall be equivalent to the make specified on the layout drawings or in Part V.

4.5.11 All equipment stored or installed on site shall be adequately protected at all times, until the final overall acceptance of the entire installation by the engineer.
4.6 REFRIGERATION CONDENSING UNITS - AIR COOLED

4.6.1 Air cooled refrigeration condensing units shall be suitable in all respects for outdoor location and shall comprise the following components housed within, or forming part of, its cabinet:-

- Refrigeration Compressors
- Air Cooled Condensing Coils
- Condenser Fans and Motors
- Refrigeration pipework and controls
- Refrigerant gas charge
- Electric switchpanel
- Internal electrical wiring.

4.6.2 Unit casing shall be constructed of not less than 1.2 mm thick mild steel panels suitably braced and framed so as to prevent drumming, whilst at the same time being arranged in easily removable panels to facilitate access to any portion of the internal components. Casing panels shall be attached to a sub-frame of welded mild steel sections, which framework shall also hold all internal equipment in position. All mild steel casing panels and framework shall be thoroughly degreased and then painted with a suitable rustproofing primer prior to the application of two finishing coats of good quality enamel or lacquer in the standard colour of the manufacturer.

Coastal unit casings shall be of galvanised construction throughout and generally in accordance with the above.

4.6.3 Units shall contain a minimum of two refrigeration compressors. These shall be of the hermetic or the accessible hermetic type, direct driven by integral suction gas cooled squirrel cage type motors, at a rotational speed not exceeding 1500 r.p.m. The compressors shall be complete with positive displacement reversible force-feed lubrication systems, and shall have low oil pressure protection, and contain crankcase oil heaters to ensure boil-off of dissolved refrigerant from lubricating oil when the compressors are stationary.

Each compressor shall have at least one stage of capacity modulation other than full load and shall be arranged to start unloaded.

4.6.4 Condenser coils shall consist of copper tubes with mechanically bonded aluminium plate fins, all housed in a robust galvanised steel frame and protected with a suitable galvanised wire mesh screen. Suitable space shall be provided at the coil ends in order that tube bends are easily accessible in the event of possible refrigerant leaks.

Condenser coils installed under coastal conditions shall consist of copper tubes with mechanically bonded copper plate fins, all housed in a robust stainless steel frame and protected with a suitable stainless steel wire mesh screen. Condensers to be Blygold treated.

4.6.5 Condenser fans shall be of the slow-running propeller type, direct driven by squirrel cage electric motors. The units shall be provided with a minimum of two propeller fans, which shall be arranged preferably for vertical discharge through suitable weatherproofed protective wire guards. The fan and motor bearings shall be of the permanently lubricated sealed type, and the motor shall be resiliently mounted so as not to transmit vibration to the unit casing.

4.6.6 Condenser air intake and discharge arrangements shall be such that no short-circuited discharge air can be drawn back into the air intake.
4.6.7 Refrigeration pipework shall be carried out in seamless, refrigeration quality copper tubing, suitable provision being made to ensure that the piping is not subjected to any stresses from vibration of the compressors. The refrigeration system shall be split into at least two stages on the liquid side for adequate capacity control. Refrigerant circuits shall incorporate replaceable core type filter-driers, sight glasses, thermostatic expansion valves and vapour proof insulation on the suction lines.

4.6.8 Automatic safety controls within the unit shall include a dual pressure switch with manual reset on the high pressure side, and an oil pressure switch with manual reset. Provision shall be made for pressure relief on the high side refrigerant piping in accordance with government regulations. Provision shall also be made for cycling the condenser fans so that the unit may be capable of operating down to an ambient temperature of 10°C db.

4.6.9 A weatherproof electrical switchpanel shall be incorporated to form part of the unit and shall house all the necessary switchgear and controls required to operate the various components within the unit. The switchpanel shall comply with best modern practice, and shall incorporate all necessary protection against overload or short-circuit. The switchpanel shall be fitted with a suitably sized main isolator backed up by High Rupturing Capacity fuses with a minimum capacity to suit the system fault level. In addition phase failure relays shall be incorporated to protect against low voltage or phase failure. The switchgear shall be interlocked so that the compressors cannot operate unless the condenser fans are operational. The switchpanel shall be fully labelled with engraved black ivorine labels having 6mm high white lettering. The labels shall be rivetted to chassis plates to identify all switchgear, relays, instruments and controls inside the switchpanel.

4.6.10 Wiring within the switchpanel and the unit shall comply with wiring regulations as relevant, and shall be neatly grouped in horizontal and vertical runs in P.V.C. trunking. All wiring shall be colour-coded in the colours red, yellow and blue for the relevant phases and black for neutral, the busbars being similarly marked. Busbars shall be copper of adequate cross sectional area, suitably spaced and mounted on stand-off type black porcelain insulators. All exposed current carrying parts must be fully insulated with P.V.C. tape of the colours mentioned above. Every wire inside and outside the switchpanel, shall be fitted with ferrules and shall be labelled with identical numbers at both ends. All outgoing leads shall be connected to a clearly marked terminal strip.

4.6.11 Air cooled refrigeration condensing units shall be selected to match the associated air handling unit, and shall be equivalent to the make specified on the layout drawings or in Part V.

4.6.12 All equipment stored or installed on site shall be adequately protected at all times, until the final overall acceptance of the entire installation by the engineer.
4.7 **REFRIGERATION PIPEWORK**

4.7.1 Refrigeration piping shall be carried out in seamless, bright, clean refrigeration quality copper tubing and recessed solder joint fittings. Fittings shall be wrought copper or tinned cast brass. Soft annealed tubing shall be used on all pipe sizes below 19mm O.D., whilst hard drawn tubing shall be utilised on all larger sizes. All pipe cuts shall be neatly reamed and cleaned prior to making joints. Silver solder shall be used and tubing shall be protected against oxidation during silver soldering by the use of dry nitrogen flowing through the tubing.

4.7.2 Liquid refrigerant lines shall incorporate the following components:-

- Bypass flow replaceable type filter driers, of angle type and rated for the full refrigeration duty of the system.
- Y-type full flow strainers.
- Isolating valves of the diaphragm type.
- Moisture indicating type liquid sight glasses.
- Angle type, backseating, capped liquid charging valves with flare charging connections fitted with flare-fitting cap nuts.
- Liquid line solenoid valves.
- Thermostatic expansions valves of the external Equaliser type.

4.7.3 Suction lines shall be vapour proof insulated with 25mm thick, preformed “ARMAFLEX” or equal insulation. The “ARMAFLEX” insulation lengths shall be applied to the piping as and when the joints are being soldered in order to reduce the joints in the insulation to a minimum. Once the piping has been tested for leaks the insulation joints shall be glued and taped.

All visible refrigeration piping and/or piping exposed to the weather shall be housed within galvanised, or ultra violet resistant P.V.C. trunking.

4.7.4 Refrigeration pipework shall be supported at centres not exceeding 2.4mm. Pipes shall be securely clamped to points of support using suitable holderbats. Insulated piping shall have moulded cork inserts of 25mm thickness and 50mm width in place of normal insulation where supports occur, vapour proofing at such points being carefully executed. Vibration eliminators of “ANACONDA” or equal make shall be installed where indicated on the drawings and the piping shall be supported immediately after such vibration eliminator.

4.7.5 All refrigeration pipework passing through walls and concrete floor slabs shall have P.V.C. sleeves within minimum 3mm thickness for the full depth of the wall and/or floor.

4.7.6 The sensing bulb of the thermostatic expansion valve shall be securely fastened to the suction line using a copper strip and brass screws.

4.7.7 Care shall be taken to ensure that pipework is neatly run in straight lines, this applying especially to soft copper tubing. Pipes shall pitch 25mm in 6m in the direction of flow to ensure oil return.
4.8 REFRIGERANT CHARGE

4.8.1 Refrigerant pipework systems shall be charged with refrigerant after evacuation and testing for leaks as outlined below:

4.8.2 Complete refrigeration circuits shall be tested by means of dry Nitrogen to a pressure of at least 50% above working pressure. With the system under the pressure of the Nitrogen, all possible points of leakage shall be brushed with a solution of soap and water to which a few drops of Glycerine have been added. All soldered joints shall be tapped with a hammer to break possible flux seals. Any leaks which may be found by bubbling of the soapy water should be made good after the Nitrogen has first been released. When a leaking joint is detected, the fitting shall be taken out, cleaned and resoldered into the pipework again.

4.8.3 Systems should next be charged with Refrigerant to a minimum pressure of 200 kPa and then brought to a pressure of at least 50% above working pressure with dry Nitrogen. A "HALIDE" or Electronic leak detector shall at this stage be used to detect any further leaks.

4.8.4 Systems found to be free of leaks shall remain under pressure for a 24 hour period. If no pressure drop is observed after this period, taking into account ambient air temperatures, the Nitrogen mixture shall be discharged to atmosphere.

4.8.5 The system shall then be evacuated by means of a suitable vacuum pump to a vacuum of 2.5mm of Mercury, allowed to stand for 12 hours, and, if no pressure rise has occurred, shall be charged with refrigerant via the charging valve.
4.9. PACKAGED AIR CONDITIONING UNITS - WATER COOLED

4.9.1 The water cooled packaged air conditioning units shall comprise the following components all housed within, or forming part of, their steel cabinet:

- Refrigeration Compressors
- Water Cooled Condenser
- Refrigeration pipework and Controls
- Refrigerant Gas Charge
- Direct Expansion Cooling Coil
- Centrifugal supply air fans with Motor and Belt Drive
- Cleanable Air Filters
- Electrical Switchpanels
- Internal Electrical Wiring

4.9.2 Unit casings shall be constructed of not less than 1.2mm thick mild steel panels suitable braced and framed so as to prevent drumming, while at the same time being arranged in easily removable panels to facilitate access to any portion of the internal components. Casing panels shall be attached to a sub-frame of welded mild steel sections, which framework shall also hold all internal equipment in position. The casing panels shall be internally lined with "sonic liner" or equivalent non-combustible material, such insulation being adequately secured to the internal surfaces with non-combustible adhesive and mechanical fasteners. All mild steel casing panels and frame work shall be thoroughly degreased and then painted with a suitable rustproofing primer prior to the application of two finishing coats of good quality enamel or lacquer in the standard colour of the manufacturer.

Coastal unit casings shall be of galvanised construction throughout and generally in accordance with the above.

4.9.3 Tenderers are to note that the unit casing specification above is the minimum required, and that preference will be given to units having double skin panel construction.

4.9.4 Units shall contain a minimum of two refrigeration compressors. These shall be of the hermetic or the accessible hermetic type, direct driven by integral suction gas cooled squirrel cage motors, at a rotational speed not exceeding 1500 r.p.m. The compressors shall be complete with positive displacement reversible force-feed lubrication systems, and shall have low oil pressure protection, and shall contain crankcase oil heaters to ensure boil-off of dissolved refrigerant from lubricating oil when the compressors are stationary. Each compressor shall have at least one stage of capacity modulation other than full load and shall be arranged to start unloaded.

4.9.5 Each compressor shall be provided with its own tube in tube, shell and coil, or shell and tube water-cooled condenser, and shall incorporate a pressure relief device to comply with Government Regulations. All tubing within the condensers shall be of copper.

4.9.6 Refrigeration pipework shall be carried out in seamless, refrigeration quality copper tubing, suitable provision being made to ensure that the piping is not subjected to any stresses from vibration of the compressors. The refrigeration system shall be split into at least two stages on the liquid side for adequate capacity control. Refrigerant circuits shall incorporate replaceable core type filter-driers, sight glasses, thermostatic expansion valves and vapour proof insulation on the suction lines. The systems shall be factory charged with Refrigerant 22.
4.9.7 Automatic safety controls within the unit shall include a dual pressure switch with manual reset on the high pressure side, and an oil pressure switch with manual reset. Units shall incorporate timing devices to delay starting of compressors in order that refrigerant pressures may first balance between starting and stopping of the compressors.

4.9.8 Direct expansion cooling coils shall consist of at least two separate refrigerant circuits and shall comprise copper tubes with mechanically bonded aluminium fins. The coils shall be encased in a heavy gauge galvanised steel casing, fitted with a 1.2mm thick stainless steel condensate pan so sized and located to prevent entrainment of moisture into the air stream, whilst also ensuring positive drainage of condensate.

Cooling coil sizes shall be selected so that the face velocity does not exceed 2.5 m/s.

4.9.9 Supply air fans shall be of the double inlet, forward curved centrifugal type, with impellers running in sealed, permanently lubricated ball-bearings incorporating pillow blocks located in the suction eye of both sides of each fan. Fan impellers shall be statically and dynamically balanced, and shall run well below critical speed. Fan assemblies shall be so mounted within the packaged air conditioning unit that they do not transmit any vibration. Where units having more than one fan are offered, these shall all be driven by a common motor.

4.9.10 Supply air fan motors shall be three phase squirrel cage type rated not less than 25% above the power input absorbed by the fans, and shall run at a rotational speed not exceeding 1500 r.p.m. The motor shall drive the fans by means of a V-belt drive having not less than two V-belts.

4.9.11 Air filters shall be equal to FIBATRON WP77, minimum 50mm thick, high performance washable, pleated panel type housed in adequate holding frames, and fitted with gaskets to ensure a positive airtight seal around them.

4.9.12 An electrical switchpanel shall be incorporated to form part of the unit, and shall house all the necessary switchgear and controls required to operate the various components within the unit. The switchpanel shall comply with the best modern practice and shall incorporate all necessary protection against overload or short-circuit. The switchpanel shall be fitted with a suitably sized main isolator backed up by High Rupturing Capacity fuses with a minimum capacity to suit the system fault level. In addition, phase failure relays shall be incorporated to protect against low voltage or phase failure. The switchgear shall be fully interlocked so that cooling and heating cannot operate simultaneously, or so that the compressors cannot operate unless the condenser water pump and the supply air fans are operational. A run down timer shall be incorporated so that the supply air fans shall continue to run for three minutes after the unit is switched off. The switchpanels shall be fully labelled with engraved black ivory labels having 6mm high white lettering. The labels shall be rivetted to chassis plates to identify all switchgear, relays, instruments and controls inside the switchpanel.

4.9.13 Wiring within the switchpanel and the unit shall comply with wiring regulations as relevant, and shall be neatly grouped in horizontal and vertical runs in P.V.C. trunking. All wiring shall be colour-coded in the colours red, yellow and blue for the relevant phases and black for neutral, the busbars being similarly marked. Busbars shall be copper of adequate cross sectional area, suitably spaced and mounted on stand-off type porcelain insulators. All exposed current carrying parts must be fully insulated with P.V.C. tape of the colours mentioned above. Every wire inside, and outside the switchpanel, shall be fitted with ferrules and shall be labelled with identical numbers at both ends. All outgoing leads shall be connected to a clearly marked terminal strip.

4.9.14 Water-Cooled Packaged Units shall be equivalent to the make specified on the layout drawings or in Part V.

4.9.15 All equipment stored or installed on site shall be adequately protected at all times, until the final overall acceptance of the entire installation by the engineer.
4.10. **COOLING TOWERS**

4.10.1 Cooling towers shall be of sufficient capacity to match the heat rejection requirements of the Water Cooled packaged air conditioners or chillers, whilst being selected in accordance with the air entering wet bulb temperature given in Part V of the Specification.

4.10.2 Cooling towers shall be of forced draft type, rectangular in shape, of sectional steel construction, and shall be equal to EVAPCO model LST, or BAC, Cooling Towers.

