DEPARTMENT OF HEALTH

NORTH WEST PROVINCIAL GOVERNMENT

REPUBLIC OF SOUTH AFRICA

CONTRACT NO: NWDoH/PS/06/18.

REPAIRS AND RENOVATION WORKS TO ICU UNIT
AT JOB SHIMANKANE TABANE HOSPITAL

PART A: BUILDING WORKS (this document)
PART B: ELECTRICAL INSTALLATION (separate document attached)
PART C: MECHANICAL INSTALLATION (This Document)
PART D: ICT INSTALLATION (separate document attached)
PART E: FIRE INSTALLATION (separate document attached)

NAME OF TENDERER : .....

TENDER SUM : .....

ISSUED BY:

THE HEAD OF DEPARTMENT
DEPARTMENT OF HEALTH
PRIVATE BAG X2068
MMABATHO
2735

Tel: (018) 391 4239 **Fax: (018) 387 6755**

PART III

RETURNABLE SCHEDULES

INTENSIVE CARE UNIT
MECHANICAL SERVICES INSTALLATIONS

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PART 3: Returnable Schedules and Additional Contract Data

The Returnable Schedules must be completed and submitted together with the Tender. Should this requirement not be complied with in full the Tender may be considered invalid.

NOTE

1. This tender document should be read together with the Main Contractors Tender Document.

2. Only tenderers who have a CIDB contractor grading designation of minimum **7ME** or higher or potential emerging enterprises may submit tender offers for the Mechanical installations.

3. The Mechanical Installation forms an integral part of the Main Contract, and no other Mechanical sub-contractor may be appointed at any time in the place of the sub-contractor whose name has been given below without prior written approval by the Representative/Agent.

4. Tenderers are to note that the Total Amount (excl. VAT) must be carried over to the Final Summary in Part A and all fixed amounts shown in the price schedule for the Installations must be included therein. No adjustment will be made for any failure by Tenderers to include these amounts in the Sub-Total for the Installation.

5. All the Returnable Schedules and the Priced Schedule for the Installation must be completed and submitted to the Main Contractor Tendering for the job to include in his submission for the Building Work.

6. Should any Mechanical Materials offered not comply with the requirements contained in the specification, the Contractor will be required to arrange for the supply of the relevant material in accordance with the Contract at no additional cost.

7. The following questionnaire must be completed and signed by the Mechanical sub-contractor:

(a) Has the company registered as an Electrical Contractor with the Electrical Contracting Board of South Africa?

Registration No.: . . . . . .

Registration Authority: . . . . . .

Date of Issue: . . . . . .

(b) Has the company registered with the Compensation Commissioner (Department of Labour) in terms of Section 80 of the Compensation for Occupational Injuries and Diseases Act?

Registration No.: . . . . . .

Date of Issue: . . . . . .

(c) Has the company furnished the Director-General (Department of Labour) with the prescribed particulars of its business in terms of Section 28 of the Unemployment Insurance Act?

Registration No.: . . . . . .

Date of Issue: . . . . . .

I/We certify that the above information is correct and undertake to comply with the provisions of the Electrical Installation Regulations 4(2) and 6(1) published under notice R2920 in Government Gazette No. 14350 dated 23 October 1992.

Name of Mechanical Sub-Contractor: . . . . . .

Address: . . . . . .

. . . . . .

. . . . . .

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Tel No.: . . . . . .

Cell No.: . . . . . .

Fax No.: . . . . . .

Signature of Mechanical Sub-Contractor: . . . . . .

Date: . . . . . .

Part 3 List of Returnable Documents

1 Returnable Schedules required for tender evaluation purposes

The tenderer must complete the following returnable schedules as relevant:

- Compulsory Enterprise Questionnaire
- Record of Addenda to Tender Documents
- Proposed Amendments and Qualifications
- Certificate of Authority
- Schedule of Proposed Subcontractors
- Schedule of recently completed and current contracts
- Schedule of plant and equipment
- Occupational Health and Safety Questionnaire
- Occupational Health and Safety Statement
- Quality control procedures
- Evaluation Schedule: Tenderer's Experience
- Evaluation Schedule: Experience of Key Staff
- Evaluation schedule: Quality control procedures
- Tender evaluation schedule

2 Other documents required for tender evaluation purposes

The tenderer must complete the following returnable documents:

1. Certificate of attendance at clarification meeting
2. Tax Clearance Certificate for Tenders
3. Form of Intent to Provide a Performance Bond
4. Proof of Registration with the CIDB
5. Share Certificates of Tendering Entity

3 Returnable Schedules that will be used for tender evaluation purposes and be incorporated into the contract

1. Particulars of Mechanical contractors
2. Particulars of specialist contractors
3. Electrical / Mechanical / Security material and equipment schedule
4. Schedule of imported material & equipment

4 Other documents that will be incorporated into the contract

1. CIDB Certificate
2. Certified ID copies of all members and directors
3. Joint venture agreement if JV appointed
4. Letter of good standing from Compensation Commissioner (Workmen's Compensation)
5. Company registration documents

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Compulsory 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: . . . . . .