4.10.3 The Cooling Tower sump and main supports shall be constructed of hot-dip galvanised steel with a minimum thickness of 2mm. Reinforcing angles and channels shall be 4mm thick hot-dip galvanised steel. Standard sump accessories shall include access doors, stainless steel strainers, and brass make-up valve with unsinkable, foam filled, plastic float.

4.10.4 Fans shall be of the forward curved centrifugal type, statically and dynamically balanced. The fans shall be mounted on either a solid steel shaft or a hollow steel shaft with forged bearing journals. Shafts with welded journal construction or centre bearings shall not be permitted. The fan shaft shall be supported at each end by heavy duty, regreasable, self-aligning ball bearings in cast iron housings.

4.10.5 Driving motors serving the cooling tower fans shall be of the drip proof, squirrel cage type, and shall run at a rotational speed not exceeding 1500 r.p.m. The motor shall be mounted on an adjustable base external to the unit for ease of service and maintenance. The V-belt drive shall be designed for not less than 150% of the motor nameplate power rating. The motor and drive shall be installed with a protective canopy.

4.10.6 The cooling tower fill shall be of a fill type with a serpentine arrangement, with built in water distributors and air turbulators. It shall be constructed of self-extinguishing, polyvinyl chloride with a minimum thickness of 0.5mm, and shall be resistant to rot, decay and biological attack.

4.10.7 The spray header and branches shall be constructed of Schedule-40, polyvinyl chloride pipe for corrosion resistance, and shall have a steel connection for attachment of the external piping. The branches shall have removable plugs in the ends for cleaning purposes. The water shall be distributed over the fill by precision moulded spray nozzles with large, 9.5mm by 25.4mm, orifice openings to eliminate clogging.

4.10.8 Eliminators shall be constructed entirely of inert polyvinyl chloride in easily handled sections. The eliminator blades shall be spaced at 25.4mm centres, and shall incorporate three changes in air direction to ensure complete removal of all entrained moisture from the discharge air stream. They shall have a hooked leaving edge to direct the discharge air away from the fan’s intake to minimise recirculation.

4.10.9 Cooling towers installed at the coast shall be coated with Power Bond II finish (cold tar epoxy coating) or equivalent, for maximum protection against corrosion. All paintwork shall be made good as required once the cooling tower has been installed. Alternatively a casing constructed from fibreglass will be acceptable.

4.10.10 Where cooling towers located in plantrooms under conditions where papers and plastic bags are likely to be drawn into the cooling tower fans, these towers are to be fitted with suitable weld mesh screens across the entire air intake section.
4.11 CLOSED CIRCUIT COOLERS

4.11.1 Closed Circuit Coolers shall be of sufficient capacity to match the heat rejection requirements of the Water Cooled packaged air conditioners or chillers, whilst being selected in accordance with the air entering wet bulb temperature given in Part V of the Specification.

4.11.2 Closed Circuit Coolers shall be of the induced or forced draft type, rectangular in shape, of galvanised sectional steel construction and shall be equal to EVAPCO model ATW or LSW, or BAC, Closed Circuit Coolers.

4.11.3 The Closed Circuit Cooler sump and main supports shall be constructed of hot-dip galvanised steel with a minimum thickness of 1.8mm. Reinforcing angles and channels shall be 4mm thick hot-dip galvanised steel. Standard sump accessories shall include access doors, stainless steel strainers, and brass make-up valve with unsinkable, foam filled, plastic float.

4.11.4 Fans shall be of the forward curved centrifugal type, statically and dynamically balanced. The fans shall be mounted on either side of a solid steel shaft with forged bearing journals. Shafts with welded journal construction or centre bearings shall not be permitted. The fan shaft shall be supported at each end by heavy duty, regreasable, self-aligning ball bearings in cast iron housings.

4.11.5 Driving motors serving the closed circuit coolers fans shall be of the drip proof, squirrel cage type, and shall run at a rotational speed not exceeding 1500 r.p.m. The motor shall be mounted on an adjustable base external to the unit for ease of service and maintenance. The V-belt drive shall be designed for not less than 150% of the motor nameplate power rating. The motor and drive shall be installed with a protective canopy.

4.11.6 The cooling coil shall comprise steel tubing circuits supported by a heavy steel frame. The assembled coil shall be tested at 2400 kPa air pressure under water to ensure that it is leak free. The airflow through the coil shall be counterflow to the water flow, and the tubes of the coil shall be staggered in the direction of the flow to obtain a high film co-efficient. To protect the coil against corrosion the entire tubing and frame assembly shall be hot-dip galvanised.

4.11.7 The spray header and branches shall be constructed of Schedule-40, polyvinyl chloride pipe for corrosion resistance. The branches shall have removable plugs in the ends for cleaning purposes. The water shall be distributed over the coil by precision moulded spray nozzles with large, 9.5mm by 25.4mm, orifice openings to eliminate clogging.

4.11.8 Eliminators shall be constructed entirely of inert polyvinyl chloride in easily handled sections. The eliminator blades shall be spaced at 25.4mm centres, and shall incorporate three changes in air direction to ensure complete removal of all entrained moisture from the discharge air stream. They shall have a hooked leaving edge to direct the discharge air away from the fans air intake to minimise recirculation.

4.11.9 Closed circuit coolers installed at the coast shall be coated with Power Bond II finish (cold tar epoxy coating) or equivalent, for maximum protection against corrosion. All paintwork shall be made good as required once the closed circuit cooler has been installed. Alternatively a casing constructed from fibreglass will be acceptable.

4.11.10 Where closed circuit coolers and/or evaporative condensers located in plantrooms under conditions where papers and plastic bags are likely to be drawn into the closed circuit cooler/evaporative condenser fans, these closed circuit coolers/evaporative condensers are to be fitted with suitable weld mesh screens across the entire air intake section.
4.12 WATER TREATMENT

4.12.1 GENERAL

The Equipment and Chemical program are to be supplied by specialists in this field. The chemicals are to be compatible with all metals and materials that may be found in the system to be treated.

Chemicals utilised are to comply with the regulations of the local Authorities.

The Water Management Specialist / Chemical Supplier should ensure that his Program includes the optimisation of all the resources involved. Thus chemical usage, water and energy consumption will be taken into consideration.

Chemicals and services must be provided for the 12-month maintenance period. The Supplier will do at least a monthly service where water analysis tests are performed and a written report provided.

Corrosion racks must be installed and a quarterly report on the corrosion rates being experienced must be provided.

The chemical supplier must take safety and aesthetics into account and provide suitable holdings tanks from which the chemicals can be dosed.

Chemical Programs

The following systems shall be chemically treated:

- open condenser water systems
- closed hot and/or chilled water systems

4.12.2 PRETREATMENT

The Open and Closed systems must be flushed out and pretreated using a suitable chemical designed for this purpose.

The pre-treatment chemical and the procedure followed, must clean the systems, minimise flash corrosion and prepare them for the ongoing maintenance program.

4.12.3 WATER TREATMENT CONTROL EQUIPMENT

The water treatment unit shall be installed in the make-up line prior to the Closed Circuit Coolers or Cooling Towers. The unit shall be fitted in a horizontal straight pipe section.

Automatic control of the water stabilisation chemicals and bleed control is required.

The stabilization chemical for the open system should be dosed using a proportional feeding system.

This is to be achieved by the installation of a suitable water meter in the make-up line to the cooling towers. This water meter will send an activating pulse to the dosing pump.

A water meter and Y-tape strainer shall also be installed in the make-up line before the water treatment unit in order to record the make-up flow rate, and to collect all direct within the municipal mains water feed pipeline.

The water meter is to be installed with a by-pass to allow for maintenance without having to shut down the entire system.

The microbiological control chemical should be dosed using a pump that is timer controlled. It must be possible to set the frequency and length of time of dosing accurately.
The bleed off must be controlled by a conductivity sensor that is installed in a by-pass line between the supply and return lines from the cooling towers. A solenoid valve, that is normally closed, is to be activated via the sensor once a preset conductivity is reached. It must be possible to test the bleed unit manually, if so desired.

The chemical feed system and the bleed control system is to be two separate systems.

All of the above equipment is to be housed in suitable enclosures and must comply with all safety regulations including the Occupation Health and Safety Act.

4.12.4 OPEN COOLING SYSTEMS

The open condenser water treatment should achieve:

- water stabilization
- microbiological control

Stabilization of the condenser water will be such that neither scale forming nor corrosion will be allowed to take place in an uncontrolled manner.

Microbiological control will be the treatment of the water so that slime, bacteria (including disease-carrying bacteria such as Legionella) and algae are kept in check.

4.12.5 CLOSED SYSTEMS

The closed system hot and/or chilled water systems shall be treated such that the design heat transfer efficiency is maintained. This is to be achieved by keeping the system free of corrosive attack, deposit formation and any microbiological growth.

The chemical program for the closed systems must cater for and be compatible with all metals and materials that may be encountered.
4.13 WATER PUMPS

4.13.1 Water Pumps shall be sized by the Air Conditioning Contractor to handle the required water quantity against the calculated total head pressure, while operating at an efficiency of not less than 55%.

4.13.2 Water Pumps shall be of the non-overloading, centrifugal, volute type. They shall be of the vertically split, single suction type having the casing secured directly to the bedplate and operating at a rotational speed not exceeding 1500 r.p.m.

4.13.3 Water Pumps having discharge connections not exceeding 75mm may be of the close coupled type in which the impeller is overhung on the motor shaft, or, of the bracket-mounted type in which the casing is overhung from the bearing bracket. Pumps of either type shall operate at a rotational speed not exceeding 1500 r.p.m., except that where the total dynamic head exceeds 20m, rotational speeds not exceeding 3000 r.p.m. may be permitted.

4.13.4 Casings shall be designed for a working pressure of 5 bar or 1.5 times the actual discharge pressure, whichever is greater. Pressure classification of flange connections shall correspond to casing working pressures.

4.13.5 High points of pump casings shall be provided with air vent cocks. Low points of casings shall be provided with valved drains, and inlet and outlet connections shall be provided with properly located gauge tappings. Casing brackets of vertically split pumps equipped with stuffing boxes shall be arranged to form drip pockets. A drip pipe shall be run from each drip pocket and shall terminate over the nearest drip funnel or floor drain.

4.13.6 Impellers shall be bronze and shall be dynamically balanced. Impellers of pumps having 40mm and larger discharge connections shall be fully enclosed and hydraulically balanced.

4.13.7 Shafts for pumps with mechanical seals shall be stainless steel, monel metal, or shall be carbon steel with sleeves of bronze, chrome iron or nickel iron, extending through the mechanical seals. Shafts shall be provided with water slingers where mechanical seals are used.

4.13.8 Bearings for close coupled pumps shall be of the ball or roller type. Bearings for all other pumps shall be either ball or roller type, or ring oiled, or wool packed sleeve bearings with ample oil reservoirs. Thrust bearings shall be of either the ball or Kingsbury type. Bearings shall be effectively sealed to prevent loss of oil, and entrance of dirt or water.

4.13.9 Stuffing boxes will not be accepted by the Engineer.

4.13.10 All pumps, other than close coupled pumps, shall be provided with suitable flexible couplings with earthing straps. Couplings shall impose no restriction on normal end play or expansion.

4.13.11 Pumps shall be factory-assembled by their suppliers, together with their driving motors, on a common welded steel bedplate fabricated from mild steel channel sections. Bedplates shall be robustly constructed and free from distortion. Machine spacer plates or shimstock shall be used to align the pump and motor. Drives and associated guards shall comply with the relevant sections of the specifications, drives being works-aligned, and alignment rechecked after installation of the pumps on site, immediately prior to setting into operation.

4.13.12 Water Pumps shall be supplied as complete sets by their suppliers, incorporating pumps, bronze impellers, motors, drives, bedplates, stainless steel drip trays etc., factory assembled and despatched to the project complete in all respects.
4.14 **WATER PIPEWORK**

4.14.1 Water piping systems shall follow the routes indicated on the relevant Drawings. Piping shall be arranged to maintain sufficient headroom, keep access ways unobstructed and not interfere with maintenance and adjustment of valves and equipment.

4.14.2 Where pipe sizes are not indicated on the Drawings, pipes shall be sized for a maximum water velocity of 2.5 m/s within the Plant Rooms, and a maximum of 2 m/s for piping extending between the Plant Rooms and the Closed Circuit Coolers or Cooling Towers.

4.14.3 Steel piping shall have a minimum thickness equal to medium grade to SABS: 62.1971. Piping for closed circuit condenser water systems shall be of black medium type with welded joints. Galvanised medium piping shall be used on all open vented systems, such as cooling water type condenser water systems, drainage and mains water supply pipework. It shall not be permissible to weld or burn with a cutting torch any galvanised piping without having it regalvanised by an electroplating process.

4.14.4 Long radius bends shall be used wherever possible, elbows only being permissible where limited space dictates their use. Reductions in pipe sizes shall be effected with reducing sockets, bushing reducers not being permissible. Threaded fittings shall be malleable iron to B.S.S. 143 or SABS 509:1955, or wrought steel to B.S.S. 1740-1971, as relevant. Welded fittings shall be genuine butt-weld fittings, to ASTM A234 GR.WPB-Dimensions to BS1640 or ASA B16.9. Welding of threaded fittings is not permitted.

4.14.5 **VALVE SCHEDULE**

All globe and gate valves (except screwed gate), shall incorporate back seating on spindles to facilitate repacking of gland under pressure.

All valves installed shall be of a high standard of manufacture and well known brand.

Types of valves shall be of the same manufacture.

Screwed valves shall be to BS.21 taper.

Flanged valves shall be BS4504 standards with connecting flanges to match.

ASA Standards will be accepted on steam installations (1050 kPa and over).

Screwed valves to be used up to and including 50mm, 65mm and over to be flanged valves.

Valves will be selected to conform to the pressure/temperature rating and duties applicable to the particular system, or application where being installed.

All valves shall conform to the following material specifications:

- Bronze BS1400 LG 2-C/ASTM B62
- Cast Iron BS 1452 GR 14/ASTM 126 Class B
- Malleable ASTM A-47 GRD 32 510
- Ductile BS 2789 (1961) ASTM or A 395
- Cast Steel ASTM A 216 GRD W C B

Strainers shall be of the “Y” pattern, bronze screwed, with stainless steel screen equal to TOA fig. “Y” or cast iron body flanged, bolted cover with blow down plug and stainless steel screen to be fitted with extraction handle for easy removal, to SHOWA fig. 33 or equal.

Screen perforations as follows:

- up to and including 50 mm 1,2mm dia
- 65mm to 150mm 2,0mm dia
- 200mm and over 3,5mm dia

Gate Valves shall be SABS 776-1975, Class B screwed, or equal, or cast iron body flanged with bronze rising spindle, and trim, outside screw and yoke, solid wedge disc, to BS 5150 J Fig. KF 502 or equal.
Globe Valves shall be bronze body screwed, internal screwed bonnet, rising spindle bronze to bronze tapered seats to Conti Fig. 70400 or equal, or cast iron body flanged with bronze rising spindle, and trim, outside screw and yoke to BS 5152 J Fig. KF 501 or equal.

Check Valves shall be bronze screwed, swing check type, bronze seats to Conti Fig. 77104 or equal, or cast iron body flanged solid, cast iron flap with bronze trim and bolted cover to BS 5153 J Fig. KF 601 or equal.

Alternative Wafer type, non-slam check valves, central pivoted butterfly flaps with bronze on BUNAN seats to DIN 3202, or API 594 J, Fig. KF 301 or equal.

Balancing Valves shall be Crane, Tour or Anderson or equal, shut-off/balancing valve with pressure sensing points over the valve for determining water flow rates. All valves to have calibration markings and 65mm and over, flanged cast iron Epoxy coated.

4.14.6 At all high points of the water systems fit PURG-O-Mat Fig. KS 69, or equal, automatic air vents with integral check valves. Each air vent shall be preceded by a gate valve to allow maintenance of the air vents. Automatic air vents shall ensure positive removal of all air from water piping systems. At all low points of the systems fit 15mm diameter drain cocks with hose unions, these valves so located that the entire piping system can be completely drained. Fit such drain valves at equipment if necessary to allow complete drainage.

4.14.7 Closed circuit condenser water and chilled water systems shall be connected to an expansion tank. The tank shall be of adequate size to suit the system, and shall be manufactured from 2mm galvanised sheet steel. The minimum water level in the tank shall be kept at approximately 300mm from the bottom by means of a 20mm nominal size ball valve. The tank shall be provided with a separate quick filling connection, overflow, and a lid with an air vent.

4.14.8 At all equipment connections to vibrating equipment fit flexible connectors equal to Fig. KF 401, as supplied by Kerr Valves. All flexible connectors shall have flanged joints and be capable of a 16 bar, or 1.5 times the system working pressure, whichever is the higher value.

4.14.9 Copper earthing straps shall be fitted over all flexible connections and shall be carried out in accordance with the standard wiring regulations (see Clause 31.1 - Page 50).

4.14.10 Pipe joints shall be neatly made, all pipe cuts properly cleaned and reamed. At all connections to equipment use flanged joints to conical face unions for smaller pipe sizes up to 40mm nominal bore. Incorporate sufficient flanged joints or unions to allow dismantling of sections of pipework to facilitate access to plant items for maintenance purposes. Use screwed joints one galvanised pipework up to, and including, 100mm nominal size, and on black piping up to, and including, 50mm nominal size. Where galvanised piping is called for above 100mm diameter, use black piping with welded joints, all hot-dip galvanised after welding.

Black piping all sizes over 25mm diameter may be welded. Screwed joints on piping up to 25mm diameter shall utilise P.T.F.E. jointing tape equal to 3-M manufacture. For larger joints use Hemp and Stag, or equivalent jointing compound. Flanged joints shall include Klingerite gaskets or equivalent. Caulking of joints will not be permitted.

4.14.11 Plug open ends of pipings, drains, fittings and equipment connections during installation to keep systems free of rubble, dirt and other foreign matter.

4.14.12 Maximum support spacing for pipework shall be:-

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Support Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>50mm diameter and smaller</td>
<td>3 m</td>
</tr>
<tr>
<td>65 to 100mm diameter</td>
<td>4.5 m</td>
</tr>
<tr>
<td>above 100mm diameter</td>
<td>6 m</td>
</tr>
</tbody>
</table>

4.14.13 All piping systems shall be flushed out properly to ensure cleansing, prior to the operation of the plant.

4.14.14 Piping systems shall be tested by means of an hydraulic pump to twice the operating pressure of the system, or, where it is not permissible due to the maximum allowable piping working pressure, the piping shall be tested to the limit set by such maximum allowable working pressure.
4.14.15 **PRESSURE INDICATION**

All dial pressure gauges shall be snubbed or glycerine filled to prevent pointer vibration. Gauges shall have an accuracy of 2%. The range shall extend to 150% of the maximum operating pressure.

All inclined manometer differential pressure gauges shall have an accuracy of 2%. The range shall extend to 150% of the maximum operating pressure, with graduation being in steps of 10 kPa.

All differential dial pressure gauges shall have an accuracy of 2%, and shall not be less than 100mm diameter. Zero pressure reading shall be in the centre, and the range of scale on either side shall extend to 150% of the maximum operating pressure, with provision being made for individual pressure reading.

4.14.16 **TEMPERATURE INDICATION**

All direct reading thermometers and temperature reading devices shall have an accuracy of 0,5ºC, and a range of -10ºC to 10ºC, unless otherwise specified, with graduation being in steps of 1ºC.

Stem thermometers shall be approximately 100mm long, and dial type thermometers approximately 80mm diameter.

Wells shall be set vertical or at an angle to retain oil. Pipes smaller than 80mm bore shall be enlarged at points where wells are installed as per following table:

<table>
<thead>
<tr>
<th>Pipe bore (mm)</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>32</th>
<th>40</th>
<th>50</th>
<th>65</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size of enlargement (mm)</td>
<td>32</td>
<td>40</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>65</td>
<td>80</td>
</tr>
</tbody>
</table>

The sensor element shall be at the centre of the pipe.
4.15 CHILLED WATER PIPEWORK INSULATION

Chilled water piping shall be insulated, using rigid preformed sections having a bore to suit the pipe.

The insulation shall be externally covered. The covering to the insulation shall form a complete vapour barrier as specified below.

Insulation in plantrooms and enclosures, insulation which is visible, and insulation exposed to the weather, shall be finished with two coats of polyester resin reinforced with 300g fibreglass Chopstrand. This shall be sanded smooth followed by finishing tissue and coated with a resin rich topcoat pigmented to the colour codes in Clause 36.6 of this section. The finish on insulation exposed to the weather shall be white in colour.

Factory made, fibreglass coated (as above), preformed saddle sections of pipe shall be placed at all hanging support points. The pipe supports shall be placed over these saddle sections, allowing for a continuous vapour seal across the pipe insulation.

The densities of the insulation at hanging/support points shall be as follows:

15 mm to 100 mm diameter - 60 kg/m³
Above 150 mm diameter - 80 kg/m³

Rigid preformed piping insulation shall be applied, wherever possible, for the insulation of bends, tees, elbows, flanges and valves. Where pre-formed pipe insulation is not possible to use, blocks or batts shall be securely wired or banded in position and all joints and voids shall be filled with mineral wool.

Where practically possible, piping shall be supported OUTSIDE the insulation on cradles. Where the load on the insulation exceeds the strength thereof, a suitable part of the insulation shall be replaced by material having higher crushing strength.

Where insulation is specified for piping, the same shall apply to all fittings and pipe connections within the system.

The Sub-contractor shall base his main offer on the following specification:

- INSULATION
  POLYISOCYNURATE (PIC)
  35 kg/m³;

- PRIMER
  Make
  Bitumen Emulsion, First Coat Pipe section seal
  PEKAY BE2 BITUMEN EMULSION

- JOINT SEAL
  Make
  PEKAY MASTIC 220

- BINDING TAPE
  Make
  Vinyl Buff Tape 24mm wide
  3M

- VAPOUR SEAL
  Make
  TWO COATS POLYESTER RESIN

- MEMBRANE
  Make
  300g FIBREGLASS CHOPSTRAND

- FINISH VAPOUR SEAL
  Make
  HIGH GLOSS ENAMEL

- FINISH VAPOUR SEAL
  Make
  PIGMENTED RESIN RICH TOPCOAT

- INSULATION THICKNESS
<table>
<thead>
<tr>
<th>Diameters</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>15mm - 80mm</td>
<td>25mm thick</td>
</tr>
<tr>
<td>Above 100mm</td>
<td>50mm thick</td>
</tr>
</tbody>
</table>

CONCEALED PIPING AND EXPOSED PIPING INSIDE BUILDING

<table>
<thead>
<tr>
<th>Diameters</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>15mm - 65mm</td>
<td>25mm thick</td>
</tr>
<tr>
<td>Above 80mm</td>
<td>50mm thick</td>
</tr>
</tbody>
</table>

EXPOSED PIPING TO THE WEATHER
4.16. DUCTWORK

4.16.1 Ductwork shall be carried out in accordance with the details shown on the Drawings, and shall be fabricated from prime quality galvanised sheet steel. All duct sizes indicated on the drawings are metal sizes, and include the necessary allowances for any internal insulation which may be specified.

4.16.2 Ductwork shall be fabricated and installed in accordance with the following specification, which shall be read in conjunction with the standards set by the South African Bureau of Standards (SABS) Standard Specification for Air Conditioning Ductwork, SABS 1238-1979, which shall be adhered to in detail except only as hereinafter specified.

4.16.3 Rectangular ductwork sheet steel thickness and cross breaking length shall be as follows:-

<table>
<thead>
<tr>
<th>Duct Size long side mm</th>
<th>Semi Perimeter</th>
<th>Duct Joint</th>
<th>Sheet Steel thickness</th>
<th>Cross Breaking long side mm</th>
<th>Breaking length mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 750 &lt;1150</td>
<td>Slip &amp; Drive</td>
<td>0.6</td>
<td>2400</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 750 &gt;1150</td>
<td>Mez</td>
<td>0.6</td>
<td>2400</td>
<td></td>
<td></td>
</tr>
<tr>
<td>760 to 1350</td>
<td>Mez</td>
<td>0.8</td>
<td>1500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Above 1350</td>
<td>Mez</td>
<td>1.0</td>
<td>1500</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.16.4 Longitudinal seams shall be Pittsburgh lock on all duct sizes. Cross joints on concealed ductwork having a semi-perimeter not exceeding 1150mm shall be as follows:-

<table>
<thead>
<tr>
<th>Duct Size long side mm</th>
<th>Long Side</th>
<th>Short Side</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 750 &lt;1150</td>
<td>Slip</td>
<td>Drive Slip</td>
</tr>
</tbody>
</table>

Cross joints on concealed ductwork having a semi-perimeter in excess of 1150mm shall be of Mez or equal flange type, installed in accordance with the manufacturer’s recommendations. As an alternative to the Mez or equal flange joints, 40mm x 3mm angle flange joints may be used.

Cross joints on all exposed ductwork shall be of Mez or equal flange type.

4.16.5 Ductwork supports shall be of rod and angle type, sheet metal straps not being permitted. The size and spacing of these supports shall be as follows:-

<table>
<thead>
<tr>
<th>Duct Size long side mm</th>
<th>Semi Perimeter</th>
<th>Angles Rods</th>
<th>Spacing dia mm</th>
<th>Max - mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 750 &lt;1150</td>
<td>40 x 2</td>
<td>6</td>
<td>2400</td>
<td></td>
</tr>
<tr>
<td>Up to 750 &gt;1150</td>
<td>40 x 2</td>
<td>6</td>
<td>2400</td>
<td></td>
</tr>
<tr>
<td>760 to 1350</td>
<td>40 x 3</td>
<td>8</td>
<td>2400</td>
<td></td>
</tr>
<tr>
<td>Above 1350</td>
<td>40 x 6</td>
<td>8</td>
<td>3000</td>
<td></td>
</tr>
</tbody>
</table>

Rods shall be cut back so as not to protrude beyond the angle bracket.

4.16.6 Rectangular ductwork shall be regarded as low velocity, low pressure ductwork, suitable for pressures up to 500 Pa and velocities up to 10 m/s. It shall accordingly be fabricated and installed to comply with the above requirements, and SABS 1238-1979.

4.16.7 All cross joints in ductwork shall be sealed with a liberal coating of 3M or equal Duct Sealer. Longitudinal joints/seams exposed to the weather shall be made waterproof.

4.16.8 All duct connections to vibrating equipment shall consist of a flanged joint, followed by a flexible connector, consisting of a neoprene covered, fiberglass cloth, fixed on either side of the joint in a double lock seam, to form an airtight flexible joint with a minimum of 50mm separation between metal edges. Ducting at flexible joints shall be so supported that the ductwork is held square with the adjoining ducting and no stress is imposed upon the flexible joint. Copper earthing straps shall be fitted over all flexible
duct connections and be carried out in accordance with the standard wiring regulations.

The flexible connections exposed to the weather shall be covered with a sheetmetal strip, to protect the flexible material from direct sunlight.

4.16.9 Flexible ducts shall be **EUROPAIR INSULATED ISODEC – TYPE 25A**, or approved equal. They shall comprise aluminium innercore, shielding the fibreglass insulation from the airstream. The outerjacket / vapour barrier shall be of a very tough spirally reinforced multiple layer aluminium laminated construction. Where flexible ducts connect to normal sheet metal ductwork or other equipment, a liberal coating of 3M or equal Duct Sealer shall be used, the joint then sealed with **DURO – DYNE**, or equal, 75mm wide duct tape, and finished with an approved clamp or metal strap to ensure an airtight joint.

4.16.10 Circular flexible ducting connected to supply air diffusers shall not exceed 1,5 metres in length.

4.16.11 All supply air ducting shall be pressure tested with a maximum permissible leakage of 5% at a test pressure of twice the working pressure.

4.16.12 The maximum permissible leakage rate for return and ventilation air systems shall not exceed 5%.

Kitchen canopy and fume extract air ducting systems shall be made 100% airtight.

4.16.13 All insulated ducting in storage, or in position, shall be adequately protected at all times.

4.16.14 All ducting joints exposed to weather shall be waterproof and corrosion free.

4.16.15 All ducting exposed to the weather shall be painted as per Clause 4.36.2 of this section. Colour coding shall be as per Clause 4.36.6 of this section.
4.17 DUCTWORK INSULATION

4.17.1 Ductwork shall be insulated according to the requirements noted on the Drawings and in accordance with the following specifications.

4.17.2 Where noted on the Drawings, the supply air ducting shall be internally insulated with 25mm thick "sonic liner" or equal, glued to the inside surface of the ducting with a fire retardant adhesive. In addition the insulation shall be further mechanically secured with Grip Nails, or 'Spotter Pins', at 450mm centres, and not more than 75mm from the edges of each panel. The insulation ends shall be covered with 0.8mm thick galvanised metal strips rivetted to the duct panels to prevent erosion of particles of the insulation into the air stream.

4.17.3 External supply and return air ducting shall be internally insulated with 50mm thick "sonic liner" or equal, glued to the inside surface of the ducting and mechanically secured as specified in clause 17.2 above.

4.17.4 Ducting installed in open roof spaces above insulated ceilings shall, in addition to being insulated internally with 25mm thick "sonic liner" or equal in accordance with clause 17.2, be wrapped externally with 50mm thick "foil faced" or equal fibreglass insulation, unless otherwise noted on the drawings. This external insulation shall be strapped around the ducting with strapping bands fixed at 1200mm centres, and joints sealed with foil duct tape.

4.17.5 All supply and return air ducting installed in open plantrooms and exposed to the weather shall be insulated with 40mm thick polyisocyanurate (PIC) foam insulation (35 kg/m²) glued onto the ducting. All joints in the ducting are to be sealed before application of the insulation. The insulation shall be covered with 300 g fibreglass chopstrand. The chopstrand shall be covered with two coats polyester resin. This shall be sanded smooth and coated with a resin rich topcoat pigmented in white colour.

4.17.6 Ventilation ducting only installed above ceilings and below concrete slabs shall be uninsulated, unless otherwise noted on the Drawings.
4.18 DIFFUSERS, GRILLES AND LOUVRES

4.18.1 Air distribution shall be effected by means of ceiling diffusers or grilles of the sizes, types and having the discharge patterns as indicated on the Drawings.

4.18.2 Ceiling Diffusers and grilles shall be fixed to spigots extending not less than 100mm from the ducting, unless otherwise indicated on the Drawings, and shall be securely fixed so that no screws or other fixing devices are visible.

4.18.3 Supply air diffusers shall be of steel construction, and shall consist of an inner core which shall be easily removable from the outer section to facilitate access to the volume control damper located behind the diffuser. The inner core shall consist of concentric rectangular collars and the outer section shall consist of a single rectangular or bevel collar provided with a concealed spigot for attaching the diffuser to the supply ductwork.

The rear backing including the disc of all supply air diffusers for coastal projects, shall be lagged with a minimum 3mm thick life care - fire and heat resistant foam.