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

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

Section 4: Particulars of sole proprietors and partners in partnerships

Name*	Identity number*	Personal income tax number*

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

Section 5: Particulars of companies and close corporations

Company registration number . . . . . .

Close corporation number . . . . . .

Tax reference number . . . . . .

Section 6: Record in the 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:

Name of sole proprietor, partner, director, manager, principal shareholder or stakeholder	Name of institution, public office, board or organ of state and position held	Status of service (tick appropriate column)	
		Current	Within last 12 months

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 an accounting authority of any national or provincial public entity
☐ A member of the National Assembly or the National Council of Province	☐ An employee of Parliament or a provincial legislature
☐ A member of the board of directors of any municipal entity	☐ An official of any municipality or municipal entity

Name of spouse, child or parent	**Name of institution, public office, board or organ of state and position held**	**Status of service (tick appropriate column)**	
		Current	**Within last 12 months**

*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 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; and

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 ---------- Date ----------

Name ---------- Position ----------

Enterprise name ----------

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Record of Addenda to tender documents

We confirm that the following communications received from the Employer before the submission of this tender offer, amending the tender documents, have been taken into account in this tender offer:

	Date	**Title or Details**
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

Attach additional pages if more space is required.

Signed ..... Date .....

Name ..... Position .....

Enterprise name .....

Proposed amendments and qualifications

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 to his tender and reference such letter in this schedule.

The Tenderer's attention is drawn to clause F.3.8.2 of the Standard Conditions of Tender referenced in the Tender Data regarding the employer's handling of material deviations and qualifications.

Page	Clause or item	Proposal

Attach additional pages if more space is required

Signed ..... Date .....

Name ..... Position .....

Enterprise name .....

Certificate of Authority

This Returnable Schedule is to be completed by the Tendering Entity giving authority for the person to sign the tender documentation..

We, the undersigned, are submitting this tender offer in Joint Venture and hereby authorise Mr/Ms . . . . . , authorised signatory of the company . . . . . , 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.

NAME OF FIRM	ADDRESS	DULY AUTHORISED SIGNATORY
Lead partner CIDB registration number: ……		Signature. . . . . . Name …….. Designation
CIDB registration number: ……		Signature. . . . . . Name …….. Designation
CIDB registration number: ……		Signature. . . . . . Name …….. Designation
CIDB registration number: ……		Signature. . . . . . Name …….. Designation

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Schedule of Proposed Subcontractors

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

If we are awarded a contract we agree that this notification does not change the requirement for us to submit the names of proposed Subcontractors in accordance with requirements in the contract for such appointments.

	Name and address of proposed Subcontractor	**Description of Work to be executed by Subcontractor**	**Previous experience with Subcontractor**

Attach additional pages if more space is required

Signed ..... Date .....

Name ..... Position .....

Enterprise name .....

DEPARTMENT OF HEALTH:

Schedule of recently completed and current contracts

List not more than seven contracts completed in the last five years

Contract title:		**Employer (name) Place (town)**	**Reference person**		**Contract Amount (R million)**	**Contract Period (months)**	**Date of Completion***
			Name	**Tel**			
1							
2							
3							
4							
5							
6							
7							

*Completed means that a certificate has been issued in terms of a contract by the employer, signifying that the whole of the construction works have reached a state of readiness for occupation or use for the purposes intended, although some minor work may be outstanding.

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List all current contracts not complete at the time of submitting this tender

Project:		**Employer (name) Place (town)**	**Reference person**		**Contract Amount (R million)**	**Contract Period (months)**	**Date of commencement**	**Date of expected Completion***
			Name	**Tel**				
1								
2								
3								
4								
5								
6								
7								
8								

*Date when defects liability period commenced

Signed ..... Date .....

Name ..... Position .....

Enterprise name .....

Schedule of plant and Equipment

The following are lists of major items of relevant equipment that I / we presently own or lease and will have available for this contract or will acquire or hire for this contract if my / our tender is accepted.

(a) Details of major equipment that is owned by and immediately available for this contract.

Quantity	Description, size, capacity, etc.

Attach additional pages if more space is required.

(b) Details of major equipment that will be hired, or acquired for this contract if my / our tender is acceptable.

Quantity (hired)	**Description, size, capacity, etc.**	

Attach additional pages if more space is required.