Supply air diffusers shall be equal to RICKARD model CCD or VCD, complete with dampers, and shall be finished in an epoxy powder coating in a colour to suit the Architects requirements. Alternatively fibreglass or aluminium diffuser casings will be acceptable.

4.18.4 Supply air grilles shall be of the double deflection type, consisting of two rows of individually adjustable aerofoil section vanes, the front vanes being horizontal and the rear vanes vertical. The vanes shall be housed in a surrounding fixing flange with neat mitred joints at the comers. The entire grille assembly shall be of extruded aluminium construction and shall be finished in plain anodised aluminium unless otherwise noted on the Drawings.

Supply air grilles shall be equal to EUROPAIR OR TROX complete with factory fitted opposed blade dampers.

4.18.5 The multivane opposed blade dampers provided with supply air diffusers and grilles shall be finished in matt black lacquer. The dampers shall be attached to the rear of the grilles and fitted into the spigot connections or the diffusers and shall be adjustable, by means of a key or a lever, from the front of the installed diffusers and grilles.

4.18.6 Return air grilles shall consist of aluminium grid core housed in an extruded aluminium fixing flange with neat mitred comers and finished in plain anodised aluminium, unless other noted on the Drawings.

Return air grilles shall be equal to EUROPAIR OR TROX with a 12mm grid core.

4.18.7 Door grilles shall be of extruded aluminium construction, equal to EUROPAIR OR TROX suitable for fitting into doors of varying thickness, and shall be finished in a colour to suit the Architects requirements. Door grilles shall be fixed to doors by means of countersunk screws with a colour to match the door grille.

4.18.8 Outside air intake weather louvres shall be of the extruded aluminium, fixed vane type, fitted with a metal vermin proof screen on the rear side, as well as an opposed blade damper.

Dampers shall be provided with a locking device so that once they have been set for the correct air flow they can be permanently locked in position. Louvres shall be finished in plain anodised aluminium.

Where indicated on the Drawings the outside air intake louver assembly shall be fitted with filter holding frames, with firmly fixed foam rubber gaskets and spring clips, for the attachment of the fresh air filters, as later specified herein. The frames shall be fixed to the weather louver so as to prevent any air by-passing the filters.

4.18.9 Rubber gaskets shall be glued to the rear of the fixing flanges of all diffusers, grilles and louvres, to ensure airtight seals and prevent smudging.
4.19 DAMPERS

4.19.1 Dampers shall be provided where shown on the Drawings for shut-off, bypass or volume control purposes, or where required to comply with local fire codes.

4.19.2 Volume control dampers shall consist of multiple blades acting in opposed blade manner, the blades being robustly linked together to operate in complete unison. Individual blades shall be hooked-edge construction, so bent for rigidity. The blades shall have steel trunnions mounted in bronze sleeve bearings or ball bearings. Permanently set dampers shall be provided with suitable devices to facilitate locking them in position, with 'Open' and 'Shut' position indicated.

Motorised dampers shall include suitable fastenings and supports for motor actuators.

Dampers shall be the product of an accredited manufacturer of such items, equal to DURO-DYNE. Damper sections shall be housed in flanged steel metal casings of 1.6mm thick galvanised steel. Damper blades shall not exceed 200mm in width and 1000mm in length. Dampers over 1000mm in length shall be sectionalised into separate cells, each with its own shaft and bearings, to ensure that the blade length of each section does not exceed 1000mm.

4.19.3 Fire dampers shall be equal to BLENDAIR or TROX, and manufactured to a recognised fire code with a two-hour fire rating. Damper casings shall have flanged ends and damper blades shall not exceed 300mm in width. The fire dampers shall comply in all respects with the requirements of the local municipal fire authorities in the area where they are to be installed.

Damper blades shall be closed by the operation of approved fusible links, located where they would be immediately affected by an abnormal rise in temperature of the air stream. When called for on the Drawings, the blades shall also be actuated by solenoid operators which shall be provided by the damper manufacturer. When closed the blades shall be held by a catch arrangement so as to provide a positive seal against the air stream.

4.19.4 Duct mounted air volume control dampers and fire dampers installed in ducts shall be provided with a minimum 300 x 300mm inspection opening, so that the dampers may be checked, maintained and reset when required. These inspection openings shall be covered with suitably sealed access panels.
4.20 **SOUND ATTENUATORS**

4.20.1 Sound Attenuators shall be provided and installed in the positions indicated on the Drawings, and shall be selected to provide the Noise Criteria levels specified in Part V hereof. Sound Attenuators shall be of factory fabricated type equal to those manufactured by **SOUND ATTENUATORS LIMITED**.

4.20.2 The sound absorbing lining material shall impart no odour to the air, shall not delaminate readily, and shall have no loose material or any exposed surface that may be detached by the air stream either during installation, or under regular operating conditions. The material shall also be non-combustible.

4.20.3 All lining material shall be in good condition at the time of final inspection. Material that has been damaged in shipment by rough handling, vibration or exposure, shall be rejected. Material that has been damaged prior to final inspection shall be replaced or coated to prevent detachment of loose material as directed by the Engineer.

4.20.4 Sound absorbing lining material generally shall have a density of not less than 16kg per m³, a thickness of not less than 25mm, and sound absorbing efficiency at each frequency of not less than the following:

<table>
<thead>
<tr>
<th>Frequency cycles per second</th>
<th>250</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent absorption</td>
<td>45</td>
<td>65</td>
<td>65</td>
<td>80</td>
</tr>
</tbody>
</table>

4.20.5 The factory fabricated sound attenuators shall be complete units consisting of an outer casing, sound absorbing material and internal baffles and supports. Casings shall be made of zinc-coated steel, not lighter than that specified herein for ducts of the same outside dimensions.

4.20.6 Sound attenuators installed in any extract system from a kitchen canopy shall be Melinex lined.

4.20.7 Sound attenuators that form part of a system that operates under smoke/fire conditions shall have their lining covered with perforated plate.
4.21 AIR FILTERS

4.21.1 Air filters shall be installed before the coils in the packaged air conditioning units and the air handling units, and shall be equal to FIBATRON WP77, minimum 50mm thick, high performance, washable, pleated panel filters.

4.21.2 Long life air filters installed in independent air filter banks in Plantrooms, or before the coils in packaged air conditioning units and air handling units, where indicated on the Drawings, shall be equal to BRANDT EXPO 3000 extended surface air filters with VILEDON type PSB 290 filter media having an arrestance of 90% (ASHRAE). Each filter cell shall be suitable for the manufacturer's recommended air flow of 0.83 m³/s at an initial resistance of 20Pa. Manometers to be used in conjunction with these filters shall be set for a final resistance of 150 Pa.

4.21.3 Fresh air filters shall be of the same make, type and size as the return air filters fitted in the units, and shall be fitted into the holding frames installed on the rear of the outside air intake weather louvre, so as to be easily removable from inside the plant room area or building.

4.21.4 Air filters shall be fitted into holding frames which shall be so designed to allow a negligible quantity of air to bypass the filters.

4.21.5 All filter banks shall be mounted in easily accessible positions and shall be reachable with a normal 1.8m long ladder.
4.22 PROPELLER FANS

4.22.1 Propeller fans shall be of the size and type as indicated on the Drawings, and shall be capable of the duties specified in Part V hereof.

4.22.2 Propeller fans shall be of the direct connected, motor-driven type equal to DONKIN, WOODS, LUFT or ZIEHL manufacture. Wheels shall have steel or aluminium blades with heavy hubs. The fans shall be quiet in operation and shall be dynamically balanced.

4.22.3 Mounting rings or plates shall be cast, or die formed, to smooth curves where the air enters the wheels. Mounting plates shall be heavy enough to prevent distortion and shall be turned up at all edges or braced with steel angles.

4.22.4 Propeller fans mounted below the ceiling shall be provided with wire mesh guards.

4.22.5 Where indicated on the Drawings, propellers fans shall be mounted within correctly proportioned fan chambers suitable for connecting to ducting. The fan chambers shall be designed to allow the required space for radial air flow into, and from the impeller tips, and shall be fitted with diaphragm plates for mounting the fans, suitable fixing flanges at both ends, external terminal boxes and an access door for inspection and maintenance of the fan motors. The fan chamber casing shall be manufactured of 1.2mm thick galvanised sheet steel.

4.22.6 Exhaust fans to be installed through walls shall be equal to WOODS XPELAIR type WX, built-in wall fans, having an ivory coloured finish and complete with a back-draught shutter to open and close as the fan is switched on and off.

4.22.7 Exhaust fans to be installed through windows shall be equal to WOODS XPELAIR type GX, having an ivory coloured finish, and shall be complete with automatic shutters which shall close off the fan openings when the fans are not in operation. The fans shall be fitted through the windows in circular openings in the glazing, to be provided by the Principal Contractor.

4.22.8 Single phase fans shall be wired in neatly affixed, suitably rated, three core white cabtyre flex to white plugtops, to be plugged into adjacent switch plugs to be provided by others, in the positions indicated on the Drawings.

4.22.9 All ferrous parts of fan components shall be corrosion free.
4.23  **AXIAL FLOW FANS**

4.23.1 Axial flow fans shall be of aerofoil type equal to DONKIN, WOODS, LUFT or ZIEHL manufacture. They shall be of the size and type as indicated on the Drawings, and shall be capable of the duties specified in Part V hereof.

4.23.2 Fan impellers and hubs shall be of die-cast aluminium alloy and shall be accurately balanced to ensure vibrationless running.

4.23.3 The fan casing shall be fabricated from heavy mild steel plate, suitably reinforced and fitted at each end with a flange drilled for fixing. An inspection door of ample size shall be provided in the casing.

4.23.4 The fan motor, with frame diameter matching the impeller hub size, shall form an integral part of the fan. The motor shall be of the totally enclosed, squirrel cage type, suitable for the supply voltage specified. Motor connections shall be brought out to terminals located in a weatherproof, external terminal box which shall be an integral part of the fan casing.

4.23.5 Fans shall be resiliently mounted on, or suspended from, strong angle iron brackets by means of suitable anti-vibration mountings.

4.23.6 Fan speeds shall not exceed the maximum values specified in Part V hereof.

4.23.7 All ferrous parts of fan components shall be corrosion free.
4.24 CENTRIFUGAL FANS

4.24.1 Centrifugal fans shall be equal to DONKIN, WOODS, LUFT or ZIEHL manufacture, having capacities as called for in Part V hereof, and shall be installed in the positions as indicated on the drawings.

4.24.2 Centrifugal fans shall be of the multi-vane type with forward or backward curved vanes, and shall be of single or double inlet as specified in Part V hereof, or as indicated on the drawings.

4.24.3 The fan casing shall be fabricated from heavy sheet steel, reinforced and rigidly supported by means of a steel angle superstructure, and shall be corrosion free.

4.24.4 Bearings shall be of the sleeve, ball or roller type in accordance with the fan manufacturer's standard practice. They shall however be selected and fitted for quiet operation in accordance with the bearing manufacturer's recommendations. Where bearings are located in the air stream, precautions shall be taken to prevent the loss of lubricant. The runners of single inlet fans shall be overhung from outboard bearings.

4.24.5 The fan wheel and shaft shall be statically and dynamically balanced and designed to prevent vibration at the required operating speed. This operating speed shall be well below the first critical speed.

4.24.6 Fan drives shall be by means of V-belts and grooved pulleys. Fan motors mounted on the fan housings are not acceptable.

4.24.7 Large fan housings shall be made up in sections to permit installation through available openings in the building.

4.24.8 Fan shafts shall be of steel, and shall be properly protected against corrosion by means of suitable wrappings, and protective grease coatings.

4.24.9 All ferrous parts of fan components shall be corrosion free.

4.24.10 All fan casings shall be fitted with removable airtight access panels, to ensure maintenance inspections of fan internal casings.
4.25 ELECTRIC MOTORS

4.25.1 All electric motors on the installation shall be of one make unless forming an integral part of the equipment served, and shall not operate in excess of 1500 r.p.m., unless approved by the Engineers for specific applications.

4.25.2 Motors shall be 380 volt, three phase, 50 Hertz for all sizes from 0.4 kW upwards. Smaller motors may be 220 volts, single phase, 50 Hertz.

4.25.3 All motors shall be of the totally enclosed, fan cooled type, and shall have metric frame dimensions. Motors shall be quiet in operation and corrosion free to the full acceptance of the Engineers.

All electric motors for outdoor condensing units shall be of the weatherproof type, and all motor components shall be corrosion free.

4.25.4 Three phase motors shall all be squirrel cage, induction type, with special high torque motors being used on high inertia loads such as large centrifugal fans.

4.25.5 Starting methods for three phase motors shall be in accordance with local regulations. In the event that these regulations are not available at the time of tender, the following starting methods shall be allowed for:

- Motors up to 4 kW direct-on-line
- Motors above 7 kW Star-delta (where the site is not serviced by its own transformer)
- Motors above 22.5kW Auto transformer started in three steps

4.25.6 Single phase motors shall be of the capacitor run or start type, protected by a manual reset overload.

4.25.7 The nameplate rating of electric motors shall be at least 15% greater than required, on motors below 15kW. On larger motors a 10% margin shall be allowed.
4.26 **MACHINERY DRIVES**

4.26.1 Direct drive couplings shall be of the non-lubricated type, rated at least 125% of driving motor horsepower, and flexible to allow minor misalignment. "Pin-and-push" type couplings shall not be used, all direct drive couplings being of **FENAFLEX** type FX, as manufactured by Fenner or approved equal. Direct drives shall be accurately aligned using the appropriate instruments to within 0.25mm.

4.26.2 V-belt drives shall in no case consist of less than two belts, and shall be selected in accordance with manufacturer's rating, plus one additional belt per drive. Sheaves shall be machine cast iron with Taperlock shaft bushes, all equal to Fenner. Aluminium pulleys will not be permitted. All drives on the installation shall be of the same make, and of modern high-capacity belt section, such as Fenner **ALPHA, BETA**, etc. V-belts shall be fitted in matched sets only.

4.26.3 All drives shall be fitted with adequate drive guards complying with the relevant Government regulations, which guards shall be readily removable for access to the drives. Guards fitted to the belt drives shall have an expanded metal face to enable visual inspection of the drive without the need to remove the guard.
4.27  ELECTRIC HEATER BATTERIES

4.27.1 Electric heater elements shall be of the factory-bent type, so arranged that all connections are on the same side. They shall be black heat, rated for still air operation by their manufacturer’s, but operated at a minimum air velocity of 5 m/s. Elements shall be rated for 250 volt site electricity supply, with consequent lower wattage heat output and lower sheath temperature. Arrangement for heater elements within the heater batteries shall be such that they are uniformly spaced across the width of the duct to present equal air flow over each element. When necessary they shall be arranged in staggered rows to ensure the best distribution of air flow over individual elements.

4.27.2 Heater elements shall be fitted into a frame attached to a terminal box, the frame fitted into a rectangular opening on one side of the duct. The frame shall be constructed of 1.6mm bent-up galvanised sheet steel channel, and the terminal box, frame and heaters assembly shall be readily withdrawable from the heater casing.

4.27.3 Terminal boxes shall be fabricated from 1.2mm galvanised sheet, and fitted with a hinged cover fabricated from 15% free area flattened expanded mesh to allow adequate ventilation. No screws, fixings or sharp edges shall project into the terminal box. The hinged terminal box shall be carried out with silicone insulated heat resistant cable wired to a porcelain terminal strip, to which incoming P.V.C. insulated cables are also to be connected. Connections for looping wiring within the terminal box shall be executed with porcelain connectors.

4.27.4 Ductwork attached to heater batteries shall be insulated internally with 6mm MB700 glassfibre millboard for 500mm on air inlet side, and 1000mm on air leaving side, if space permits.

4.27.5 Heater batteries shall be protected against overheating with fire safety thermostats of the manual reset, rigid tailstock type, sensing temperature in ductwork on the leaving side of the battery. Thermostat locations shall be such that their operation is unaffected by radiation from the heater elements, and their temperature setpoint shall be 55ºC. Thermostats shall have single pole, double throw contact arrangement to enable trip condition to be indicated by means of pilot lamps on the relevant electrical switch panels.

4.27.6 All air handling plants fitted with electric heater batteries shall be so automatically controlled that when the plants are shut down, the operation of heater elements is stopped, but fans shall continue to operate for 3 minutes before shutting down, all to cool off heater elements for prolonged life, as well as to prevent false tripping of fire protection thermostats.
4.28 ELECTRODE HUMIDIFIERS

4.28.1 Electrode type, steam generating humidifiers shall have the capacities as called for in Part V of the Specification.

4.28.2 Humidifiers shall be installed in full accordance with their manufacturer's instructions, with their steam injection nozzles fitted in the positions indicated on the Drawings.

4.28.3 Humidifiers shall be piped to suitably selected steam injection nozzles, each being of sufficient length so as to extend over the full length of the coils or the ducts, or be the maximum standard length available for the manufacturer's of the humidifiers, and positioned for optimum mixing of the steam discharge with the air, without condensate forming on any adjacent casings or inside the supply air ducts. Should steam distribution hosing runs, because of their length, cause excessive steam temperature drop and a consequent high rate of condensate within them, then the hoses shall be insulated with suitably sized light density, performed fibreglass sectional lagging, covered with P.V.C. plastic sheeting, overlapped over each section, and fixed with approved adhesive.

Each humidifier shall be supplied with two sets of spare replaceable electrode elements.

4.28.4 Water connections to, and drain connections from, the humidifiers shall be carried out in water quality tubing using SECUREX, or equivalent compression type fittings. The mains water serving the humidifiers must NOT BE TREATED, and shall be taken from the mains water supply connections to be provided by others, in each plant room, in the positions indicated on the drawings.
4.29 AUTOMATIC CONTROLS

4.29.1 Provide, install and set into operation all the automatic control devices shown on the relevant Diagrams, and interlock same as required to perform their function correctly. The sub-Contractor shall note that the various controls shown on the drawings, and as mentioned herein, indicate the basic control elements and functions required only. They shall additionally furnish all ancillaries necessary to fulfil the desired plant operation.

4.29.2 All control equipment shall comply with the following:

4.29.2.1 Valve and damper operators shall be quiet in operation. In the event of power failure, operators shall be provided with spring return so that they will “fail safe” in either the normally open, or normally closed position as required.

Operators operating in sequence with other operators shall have adjustable operating ranges and starting points, to permit adjustment of the control sequence as required by the operating characteristics of the system.

4.29.2.2 Temperature and Humidity controllers shall be of the type specified in Part V of the Specifications, and as indicated on the Wiring diagrams.

Thermostats shall have bimetal, vapour pressure, liquid filled, or resistance type sensitive elements, and humidistats shall have sensitive elements of human hair, or other suitable material of approximately equal sensitivity, or of the hygroscopic resistance type.

Room thermostats, electronic sensors and room humidistats shall be securely attached to suitable bases mounted on the walls or other building surfaces. Each thermostat, electronic sensor or humidistat shall be located where shown, or, if not shown, where it will respond to average temperature or humidity in the area controlled.

Thermostats, sensors and humidistats generally shall be mounted 1.8m above the floor, unless otherwise indicated on the drawings, and shall not be mounted on outside walls or partitions if other locations are possible.

Thermostats mounted on outside walls shall be provided with insulating bases.

Room thermostats and room humidistats in which the adjusting mechanism is integral with the sensing element shall have locked, or concealed adjusting devices, by means of which the operating points can be adjusted through a range of not less than 5 degrees and 10 per cent, respectively, above and below the operating points specified.

4.29.2.3 Electric temperature control systems operating at less than the normal lighting circuit voltage shall be provided with transformers to supply power for the equipment.

Transformers and line voltage controllers serving individual ventilation or air conditioning units may not be fed from the fan motor leads.

Transformers other than transformers in bridge circuits shall have primaries wound for the correct control circuit voltage. Each transformer shall have adequate capacity to operate simultaneously all apparatus connected to it, and shall be capable of carrying a 25 per cent overload for one hour. Each transformer shall be enclosed in a steel cabinet with conduit connections, and shall have a fused disconnect switch on the primary side, and a fuse cut-out, or thermal cut-out, on the secondary side, if the output exceeds 50 volt amperes. One leg of the secondary winding of every transformer shall be properly earthed.

4.29.3 AIR CONDITIONING, VENTILATING, HEATING AND EXHAUST PLANTS

4.29.3.1 Plants shall be switched ON and OFF automatically, by means of an electrically operated time switch, driven by a totally electronic unit to allow the switch to continue operating, without interruption to its programme, during power failure of up to eight (8) hours.
Time switches shall incorporate a weekend cut-out feature, and shall be set to operate the plant during the hours listed in Part V hereof.

Time switches shall be installed within the electrical switchpanel, and shall be interlocked with a rotary type MANUAL\OFF\AUTO over-riding control switch, so that the plant may be operated manually, or switched off on Public Holidays, without interruption of the programme of the time switch.

MANUAL\OFF\AUTO switches shall be mounted in the positions indicated on the Drawings.

Where applicable, as indicated on the wiring diagrams, the time switch shall be replaced with an optimised start control system equal to LANDIS & GYR, STAEFA, SATCHWELL or equal, which shall influence the plant starting time, to ensure the desired indoor temperature at the beginning of the occupied period.

4.29.3.2 Where applicable, as indicated on the relevant Diagrams, plants shall be protected against low voltage or single phasing by an electronic single phase/low voltage monitoring device, pre-set to trip the entire plant should the line voltage drop by more than 10%, or the loss of one or more phases. The device shall be set to reinstate the operation of the plant five minutes after the voltage has returned to normal.

4.29.3.3 Fire safety thermostats of the rigid tailstock type shall be mounted in the return air stream to each unit, or behind the common return air opening to the plant room, as applicable, and if indicated on the drawings, to sense the return air temperature and shut-down the entire system should the return air temperature exceed ±40ºC. These safety thermostats shall be of the manual reset type.

4.29.3.4 Plants shall be started in sequence by means of time delay relays. The timing between switching stages shall be set at not less than 20 seconds.

4.29.3.5 Where applicable, the temperature control circuit of each compressor unit shall be interlocked with the condenser fan switch so that the compressors will not operate unless the fan switch contacts are closed.

4.29.3.6 Cooling and heating thermostats, or temperature sensors, shall be installed in the positions indicated on the Drawings to control cooling and heating through the number of stages as called for in Part V of the Specification.

4.29.3.7 Thermostats or temperature sensors positioned within the conditioned space shall be mounted on neat, recessed wall boxes of sufficient size, so as to project at least 25mm on all sides of the controller.

4.29.3.8 Each refrigerant circuit within the packaged air conditioning units shall include a dual pressure switch with manual reset on the high pressure side, and an oil pressure switch, with manual reset feature, to stop the compressor if the oil pressure drops below a preset minimum, all as previously specified herein.

4.29.3.9 Ventilation fans shall be interlocked with the air conditioning plant as called for on the relevant Drawings.

Fresh air intake fans shall be interlocked to operate only when the plant is switched on.

An additional manual override facility shall be provided to operate fresh air fans, for service inspection purposes.

Exhaust fans will be switched on and off at their relevant control points.
4.30 **SWITCHPANELS AND CONTROL BOARDS**

4.30.1 Provide and install, in the positions indicated on the Drawings, switchpanels and control boards complying in operating principals with the automatic control sequence as described before.

30.2 Before commencing with the manufacture and wiring of the switchpanels and control boards, the Sub-contractor shall submit three copies of up-to-date Wiring Diagrams, schematic ladder type Diagrams of the control systems, and dimensioned panel layout Drawings to the Engineer for approval. All Drawings shall show the correct terminal numbers and wire identification numbers to be used.

The Engineer shall be informed of all modifications to the wiring made until the end of the guarantee period, and updated drawings shall be submitted immediately after each modification is made.

4.30.3 The complete electrical installation, and all electrical equipment and material covered under the Sub-contract shall comply with the latest edition of the S.A.B.S. Code of Practice. The workmanship and installation shall comply with the S.A.B.S. Code of Practice for the wiring of premises, the Factories, Machinery and Occupational Safety Act of 1984, Local Municipal Regulations and Bye Laws.

All components of a similar nature shall be of one make with corresponding parts being interchangeable. All equipment shall be of robust construction and have ample ratings for the duties imposed.

4.30.4 The System Fault Levels for which the switchpanel components shall be designed and selected shall be 10KA, or as otherwise noted in Part V of these Specifications, for each switchpanel and control centre.

All equipment in the switchpanels such as fused switches and moulded case circuit breakers, for controlling outgoing circuits, shall be rated accordingly.

4.30.5 Switchpanels and control boards shall be of the floor mounted type for panels having a total face area in excess of 1,2 m², and wall mounted if less than 1,2 m². Where switchpanels exceed 1,2 meters in length they shall be divided into multi-sections.

Switchpanels shall be arranged for front access only, and bottom cable entry with the main incoming isolators positioned on the extreme left hand side of each switchpanel. All switchpanels shall be arranged for top exit via cable ducts.

When starting equipment creates higher than normal ambient temperatures, the switchpanels shall be adequately ventilated by means of splash-proof, top ventilation openings provided with vermin proof screens.

Switchpanels and control boards shall be the products of specialist manufacturer’s of this class of equipment, as approved by the Engineer, and shall be purpose made to contain all switchgear, controls, instruments and indicating equipment, and shall be complete with all internal wiring, all conforming with the following requirements.

4.30.6 Switchpanel and control board casings shall be fabricated from 2.0mm thick mild steel suitably stiffened with mild steel sections and fitted with removable, hinged doors, with flush-mounted locks each provided with triplicate keys, as well as removable panels secured with chromium plated dome nuts.

Wall mounting panels shall be of the surface type with removable inner mounting chassis.

Floor standing switchpanels and control centres shall be mounted on channel section, mild steel bases.

Door widths shall not exceed 900mm for all switchpanels. All doors, removable covers, door pillars, mullions, etc., shall be dust resistant and provided with oil resistant, closed-cell composition, synthetic rubber or similar gaskets. Gasketed surfaces shall be so constructed that gasketing material is retained by metal channels, and does not depend entirely on an adhesive holding the gasket on a flat metal surface.

All fixing screws shall enter holes tapped into an adequate thickness of metal, or nuts welded to the back surface of the metal plates. Self-tapping screws will not be accepted.
Switchpanels shall be so designed that no circuit breaker toggles shall protrude through the doors. All switches, the main circuit breakers, on/off handles, instruments and indicating equipment, reset buttons and pilot lamps only shall, however, be fully exposed and operable, as relevant, without the need to open the doors to the switchpanels, this equipment being flush mounted on the door of the switchpanel or on a fixed panel section on one side, or on top of the switchpanel. Adequate barriers shall be provided in the switchpanels to segregate load circuit compartments from the busbar chamber, in such a way that transmission of flame from one compartment to another is minimized.

The electrical equipment within the panels shall be mounted on a steel chassis. The chassis shall also be used for the mounting of the relevant busbars.

Finish of the panels shall be in enamel. Orange on the outside and White inside. Boards shall be given three coats of paint after an initial coating of zinc-rich primer, to give a high-class gloss finish. Colour samples of the Orange enamel paint shall be approved by the Engineer prior to the switchpanels being painted. All switchpanels and control boards shall be fitted with earthing straps, in accordance with the standard wiring regulations.

4.30.7 Busbars shall be provided in hard drawn annealed copper, loaded to not more than 1.55 Amps per mm. of copper, on a ±50°C rise, and shall be enclosed in a top horizontal and accessible compartment, with steel casing separating the busbars from other equipment. Busbars shall be mounted on porcelain or epoxy resin type busbar insulators mechanically braced to withstand 40 kA through fault current. The clearance between busbars shall not be less than 40mm between phases, and 25mm to earth, and they shall be secured by bolts having a diameter of not less than the thickness of the busbars, with a minimum diameter of 8mm. Machined bolts and nuts with washers and spring washers shall be used, and busbar supports shall have a maximum pitch of 900mm. Connections shall be made by means of copper, preferably double indent, compression lugs. All busbar joints shall be silver or tin plated, and connected with high tensile steel cadmium plated bolts and lock washers. Busbars shall be taped after all connections are made. Busbar droppers to circuit breakers shall be of minimum section 10 mm², single copper conductor.

4.30.8 Neutral bars are to be not less than half the cross-sectional area of the phase busbars, but not less than 25mm x 6mm, and are to be mounted on porcelain or epoxy resin type insulators, where heaters or other phase to neutral loads are used.

Where neutral bars are purely on the control side, 15mm square brass bars with 2 tapped holes per way may be used, mounted on bakelite or equal insulators.

4.30.9 Earthing straps of not less than 25mm x 6mm copper shall run the full length of the complete floor standing panels, either at the top or bottom of the panels, where it must be securely bolted to the switchpanel framework to ensure good continuity.

Wall mounted switchpanels shall be provided with an earthing brass bolt of not less than 10mm diameter, securely fixed to the panel chassis.

4.30.10 All wiring within the panels shall be neatly grouped in horizontal and vertically run, approved fire resistant P.V.C. trunking, with dip-on removable covers. All wiring shall also be colour-coded in the colours red, white and blue for the relevant phases, and black for neutral, the busbars being similarly marked.

Power wiring shall be of 2.5 mm², minimum section P.V.C. covered, stranded wire, rated for 600 volts.

Control wiring from the secondary side of control transformers shall be minimum 1.5mm² P.V.C. covered, stranded, 250 volt grade wire with bared ends soldered. All switchpanels shall be carefully designed and sized to ensure ample space for wiring and making-off incoming cables.

4.30.11 Where required (due to fault level considerations), Current Limiting Circuit Breakers shall be used to reduce fault current levels to less than 5kA r.m.s., alternatively 7.5 kA “let-through-current”. The circuit breakers to be used shall be the manually operated, trip-free type, with adjustable magnetic/thermal trips in each phase.
4.30.12 All fuses shall be of the HRC type, with minimum rupturing capacity to suit the system fault levels at 400 volts. Spare fuses of 25% of the total quantity, with a minimum of three of each size and type, including control circuit fuses shall be provided.

4.30.13 Isolators shall be of the 'on load' type, and of ample rating for the maximum load applicable. Live side terminals on all isolators must be shrouded or otherwise insulated against inadvertent contact.

Isolators installed within the switchpanels shall be housed in separate enclosures, the door of which shall be interlocked with the switch operator, to prevent the door from being opened unless the switch is in the open position, and prevent closing of the disconnect switch while the door is open, unless a manual by-pass is actuated, also to prevent closing of the disconnect switch until the door hardware is fully engaged. The stem operating the isolator shall not be less than 12mm in diameter, and shall not protrude more than 100mm. Provision shall be made for padlocking the disconnect switch in the open position only, with up to three 10mm shackle padlocks regardless of whether the door is open or closed.