Signed ---------- Date ----------

Name ---------- Position ----------

Enterprise Name: ----------

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OCCUPATIONAL HEALTH AND SAFETY QUESTIONNAIRE

1. HEALTH AND SAFETY POLICY

(a) Can a copy of current health and safety policy including procedures for risk assessment be supplied? Yes □ No □

(b) Please give full reasons, on a separate sheet, if the health and safety policy cannot be provided.

.....
.....

2. HEALTH AND SAFETY ADVICE

Do you

(a) Employ a full time health and safety advisor? Yes □ No □

(b) Use the services of a health and safety consultant? Yes □ No □

(c) Have access to the services of a health and safety group? Yes □ No □

4. ACCIDENT AND INCIDENT STATISTICS

(a) Have any dangerous occurrences been reported within the last three years? Yes □ No □

If Yes, please give brief details:

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

(b) Has any employee or persons under your control been fatally injured at work within the last three years? Yes □ No □

If Yes, please give brief details:

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

The undersigned, who warrants that he / she is duly authorised to do so on behalf of the enterprise, confirms that the contents of this schedule are within my personal knowledge and are to the best of my belief both true and correct.

Signed ---------- Date ----------

Name ---------- Position ----------

Enterprise Name: ----------

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OCCUPATIONAL HEALTH AND SAFETY ACT: STATEMENT BY TENDERING ENTITY

I, ... duly authorised

to represent .....
(company name)

in my capacity as .....
hereby confirm that I accept full and exclusive responsibility for compliance by myself and all persons who perform work for me with the provisions of the Occupational Health and Safety Act, No. 85 of 1993 (as amended) and all regulations promulgated from time to time, whilst performing work on;

.....

I confirm that all employees who perform work on the site shall be properly trained to do this in a manner which is safe and without risk to health and safety to themselves and others in the vicinity and undertake to have our activities adequately supervised in the interest of health and safety.

Signed ---------- Date ----------

Name ---------- Position ----------

Enterprise Name: ----------

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Experience of KEY STAFF

The following is a statement of similar work successfully executed by key staff members that will be utilised on this contract in the last three years:

Position	Name	Previous Projects and Position	Value of Work inclusive of VAT (Rand)	Client Name and Contact no.
Site Agent				
General Foreman				
Safety Officer				

The undersigned, who warrants that he / she is duly authorised to do so on behalf of the enterprise, confirms that the contents of this schedule are within my personal knowledge and are to the best of my belief both true and correct.

Signed ---------- Date ----------

Name ---------- Position ----------

Enterprise Name: ----------

Quality Control Procedures

QUALITY MANAGEMENT QUESTIONNAIRE

(a) Does the tenderer have a quality management system which is certified in terms of ISO 9001: 2000

Yes □ No □

(b) If "yes", tenderer to supply a brief summary of structure of system:

.....

.....

(c) If "no", do the tendered intend to apply for certification and by when; Yes □ No □

Date ----------

If the tenderer does not intend to apply for certification, he/she shall submit details of the quality management system they intend to put in place on this contract.

.....

.....

.....

.....

The undersigned, who warrants that he / she is duly authorised to do so on behalf of the enterprise, confirms that the contents of this schedule are within my personal knowledge and are to the best of my belief both true and correct.

Signed ---------- Date ----------

Name ---------- Position ----------

Enterprise Name: ----------

Evaluation Schedule: Tenderer's Experience

The experience of the tenderer or joint venture partners in the case of an unincorporated joint venture or consortium as apposed to the key staff members / experts in similar projects or similar areas and conditions in relation to the scope of work over the last five years will be evaluated.

Tenderers should very briefly describe his or her experience in this regard and attach this to this schedule.

The description should be put in tabular form with the following headings:

Employer, contact person and telephone number, where available	**Description of work (service)**	**Value of work (i.e., the service provided) inclusive of VAT (Rand)**	**Date completed**

The scoring of the tenderer's experience will be as follows:

Poor (score 40)	Tenderer has limited experience
Satisfactory (score 70)	Tenderer has relevant experience but has not dealt with the critical issues specific to the assignment.
Good (score 90)	Tenderer has extensive experience in relation to the project and has worked previously under similar conditions and circumstances.
Very good (score 100)	Tenderer has outstanding experience in projects of a similar nature.

The undersigned, who warrants that he / she is duly authorised to do so on behalf of the enterprise, confirms that the contents of this schedule are within my personal knowledge and are to the best of my belief both true and correct.

Signed ---------- Date ----------

Name ---------- Position ----------

Tenderer ----------

Evaluation Schedule: Experience of Key Staff

The experience of assigned staff member in relation to the scope of work will be evaluated from three different points of view:

1) General experience (total duration of professional activity), level of education and training and positions held of each discipline specific team leader.
2) The education, training, skills and experience of the Assigned Staff in the specific sector, field, subject, etc which is directly linked to the scope of work.
3) The key staff members' / experts' knowledge of issues which the tenderer considers pertinent to the project e.g., local conditions, affected communities, legislation, techniques etc.