4.30.14 Air break circuit breakers shall be of the double break type, and shall have a continuous rating not less than the total full load rating of the equipment. They shall have a fault capacity suitable for the design level of the system. They shall have adjustable overloads, covering the operating range of the equipment served. which shall be series tripping up to 800 Amp and C.T. operated above this value.

4.30.15 Moulded case air circuit breakers shall be rated to comply with a minimum fault level of 6kA, and a current rating to suit the load and shall be fitted with thermal overloads and instantaneous magnetic, over-current release.

4.30.16 Current transformers shall be air insulated and shall have an accuracy within 2% of the 0-100% scale output. One leg of the secondary winding shall be solidly earthed.

4.30.17 Magnetic contactors shall not be smaller than N.E.M.A. size 1 or equivalent, with encapsulated operating coils rated at 220 Volt, 50Hz. Each starter is to be furnished with one spare N.O. (Normally Open), and one N.C. (Normally Closed), auxiliary contacts rated at 5 amperes. Each starter shall also have provisions for adding two additional sets of auxiliary contact, either normally open or normally closed. Contacts and coils shall be replaceable without removing the entire contactor from the cubicle.

4.30.18 Motor Starters shall comply with BS 775 and N.E.M.A. specifications, and shall have thermal overload relays, which shall be of the bimetallic, ambient temperature compensated, manual reset type. Overload relays shall be resettable at any time after tripping, without rendering the relays inoperative. All terminals shall be shrouded, and the contact mechanism shall be trip-free, so that the snap action contacts cannot be held closed against continued overload. The ultimate trip current of overload devices shall be nominal 115% of the motor full load current.

With special hard starting, e.g. centrifugal fans, it may be necessary to increase the nominal value, but in no case shall the overload ultimate trip current exceed 130% of the motor full load current.

4.30.19 Control relays shall be either of the heavy duty industrial type, 600 volt with minimum 10 ampere replaceable contacts and shall be equipped with 110 volt, 50 Hz holding coils for continuous operation within a voltage range of 100 to 120 volts. Holding coils shall be replaceable without removing the entire relay from the cubicle or; alternatively the control relays may be of the plug-in type, hermetically sealed in plastic containers.

4.30.20 Phase failure SEQUENCE PROTECTION Relays shall be arranged to shunt trip the incoming breakers so that on failure, or phase reversing, the plants will stop. The relays shall be equal to ELECTROMATIC.

4.30.21 Timers shall be of the totally electronic unit type similar or equal to SIEMENS.

4.30.22 Sequence controllers to start plant with a minimum of 20 seconds time delay between each start-up of motors of 3kW and over shall be provided to avoid heavy current inrush on plant start-up. Sequence controllers shall be totally electronic unit type, and shall automatically recycle to zero position after power interruption, and on normal plant shutdown.

4.30.23 Pilot lights shall be of the neon or incandescent type, equal to SIEMENS with round 'Plexiglass' lenses. The colours of the lenses shall be as noted below:-
Part C3: Scope of Work

Indication
Amber
Operation
Green
Failure or Alarm
Red

Pilot lights shall be grouped in the sequence of operation of the plant components, with amber coloured lamps generally above green lamps, and the red ‘failure or alarm’ lamps below the respective green ‘operation’ lamps.

4.30.24 Reset Pushbuttons shall be similar in appearance and size to the pilot lights, equal to SIEMENS, and shall be mounted adjacent to the red failure or alarm pilot lamps on the switch-panels.

4.30.25 When indicated on the Wiring Diagrams only, the main incoming switch of the switch panel shall be fitted with a kWh-meter, three Ammeters and one Voltmeter with selector switch.

Kilowatt-hour meters shall be fitted as specified on the Drawings. The meters shall have 6 digits and manual reset knob. Above 100 Amp the kWh-meter shall be fitted with current transformers.

Ammeters shall be fitted in the power circuits of all motors of 5kW and over, and where specified or shown on the Drawings. Ammeters over 50 Amps shall be operated by current transformers of the ring type. Ammeters shall have an accuracy of 2% of the scale range or better. For non-inductive loads the scale of ammeters shall not exceed the maximum current drawn by more than 40%. Motor ammeters shall be suitable for the starting current of the motor, and shall have an extended scale in the region of the operating current.

Volt meters shall be of the moving iron or moving coil type.

All indicating instruments shall be of the flush mounted square face pattern with 96mm dials.

4.30.26 Each control circuit shall be protected with a single pole circuit breaker. Controls shall be suitable for 220 volt operation.

4.30.27 Terminal boards, or blocks, shall be mounted in each switchpanel for all external connections, and shall be so located that they are readily accessible from the front of the switchpanel, and not in the wiring gutter, leaving it completely free for power and control wiring. If terminal blocks are of the ‘split disconnect type the female part shall be secured to the removable unit cubicle, and the male part shall be free and of a closepin type. The disconnect type terminal blocks shall be held together with screws or clamps. Terminal strips shall be properly labelled, and panel field wiring shall be marked accordingly by the means of numbered ferrules. Not more than one incoming and one outgoing wire shall be fixed to any one terminal.

Labels showing the unit designations shall be provided adjacent to each of the terminals.

4.30.28 The switchpanels shall be fully labelled with engraved white ivorine labels having 6mm high black lettering. The labels shall be fixed securely to switchpanel cover or chassis plates by means of small, self-tapping screws, to identify all switchgear, relays, instruments and controls, etc., on the face of, or inside, the switchpanels.

Equipment operating above 250 volts shall be fitted also with a red danger label.

Embossed Tape or Labels fixed with adhesive will not be accepted.

The Sub-contractor shall be responsible for marking all switchgear and other equipment on the Wiring Diagrams with the wording of the labels to be used.

All cable terminals shall be clearly identified by permanent labels.

Every wire inside, and outside, the switchboard shall be fitted with ferrules, and shall be labelled with identical numbers at both ends.

All terminal numbers and wire identification numbers shall correspond with identical numbers which must be shown on the wiring and control Diagrams.
4.30.29 Work tests may be witnessed at the discretion of the Engineer, who shall be given one week’s prior notice in writing of the date on which they will take place. Three copies of Wiring Diagrams and ladder type schematic Diagrams, complete with terminal numbers, shall be sent to the Engineers at least fourteen days before testing can be commenced.

Testing shall be carried out on all completed equipment, including:

- High voltage insulation and insulation resistance tests to earth and between phases.
- Satisfactory operation of relays shall be proved.
- Closing and opening operation of all starters and contactors shall be satisfactorily demonstrated.
- All mechanical interlocks shall be satisfactorily demonstrated.
- Satisfactory operation of current and voltage instruments.
- Operation of all control circuits shall be proved by simulating operation of switching devices in the external circuit.

In addition, all components parts shall comply with the type specified in the S.A.B.S. or B.S. Standards.

The pre-delivery tests is not a final acceptance test, and does not absolve the Sub-contractor from his responsibility for the switchpanels.

All protective devices throughout shall be correctly set by the Sub-contractor to the approval of the Engineer. Before any circuit is energised, the data for correct setting is to be established.

The Sub-contractor shall be responsible for the complete electrical installation, i.e. the selection of equipment of appropriate rating and capacity, including the rupture of fuses and circuit breakers, all as covered under this Sub-contract.

4.30.30 Provide for each item of equipment located out of sight of the electrical switchpanel serving same, a remote-on-load isolator housed in a dustproof case. Where isolators are located in positions exposed to weather, they shall be of a waterproof type fitted with suitable watertight cable entry glands.
4.31 **ELECTRICAL WIRING**

4.31.1 Electrical wiring shall comply fully with the S.A.B.S. Code of Practice for the Wiring of Premises, and the additional requirements of the local authorities who have jurisdiction over the Site of Works, as well as being in accordance with best modern practice.

4.31.2 Main power incomers to plant rooms will be provided by others, excluding making-off of cables within the electrical switchpanels provided by the air conditioning Sub-contractor, who shall attend upon, and liaise with whoever brings power cabling to his switchpanels.

4.31.3 Conduits shall be galvanised to S.A.B.S. specification. All joints shall be screwed. No conduit less than 20mm shall be used. Conduit fittings and boxes shall be of galvanised iron to S.A.B.S. specification.

4.31.4 Galvanised conduits and conduit fittings shall be installed in positions exposed to weather, or in moist surrounding. Where galvanising has been removed by threading, cutting, etc., the exposed parts shall be suitably treated with cold galvanising to render them weatherproof and rust resistant.

4.31.5 Conduit shall either be screwed and locknutted on both sides, and bushed on the inside of the box or appliances in which it is terminated. Only solid brass bushes shall be used. Alternatively, and particularly in distribution boards, conduits shall be terminated with couplings and brass male bushes. PVC conduit will be allowed where it complies with local regulations.

4.31.6 Conduit in roof spaces shall be run parallel, and at right angles to roof members, and shall be secured to these members by means of saddles and screws.

4.31.7 No conduit is to cross an expansion joint in the structure without an approved arrangement for crossover. Where details of the crossover are not given, the Sub-contractor shall refer to the Engineer for instructions.

4.31.8 The Sub-contractor shall notify the Engineer in good time before any conduits in concrete are covered, so that tubing may be inspected and checked before concrete is cast, and shall attend on the Engineer during such inspections.

4.31.9 Conduit for future requirements shall be terminated with boxes and overlapping cover plates, and fitted with galvanised steel draw-wires. Where such conduit terminations project from the wall or slab, they shall be fitted with couplings and plugs. Such terminations in exposed positions shall be sealed with bitumen and protected with weatherproofing paint.

4.31.10 Inspection facilities shall be provided as specified in S.A.B.S. 0142-1981, Clause 5.4.1.d.

4.31.11 Exposed conduits shall be fitted with steel saddles of same finish as conduits, fixed at centres not exceeding 2 meters.

4.31.12 Conduit boxes to be cast in concrete shall be secured to shuttering by means of 5mm screws and nuts, unless some other method of fixing is approved by the Engineer.

4.31.13 Drawboxes and blank boxes in R.C. slabs, columns or in walls shall be fitted with substantial oversized metal coverplates, fixed with countersunk screws, before surrounding surfaces are painted. Drawbox positions must be approved and care shall be taken that they do not affect the appearance of the building adversely. Where possible a single coverplate shall be fitted for a number of adjacent drawboxes.

4.31.14 Drawboxes in roof spaces which are only accessible above ceilings, shall not be installed in positions where clearance from ceiling to roof is less than 1 meter.

4.31.15 Blank switch and plugboxes shall be fitted with blank coverplates and screws to match those specified for switches and switch sockets.

4.31.16 Mounting heights of boxes shall be as indicated on the Drawings which shall refer to the distance between the centre of the outlet box and the finished floor level, unless otherwise specified or indicated. Where two similar outlets occur adjacent to each other, these shall line up accurately horizontally, unless otherwise indicated.
4.31.17 When chasing of brickwork is carried out by the Sub-contractor due care shall be taken to prevent damaging of walls during chasing. He must ensure that other trades are not held up owing to delays in such work. Damage to brickwork will be made good by the building contractor.

Under no circumstances is facebrick, or other finished surfaces, to be chased without the permission of the Engineer.

Where it is necessary to chase structural concrete, the permission of the Structural Engineer must first be obtained. Where this is not done and the structure is chased without permission, the Sub-contractor will be held responsible for any damage to the structure which may be caused.

4.31.18 All wiring shall, unless otherwise specified, be carried out with P.V.C. insulated cable to S.A.B.S.150-1970.

4.31.19 Plastic insulated (P.V.C.\S.W.A.) cables shall be to S.A.B.S. 150-1970, and addenda thereto and shall consist of P.V.C. insulated conductors, P.V.C. beddings, galvanised steel wire armouring and a P.V.C. sheath.

P.V.C.\S.W.A. Cable ends shall be made off with approved glands. The glands shall be of the type in which the armouring is clamped between tapered cones compressed by the action of a screw and in which the gland is secured to the outlet casing by means of screwing, and/or locknutting.

Neoprene shrouds shall be used to cover the junction of the cable and the base of the gland.

4.31.20 The wiring in all Plant rooms shall be supported on cable trays or in cable ducts.

Cable supports for single, or not more than a group of three cables, shall be equal to UNISTRUT die-cast cable cleats with UNISTRUT type P-1000 channel, fixed to walls or overhead slab, at not exceeding 600mm pitch. Cables supported in this manner shall be properly straightened and neatly run to the full satisfaction of the Engineer.

Cable trays shall be run strictly in horizontal or vertical planes, any change of level, however, being done with a 45\° slope. Where cables leaving trays drop down to equipment, use minimum tray width of 150mm and two vertical UNISTRUT supporting channels fixed to horizontal tray at top and floor at bottom.

4.31.21 All earthing shall be carried out in accordance with wiring regulations, earthing connections being executed with appropriate copper earthing strip, using brass bolts, nuts and washers to ensure continuity to main building earth provided by others.

Each run of P.V.C.\S.W.A. multi-core cable shall carry an additional conductor to be used for earth continuity, and shall be properly made-off for this purpose.

4.31.22 Connections to vibrating equipment shall be made with metal sprague on conduited systems, a separate earth continuity conductor being run outside the flexible conduit.

On cable systems, leave sufficient cable slack to allow free cable movement to take up vibration.

All connections to vibrating equipment shall be made so as not to impose strain on conduits, cables, conductors or equipment, and shall be of sufficient length to allow full adjustment of motors on slide rails.
4.32 INSTRUMENTS

4.32.1 Provide and install instruments where shown on the applicable drawings, or mentioned herein as follows. All instruments shall be installed within Plant rooms where possible, and shall be mounted at eye level, and, if necessary, remote sensors shall be provided to ensure eye level accessibility. All instruments shall be installed in positions not affected by plant vibration.

Instruments shall be of the circular dial type, having equal sized dials between 75mm and 100mm in diameter, unless otherwise specified, and the same finish in either stainless steel or chrome plate. All panel mounted instruments shall be suitable for flush mounting and fixing from within the panels, without screws projecting through the panels.

Instruments shall be provided with pointers, or have painted on their dials, green lines to indicate the normal operating ranges of the services indicated, and red lines to indicate minimum and/or maximum limits.

4.32.2 Air and water temperatures shall be measured with alcohol in glass type thermometers, which shall have a guaranteed accuracy within 1% around the entire dial range, and a means for recalibrating the instruments on site. Thermometer ranges shall be suitable for the service and shall not exceed 50% above, or below, the normal operating temperatures for each instrument.

Stems or bulbs sensing temperatures in pipes shall be fitted into oil filled wells, and bulbs in ducts or plena, shall be neatly fitted on insulated brackets to the satisfaction of the Engineer.

4.32.3 Air pressure gauges shall be 50mm dial, scaled from 0 to 150% of normal operating pressure.

4.32.4 Inclined pressure differential manometers shall be installed to indicate the resistance to the air flow over all banks of filters. Each manometer shall be fitted with a spirit level to ensure proper horizontal mounting, and pointers to indicate the initial pressure drop, and when the filter media has to be changed.

4.32.5 Static pressure indicators shall be of the diaphragm actuated, dial and pointed type graduated to read from 0 to 50% more than the maximum allowable static pressure, and shall be installed to sense the leaving main supply duct pressure. The gauges shall be connected to static pressure tips of approved design.
4.33 **EQUIPMENT BASES**

4.33.1 Provide, as called for in Part V or as indicated on the Drawings, equipment bases of the applicable type as specified below:

4.33.2 Inertia bases shall comprise a reinforced concrete pad of mass one and half times that of the equipment to be mounted upon it. A welded mild steel tray, suitably reinforced and of sufficient depth to contain the required weight of concrete, shall be provided by the Sub-contractor. Welded into such trays shall be a suitable template complete with the necessary ragbolts suitable for rigidly affixing the equipment to the base, once concrete has been cast in. The Principal Contractor will pour concrete into the tray and smooth plaster it with coloured granolithic finish. The steel tray is to be positioned on an 80mm high smooth plastered “housekeeping” plinth, such plinth provided by the Principal Contractor and 150mm larger than the steel tray all round. The inertia base shall be separated from the plinth by suitable vibration isolators, as later detailed. Proper provisions in the design and construction of the steel tray shall be made for the attachment of the necessary vibration isolating mountings.

4.33.3 Floating steel bases shall be shop-fabricated from mild steel channel sections of sufficient strength and rigidity using welded joints. Such bases shall, unless otherwise called for elsewhere or noted on Drawings, be of rectangular shape, and at least 80mm larger in all plan dimensions than the equipment to be mounted onto it. The construction of the base shall be such that proper provisions are incorporated for attaching laterally, or fitting beneath it, vibration isolators of the type which each application may require. The principal Contractor will provide a level “housekeeping” plinth on which to mount the aforementioned steel base, the plinth to be 100mm minimum larger than the base all round.

4.33.4 Static plinths, 80mm minimum high, shall be provided by the Principal Contractor for mounting non-vibrating equipment upon them, the plinths to be rectangular in shape unless otherwise shown on the Drawings, and 100mm larger all around than the equipment to be mounted upon them.

The Sub-contractor shall provide and position, where required, a channel iron frame, with mitred welded comer joints, and sheet metal bottom tray for the Principal Contractor to fill with concrete. The finish of the plinths shall be tinted granolithic.

4.33.5 Anti-vibration mountings shall be utilised in conjunction with the aforementioned bases, as relevant and as indicated on the Drawings for the following listed items of equipment.

All anti-vibration mountings shall be installed in full accordance with their manufacturer's application instructions, the model numbers mentioned herein referring to equipment of Mason Industries Inc., as locally supplied by E.M. ARNOT, although other approved makes would also be acceptable.

4.33.6 All equipment bases and anti-vibration mountings shall be corrosion free.
### Part C3: Scope of Work

#### Annexes

**Reference No**: NRF/iThemba LABS/2015 – 16:07

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Minimum Static Deflection</th>
<th>Type of Mounting</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Conditioning units</td>
<td></td>
<td>Neoprene NK Vibration Pads</td>
<td>or WMW</td>
</tr>
<tr>
<td>Air Handling units and condensing units on concrete floors or bases</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling Towers over non-occupied area</td>
<td></td>
<td>Neoprene NK Vibration Pads</td>
<td>or WMW</td>
</tr>
<tr>
<td>Over occupied areas</td>
<td></td>
<td>To suit fan speed with levelling adjustment</td>
<td>Helical Spring SLR</td>
</tr>
<tr>
<td>Centrifugal Pumps over non-occupied areas</td>
<td></td>
<td>Neoprene NK Vibration Pads</td>
<td>or WMW</td>
</tr>
<tr>
<td>Over occupied areas</td>
<td>19mm</td>
<td>Helical Spring CIP with levelling adjustment</td>
<td></td>
</tr>
<tr>
<td>Axial Flow Fans</td>
<td>6mm</td>
<td>Neoprene in sheer and compression</td>
<td>30N</td>
</tr>
</tbody>
</table>

4.33.7 Full details of floating steel bases and all anti-vibration mountings selections shall be approved by the Engineer prior to the mounting being ordered, and the bases fabricated.

4.33.8 Where applicable, the Sub-contractor shall exercise particular care to prevent damage to the roof slab when hoisting, positioning and connecting the air conditioning units, and shall note that he will be held responsible for repairs caused as a result of this installation.

4.33.9 All equipment, and particularly that which is mounted on the roof, shall operate without objectionable noise or vibration being transmitted to the full satisfaction of the Engineer.

4.33.10 All cut joints and holes drilled within ducting, equipment casings, supports, stands, platforms, suspension brackets and supporting cable trays shall be fully protected against corrosion.
4.34 EQUIPMENT SUPPORTS

4.34.1 Where equipment supports, stands, platforms and suspension brackets are indicated, specified or necessary for ductwork, pipework, etc., the Sub-contractor shall provide supporting structures capable of carrying the load without distortion, affixed to the building structure in such a manner as not to subject it to undue stress.

Supporting of any rotating equipment shall incorporate vibration mountings of the type and selection specified in the applicable clauses referring to equipment bases herein.

All methods of suspension or supports shall be submitted to the Engineer for approval, and for reference to the Structural Engineer where necessary, prior to manufacture or installation.

4.34.2 Generally, supports shall preferably be proprietary products such as Unistrut, or failing this, shall be of mild steel sections, purpose fabricated for their application. Under no circumstances whatever will sheet metal straps be accepted as a supporting method. All supports shall cradle the item to be supported; supports shall not be rivetted or welded to the equipment to be carried, except in exceptional circumstances approved by the Engineer. Rod hangers shall not exceed one meter in length, and shall be of minimum diameter 12mm. For longer suspensions use mild steel angles. Angle iron supports shall be of 25mm x 3mm minimum. All supporting structures for equipment shall be hot dip galvanised.

4.34.3 Fastening methods shall employ REDHEAD or RAMSET anchor bolts, or their equivalent, for fixing supports to the building structure, it not being permissible to utilise gunpowder shot-driven bolts for this purpose, unless approval be obtained.

4.34.4 Pipework supporting holderbats shall be the product of a recognised manufacturer of such equipment, reinforced shop-fabricated saddles or similar devices. On insulated pipework, reinforced shop-fabricated saddles are to be used, up to and including 300 pipes. These saddles are to be placed at support points, and are to be clamped around the pipe. The insulation is to be taken to the edges of these saddles, joints are to be sealed, and the necessary vapour seal and reinforcing taken over the complete section. For piping with a diameter of more than 300mm, hardwood inserts consisting of two half-round, machine cut pieces timber shall be clamped around the pipe, insulation being cut away at such points, to allow proper installation of the supports. Wooden inserts shall be of the same thickness as adjoining insulation and 50mm longer than the width of the holderbat support, to permit correct finishing of the insulation and vapour sealing to them.

4.34.5 Cables and flexible pipes shall be supported on Unistrut, or equivalent, perforated galvanised cable trays, manufactured by specialists. Shop-fabricated trays or racks not being acceptable. The cable tray shall be suspended, or bracketed, using suitable mild steel angles.
4.35 **NOISE AND VIBRATION**

4.35.1 Particular care shall be taken in the selection, application and installation of all equipment used to ensure that it operates below the maximum allowed noise levels, specified in Part V hereof, and with the least vibration possible, all to the full satisfaction of the Engineer.

4.35.2 The following measures shall be taken where necessary, whether specifically called for or not, all to ensure quiet, vibration-free operation of the equipment forming part of the air conditioning and ventilation installations.

4.35.3 Rectangular ductwork in the vicinity of critical areas shall be provided with internal acoustic insulation.

4.35.4 Anti-vibration cuff connections of flexible joints shall be used on ductwork where it joins vibrating equipment such as fans and air conditioning units.

4.35.5 Pipework connecting rotating or vibrating machinery shall be provided with anti-vibration flexible joints, all as previously specified.

4.35.6 Equipment shall be mounted on vibration isolators of the correct type and selection, dependent upon deflection requirements versus vibrating frequency.

4.35.7 Pipework and ductwork shall be suspended, or mounted, using suitable supports with vibrating isolators to prevent transmission of vibration from them to the structure to which they are attached, where necessary only.

4.35.8 Suitable sound attenuating devices shall be incorporated within ductwork to reduce airborne noise to acceptable levels, as indicated on the Drawings and specified in Part V hereof.

4.35.9 If in the opinion of the Engineer, any equipment operates with, or transmits from it, objectionable vibrations or noise above the levels specified for the individual areas, it will be necessary to rectify or replace, such equipment to the full approval of the Engineer at no additional cost to the Owners.
4.36 **PAINTING AND CLEANING**

4.36.1 No untreated metal surfaces shall be permitted on the project. Items which are not galvanised or similarly protected against corrosion shall be painted, as later detailed herein. No equipment, hangers, brackets, etc., shall be permitted to be delivered on site in unprotected form; they shall be factory-coated with an approved zinc-rich primer coat before despatch from their place of manufacture.

4.36.2 Painting shall comprise the following consecutive processes. First thoroughly clean, descale and degrease all surfaces, in accordance with acknowledged good practice, follow with a good coating of approved zinc-rich primer, and finish with two coats of quality high-gloss enamel of an acceptable make. Final finish shall be to the full approval of the Engineer.

4.36.3 With the exception of ducting and piping, items with a galvanised finish, such as cable trays, need not be painted, but shall be properly cleaned with a suitable proprietary galvanised iron cleaning fluid.

4.36.4 Particular care shall be taken that appropriate primers be used as a basis for painting, and that paint be of high quality manufacture, all to provide a completely satisfactory finish to the approval of the Engineer. It shall be noted that galvanised surfaces are to be treated to ensure proper bonding of paint.

4.36.5 Whereas it would not be necessary to paint any ductwork or conduits installed in roof voids, shafts, masonry ducts, etc., or where not normally visible, it is a requirement that such equipment be properly cleaned, treated with two coats of rustproofing paint if not galvanised, or not metal subject otherwise to rust.

4.36.6 All equipment on the project shall be colour-coded in accordance with standards recognised in the Republic of South Africa and, where possible, to comply with relevant South African Bureau of Standard Colour Codes. (S.A.B.S. 1091-1975).

General colour coding for the various items of equipment shall otherwise be as follows. The numbers given in the schedule refer to the colour code numbers of S.A.B.S. 1091-1975. (Any alternative colours shall be approved by the Engineer).

All equipment shall be painted in accordance with colour code given and where factory painted items such as the Air Conditioning Units, Cooling Towers and Pumps are not painted a specified colour, they shall be repainted by the Sub-contractor.

Factory painted equipment which is required to be repainted to comply with the specified colour code shall be rubbed down prior to being given two coats of gloss enamel paint, or as required in accordance with the paint manufacturer's recommendations, and depending upon the type of paint applied at the factory.

<table>
<thead>
<tr>
<th>EQUIPMENT</th>
<th>COLOUR</th>
<th>CODE No.</th>
<th>(SABS 1091-1975)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Conditioning Units</td>
<td>Cream</td>
<td>C66</td>
<td></td>
</tr>
<tr>
<td>Air Handling Units</td>
<td>Cream</td>
<td>C66</td>
<td></td>
</tr>
<tr>
<td>Fans - Axial Flow</td>
<td>Silver</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pipework - Mains Water</td>
<td>White</td>
<td>G80</td>
<td></td>
</tr>
<tr>
<td>Condenser Water</td>
<td>Green</td>
<td>E14</td>
<td></td>
</tr>
<tr>
<td>Chilled Water</td>
<td>Blue</td>
<td>E14</td>
<td></td>
</tr>
<tr>
<td>Drains and Overflow</td>
<td>Black</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper - cleaned, polished then coated with</td>
<td>Clear Lacquer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ductwork - Supply, Return &amp; Exhaust</td>
<td>Cream</td>
<td>C66</td>
<td></td>
</tr>
<tr>
<td>Switchpanels &amp; Control panels</td>
<td>Orange</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electric Wiring Trays or struts</td>
<td>Orange</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belt Guards</td>
<td>Red</td>
<td>A11</td>
<td></td>
</tr>
<tr>
<td>Equipment Bases</td>
<td>Black</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supports &amp; Steelwork</td>
<td>Cream</td>
<td>C 66</td>
<td></td>
</tr>
</tbody>
</table>
4.36.7 On completion of the installation the Sub-contractor shall clean all equipment properly, remove all superfluous materials from the site, make good black granolithic finished equipment bases with black concrete paint, sweep out Plant rooms and make the Plant completely presentable before calling upon the Engineers to accept the plant after completion of the 'Preliminary Tests'.
4.37 **LABELLING AND IDENTIFICATION**

4.37.1 All equipment shall be labelled and identified using white Traffolite labels having 10mm high black lettering engraved on them; where two similar items exist, they shall additionally be numbered for clarity in identification. Labels shall be neatly bolted to the equipment with brass fasteners.

4.37.2 Belt guards and items of plant containing belt driven equipment shall be fitted with a label stating the number of, and the size of the belts for each V-belt drive. The labels shall be of the same type and dimensions and shall be fixed as specified above for all equipment.

4.37.3 Designate and identify each automatic control device such as 3-way valve, thermostat, damper motor etc., and fit to each a white Traffolite label having 5mm high black lettering, the label to be bolted to equipment with brass fasteners. Prepare a complete control Diagram of the installation and label with relevant designations mentioned above, all to form part of plant operating instructions which are later mentioned herein.

4.37.4 Label pipes with directional arrow neatly stencilled onto finished pipework or in the form of a durable proprietary transfer. Arrows shall be at not more than 5 meter intervals and not less than 100mm long, of good colour contrast to equipment colour background.

4.37.5 Identify all Plant rooms as 'Air Conditioning' or 'Air Handling Plant Room' with 5mm thick engraved P.V.C. sheet notices having 25mm high black lettering on a white background.

4.37.6 Provide and install all necessary notices required in terms of 'Governmental and Local Authorities' laws, such as "No Entry to Unauthorised Persons", at all Plant room entrance doors, etc. Such notices to be silk screened onto 3mm thickness P.V.C. sheet, as obtainable from Messrs Mine Safety Appliances.

4.37.6 All labels and identification designations shall correspond to the numbers/labels as specified on the drawings and in the plant operating instructions.
4.38 COMMISSIONING AND TESTING - PRELIMINARY TESTS ON COMPLETION

4.38.1 Following completion of the Works, or any portion of the Works as specified or directed by the Engineer, the Sub-contractor shall balance, set and test the Works or portion of the Works, in accordance with the following requirements, to establish the capacity and satisfactory performance of the Plant.

4.38.2 All balancing, setting and testing shall be done by the Sub-contractor entirely at his own expense. The Sub-contractor shall provide all facilities and apparatus for the testing of the Plant, and shall carry out such tests as may be necessary to satisfy the Engineer that the Plant meets with the requirements of the Specifications.

4.38.3 The Sub-contractor shall also carry out, or attend upon, all tests required by Government and Local Authorities who have jurisdiction over the Works, and shall obtain all necessary certificates of approval and acceptance, and shall provide the Engineer with triplicate copies of all such certificates prior to, or at such time as providing the Engineer with copies of his "Preliminary Test" report.

4.38.4 All test instruments shall be checked for accuracy by the manufacturer's, supplier's or approved laboratory, and certified copies of certificates showing the degree of accuracy shall be supplied to the Engineer together with the "Preliminary Test" reports.

4.38.5 Gauges, thermometers, ammeters and other instruments specified as part of the permanent Plant may be used for test purposes, providing that the Sub-contractor ensures that all such instruments are accurately calibrated. The Sub-contractor shall check the accuracy and calibrate all such instruments against laboratory tested instruments.

4.38.6 The Sub-contractor shall when required, provide the Engineer with equipment selection and performance data for all major items of plant, such as Air Conditioning Units, Air Handling Units, Cooling Towers, Pumps, Fans and Sound Attenuators.

4.38.7 The Sub-contractor shall keep full and proper written records of all tests conducted and commissioning information, such data to be properly indexed and clearly set down to form part of the Operating and Maintenance manuals called for in the Specification.

4.38.8 The Engineer reserves the right to inspect any item of equipment during manufacture or before delivery to site. The Sub-contractor shall make available any item for such inspection.

4.38.9 Electrical switchpanels shall be inspected by the Engineer at their place of manufacture, prior to delivery to Site. At such inspection and testing, the Sub-contractor shall demonstrate the functioning of the switchpanel to the Engineer. Any defects in materials, finishes and operation of the switchpanels shall be corrected at their place of manufacture, prior to delivery to site.

4.38.10 The Sub-contractor shall, on handing over the installation or any portion thereof to the Engineer, also provide the necessary certificates as proof of having conducted a satisfactory electrical test to the requirements of the electricity supply authority, such certificate emanating from such authority, and permitting full use to be made of the installation without the need for further tests.

4.38.11 The Sub-contractor shall properly test and call for inspection by the Engineer, any work which is to be covered, concealed, built-in, otherwise closed up or rendered inaccessible, before such closing up takes place. The Engineer may require any work of this nature which he has not been called on to inspect before closing up, to be uncovered or made accessible, entirely at the Sub-contractor's expense, making good included.

4.38.12 Prior to the "Final Tests" to be attended by the Engineer, the Sub-contractor shall balance, set and test the following to establish the capacity and performance of the Plant. All such "Preliminary Tests" shall be recorded by the Sub-contractor, who shall provide the Engineer with three typed copies of all test recordings which shall set out procedure, data and instrument readings obtained, as compared with the specified capacities and the manufacturer's name plate ratings where applicable. Such "Preliminary Test" reports shall be accompanied by one preliminary draft set of Operating and Maintenance Instructions prepared in accordance with the requirements as detailed herein.
4.38.13 On receipt of an acceptable preliminary test report and draft copy of the Preliminary Operating and Maintenance Instructions, the Engineer shall advise the Sub-contractor in writing so that he may arrange for the "Final Test" and issue of the Acceptance Certificate's.

THE "PRELIMINARY TESTS" SHALL INCLUDE THE FOLLOWING:

4.38.13.1 Drains shall be tested for proper functioning by pouring water down them at a rate of at least four times normal drainage.

4.38.13.2 Field assembled refrigerant piping and apparatus shall be tested with dry carbon dioxide or nitrogen, plus a small amount of refrigerant. Test procedures shall be in accordance with the latest edition of the American Standard Safety Code for Mechanical Refrigeration. Leaks in pipe joints shall be corrected by remaking the joints. Caulking will not be permitted. The vacuum test shall follow the pressure test.

Charging of the equipment with refrigerant shall follow the vacuum test as closely as is practicable to minimise the possibility of air, or moisture, being returned to the system. After charging and prior to capacity tests, joints in refrigerant piping and apparatus shall be checked with a halide torch or other equally sensitive leak detector. If leaks are found, the system shall be pumped down and the leaks corrected.

4.38.13.3 Capacities of Air Conditioning Units, Fans and other equipment shall be determined by operating tests of not less than four hours duration, after stable conditions have been established. Test procedures shall be in accordance with applicable portions of ASME and other recognised test codes, as far as field conditions permit. Capacities shall be based on temperatures and air quantities measured during such tests.

Temperature differences required for determining capacities shall be measured by thermometers having graduations that permit interpolations having an accuracy of ±0,5°C.

Air quantities may be measured by Pitot tube, anemometer or velometer, depending on the velocity and other conditions of flow.

Check alignment of all equipment drives prior to setting into operation.

4.38.13.4 Air systems shall be checked for obstructions, and balanced to provide the required air quantities at each outlet, without objectionable noise and draughts, and so that the velocity of the air is relatively uniform over the area of the outlet.

Velocity meters may be used to test all outlets and for duct velocities up to 1,5 m/s, above which velocities shall be measured with Pitot tubes. Properly capped openings shall be provided in ducting as required. Final setting of all volume adjusting devices shall be permanently marked.

Should it be necessary to re-balance any air system due to partitioning or repartitioning of the conditioned space after the specified conditions have been obtained and accepted by the Engineer in writing, then such re-balancing shall be carried out as an extra to the Sub-contract and shall be authorised, by the issue of a "Variation Order", by the Engineer.

4.38.13.5 All automatic controls and safety devices shall be checked for correct performance and satisfactory operation, and set to the respective settings required.

4.38.13.6 All electrical switchpanels shall be checked for the correct functioning of all components, electrical interlocks, all time clocks, time delay relays and automatic control devices shall be set for their correct function.

4.38.13.7 The full load running current of all electrically operated equipment shall be recorded and compared with the manufacturer's name plate ratings, which shall be recorded, together with any other relevant data stamped on the name plates. All overload protection devices shall be set to the correct values, which shall be recorded.

4.38.13.8 The Sub-contractor shall ensure that the plants operate satisfactorily and uninterrupted for a period of 7 days prior to the final acceptance by the Engineer. Evidence of this, for air conditioning systems,
shall be given in the form of a 24 hour long, continuous recording of temperature and humidity, which recording shall cover at least 50% of the areas handled by any one plant and shall be handed over to the Engineer prior to inviting him to the "Final Tests" and acceptance of the completed installation.

The original recorded graphs shall be supplied to the Engineer, and the Sub-contractor shall also obtain and provide the Engineer with the daily maximum dry and wet bulb temperature readings recorded in the area, on the same days as the inside conditions are recorded. Such information may be obtained from local weather stations.
4.39  OPERATING AND MAINTENANCE INSTRUCTIONS

4.39.1  The Sub-contractor shall furnish to the engineer before the Works are taken over, such Operating and Maintenance Instructions, together with Drawings of the Works as completed, and in sufficient detail to enable the Employer to operate, maintain, dismantle, re-assemble and adjust all parts of the Works.

The Works shall not be considered to be completed for the purpose for taking over until the required Instructions and Drawings have been supplied to the Engineer.

4.39.2  A draft copy of all written instructions shall be submitted to the Engineer for approval together with the required copies of the "Preliminary Test" report, as previously specified herein, prior to the preparation of the final copies.

THE "OPERATING INSTRUCTIONS" SHALL INCLUDE THE FOLLOWING:

4.39.3  Instruction Manuals comprising the following sections bound in a blue coloured vinyl plastic covered folder, with the name of the project typewritten on a card inserted into a clear plastic covered cardholder on the front cover.

4.39.3.1  INDEX (in detail)

4.39.3.2  DESCRIPTION OF PLANT (as installed)

4.39.3.3  OPERATION OF PLANT (as installed) to include:

- Automatic and manual start-up and shut-down procedure.
- Operation and Sequence of all automatic controls.
- Scheduled description of all Control and Safety Instruments; listing function, make, model number, range and differential (when applicable), and setting of each instrument.
- Functions of all switches, indication lamps, reset buttons and alarms; and instructions for adjusting and re-setting all controls and cut-out switches.

4.39.3.4  PLANT AND EQUIPMENT

Scheduled list of all major plant and equipment to include Description, Make, Model Number and supplier's name and address.

4.39.3.5  TEST REPORT

Copy of "Final Test" report as accepted by the Engineer. (Draft copy of "Operating Instructions" for Engineer's approval shall contain a copy of the "Preliminary Test" report.)

4.39.3.6  MAINTENANCE INSTRUCTIONS

In schedule form setting out each item of plant, and the description as necessary for preventative maintenance of the Plant as installed.

4.39.3.7  SPARE PARTS

List of spare parts supplied (in accordance with these Specifications), with detailed description of each part, make, model or part number and Supplier's name and address.

4.39.3.8  DESCRIPTIVE LITERATURE

To include manufacturer's operating and maintenance instructions, performance curves or charts and spare parts lists where applicable, and where available.
4.39.3.9 DRAWINGS

List of all Drawings and photographically reduced, Size A3, copies of all “as installed” Drawings and Diagrams to include the following:

Plant layout Drawings showing the actual positions and sizes of all plant and equipment, ducts, pipes, the location of all dampers, valves and controls, and the measured air quantities at all air intake and discharge points.

Control and Wiring Diagrams and Schematic Piping Diagrams noting, where applicable, the normal and abnormal gauge readings, control points, scale settings and time settings, differential bands, throttling ranges, time relays and the overload settings and actual rated amperages of all electrical components, and any other relevant variable and adjustable items, to permit checking and adjustments, controls and motor functions.

4.39.3.10 COPIES OF INSTRUCTIONS IN PLANT ROOMS

As required in compliance with Government and Local Regulations.

4.39.4 A copy of the “Operation of Plant” instructions shall be mounted within a glazed or plastic covered frame in the Plant rooms, in positions to be approved by the Engineer.

4.39.5 Copies of the Schematic Piping Diagrams and the Control and Wiring Diagrams shall be mounted within glazed or plastic covered frames in the Plant rooms in positions to be approved by the Engineer.

4.39.6 Copies of Government Acts and Local Regulations, as required, shall be mounted within glazed or plastic covered frames in the Plant rooms, in positions to be approved by the Engineer.

4.39.7 The Sub-contractor shall instruct the Employer’s personnel in the correct operation and use of the Plants. For this purpose the Sub-contractor shall allow for the time of a competent instructor for a total of four hours on Site, and one return trip to the Site for the purpose of providing such instruction.

4.39.8 During this period the Sub-contractor shall fully explain the layout, operation and maintenance of the plant to the Employer or the Employer’s Representative.

At the conclusion of this period of instruction the Sub-contractor shall obtain from the Employer an acknowledgement, in writing, that the instruction has been properly given for the prescribed period. Two copies of the acknowledgement shall be forwarded to the Engineer.

4.39.9 The Sub-contractor shall supply the Employer or Tenant with a plant log book that will reflect all call-out or routine service visits.
4.40 SPARE PARTS

4.40.1 The Sub-contractor shall deliver the following spare parts to the Employer’s for safe-keeping by the latter in order that repairs to the Plant can be executed with minimal delay, such parts being provided packaged in complete sets, each duly labelled with their function.

ONE set of matching V-belts for each different belt drive;
ONE set of bearings for each different fan size;
ONE pilot lamp bulb for each pilot light specified on the drawings to match those installed in the Electrical Switchpanel, and a bulb extractor if required;
ONE set of filters for each Air Conditioning and Ventilation system is to be handed to the Client’s Representative on final completion of the Works;
TWELVE months supply of chemicals for the Chemical Dosing Plant, where applicable.
ONE complete set of "0"-rings and filter for the electronic water treatment unit.

The necessary chemicals for bacterial, legionella and algae control shall be included for the purpose of water treatment required to supplement the non-chemical electronic water treatment unit.
### 4.41 MAINTENANCE

4.41.1 The Sub-contractor shall maintain and service the Plant, in accordance with the following requirements for a period of twelve months calculated from the date of the "Acceptance Certificate" or, in the event of more than one certificate having been issued by the Engineer, from the respective dates so certified.

4.41.2 During the "Maintenance Period" the Sub-contractor shall maintain and service the Plant regularly at monthly intervals, and make good any Defects in accordance with the provisions of these Specifications.

4.41.3 The Maintenance of the Plant shall be carried out during normal working hours and at each service the Sub-contractor shall attend to the following:

- 4.41.3.1 Report to an official nominated by the Employer on arriving and again on leaving the Works. Such person shall complete and sign the monthly "Service Report".

- 4.41.3.2 Check the function of each item of the Plant including all automatic controls and safety devices, for correct operation and lubrication, adjust, clean and/or replace components and ancillaries as necessary.

- 4.41.3.3 Clean all washable air filters, and check all disposable media type air filters serving the air conditioning plants, for pressure drops, fitting additional filter material, if required.

- 4.41.3.4 Check all refrigeration systems for leaks, refrigerant dryness, sufficient oil in the compressors, sufficient refrigerant gas or any other defect.

- 4.41.3.5 Check the electrical switchpanels replacing any burnt contacts or pilot lamp bulbs which have failed.

- 4.41.3.6 Take and record Wet and Dry Bulb temperatures in each of the conditioned areas and outside. Temperature readings shall be taken with a reliable sling psychrometer, and all readings shall be recorded on the "Service Report".

- 4.41.3.7 Attend to any complaints made with respect to the Plant, by the official nominated by the Employer’s, being the only person authorised to instruct the Sub-contractor or make any complaint, (other than the Engineer.) No other person shall have any right to instruct, or make any complaint to the Sub-contractor.

While attending to any Defects and the Servicing of the Plant, the Sub-contractor shall not unduly disturb the functions of the occupants in the areas concerned.

4.41.3.8 The one year maintenance period shall commence on the date of the issue of the "Acceptance Certificate". The first service to take place 1 month after date of "Acceptance Certificate". The Sub-contractor shall notify the Engineer and Client in writing, 14 days prior to this service, so that the Engineer and the Client’s Representative may be present during the services.

4.41.3.9 It is an explicit condition of this enquiry that all work carried out in pursuance of this tender enquiry will be guaranteed against failure, or defect whatsoever, for a period of 12 months from the time of Acceptance by the Client.

Any costs for labour, materials, etc., which the Sub-contractor incurs whilst maintaining the above guarantee for the specified period shall be borne by the Sub-contractor.
4.42 DRAINS

4.42.1 Provide all necessary drain piping, laid to suitable falls, from every item requiring such drainage. Such drains shall be run to the adjacent relevant drain points shown on the Drawings.

4.42.2 Drainage pipework shall be adequately sized and carried out generally in medium grade galvanised piping, all connections to equipment being effected with conical faced unions or flanges.

4.42.3 All drains from cooling coil pans for condensate disposal shall be fitted with proprietary U-traps to prevent backflow, or non-drainage due to negative air pressures.

4.42.4 Drainage pipework of longer than 4,5m run shall be provided with cleaning eyes on all bends to facilitate maintenance.
4.43 **EXCLUSIONS**

4.43.1 The Tendered price shall specifically be understood to **EXCLUDE** all the following items, it being stressed that such items will be provided by others to details given by the successful Tenderer, and approved in writing by the Engineer.

4.43.2 The provision of all Plant rooms and equipment spaces shown on the Drawings, complete with level floors, lighting, suitable airtight access doors (except Trox or equal plantroom doors), and any other builder's work, as relevant as indicated on the Drawings.

4.43.3 The provision and making good of any openings required through walls, floors, ceilings and roofs, as well as any timber framing or flashing necessary for same.

4.43.4 All concrete work associated with the provision of equipment bases as detailed herein.

4.43.5 Any item, comprised of timber, bricks, mortar or concrete which can reasonable be construed as builder's work, together with the building-in of any item required.

4.43.6 The architectural concealment of any equipment to be installed by the successful Tenderer. This would apply particularly to piping and ducting.

4.43.7 The provision of masonry shafts as shown on the Drawings, complete with smooth internal plastered finish.

4.43.8 All openings in glazing in windows for the installation of exhaust fans.

4.43.9 The provision of mains water supply points, each terminating in a gate type isolating valve within three meters of the equipment it serves, as indicated on the attached Drawings.

4.43.10 Drainage points will be provided in the positions, and of the sizes indicated on the Drawings, such drains for general equipment drainage and condensate disposal.

4.43.11 The bringing up, and connecting to, the incoming terminals of the main isolators in each switchpanel of suitably rated 380 volt, 3 phase 4 wire electricity supplies, in the positions indicated on the drawings. Suitably rated 380 volt, 3 phase, 4 wire electricity supplies to any remote fans or equipment in the positions indicated on the drawings. Suitably rated 220 volt, single phase switched socket outlets for propeller type exhaust fans in the positions indicated on the Drawings.

4.43.12 Any other item mentioned in these Specifications, or on the accompanying Drawings as being expressly for the provision of others.