A CV of the project director, site agent and general foreman of not more than 2 pages should be attached to this schedule:

Each CV should be structured under the following headings:

1 Personal particulars
- name
- date and place of birth
- place (s) of tertiary education and dates associated therewith
- professional awards

2 Qualifications (degrees, diplomas, grades of membership of professional societies and professional registrations)
3 Skills
4 Name of current employer and position in enterprise
5 Overview of post graduate / diploma experience (year, organization and position)
6 Outline of recent assignments / experience that has a bearing on the scope of work

The scoring of the experience of key staff will be as follows:

	General experience and qualifications	**Adequacy for the assignment**	**Knowledge of issues pertinent to the project**
Poor (score 40)	Key staff have limited levels of general experience	Key staff have limited levels of project specific education, skills, training and experience	Key staff have limited experience of issues pertinent to the project
Satisfactory (score 70)	Key staff have reasonable levels of general experience	Key staff have reasonable levels of project specific education, skills, training and experience	Key staff have reasonable experience of issues pertinent to the project
Good (score 90)	Key staff have extensive levels of general experience	Key staff have extensive levels of project specific education, skills, training and experience	Key staff have extensive experience of issues pertinent to the project
Very good (score 100)	Key staff have outstanding levels of general experience	Key staff have outstanding levels of project specific education, skills, training and experience	Key staff have outstanding experience of issues pertinent to the project

Note: An individual may be nominated to serve as the team leader in more than one discipline and as the team leader and a discipline specific leader.

The undersigned, who warrants that he / she is duly authorised to do so on behalf of the enterprise, confirms that the contents of this schedule are within my personal knowledge and are to the best of my belief both true and correct.

Signed ..... Date .....

Name ..... Position .....

Tenderer .....

Evaluation schedule: Quality control procedures

The quality control practices and procedures which ensure compliance with stated employer's requirements previous will be evaluated.

Tenderers should very briefly outline his or her procedures in relation to the project and attach this to this schedule.

The scoring of the tenderer's quality control procedures will be as follows:

Poor (score 40)	Quality control procedures are unlikely to ensure compliance with stated employer's requirements
Satisfactory (score 70)	Quality control procedures are possibly able to ensure compliance with stated employer's requirements
Good (score 90)	Quality control procedures are likely to ensure compliance with stated employer's requirements
Very good (score 100)	Quality control procedures are most likely to ensure compliance with stated employer's requirements

The undersigned, who warrants that he / she is duly authorised to do so on behalf of the enterprise, confirms that the contents of this schedule are within my personal knowledge and are to the best of my belief both true and correct.

Signed ---------- Date ----------

Name ---------- Position ----------

Tenderer

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Certificate of attendance at clarification meeting

This is to certify that

…… (Enterprise name)

of

……...……

……

……(address)

was represented by the person(s) named below at the compulsory meeting held for all tenderers at

……(location)

On …… (date), starting at …… ……. hrs

I have made myself familiar with all site conditions likely to influence the work and all aspects that could influence either the cost or the construction of the service.

I further certify that I am satisfied with the description of the work and explanations given at the meeting and that I understand perfectly the work to be done, as specified and implied, in the execution of this contract.

Particulars of person(s) attending the meeting

Name …….. Signature …… ……

Capacity ……..

Name …….. Signature …… ……

Capacity ……..

Attendance of the above person(s) at the meeting is confirmed by the Employers Agent, namely

Name…….. Signature …… ……

Capacity …….. Date & Time …… ……...

Tax Clearance Certificate for Tenders

The tenderer is to affix to this page:

An **Original Valid Tax** Clearance Certificate for Tenders issued by the South African Revenue Services (S.A.R.S.) in the **Name of the Tendering Entity** indicating the Trading Name.

Note:

Failure to affix such certificate **will** result in this tender not being considered for the award of the contract

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Form of Intent to Provide a Performance Bond

1 With reference to the tender of …… .... (hereinafter referred to as the " **TENDERER**" for the project …….. (hereinafter referred to as the "**CONTRACT**" for the DEPARTMENT OF HEALTH, (hereinafter referred to as the "**EMPLOYER**" for the tender dated ……..…….. for the offered total of price s of (R ……..……) ..... (in words)

2 I/We ..... in my/our Capacity as ..... and hereby representing ..... …… (hereinafter referred to as the " **INSURER**" advise that the " **INSURER**" undertakes to provide a **Performance Bond** to the **EMPLOYER** to the Employer's format included in Part C1.3 of this document within five (5) working days of the written acceptance of the contractor's tender offer.

Thus done and signed at …… on …… ……..

…… ……

Name of signatory *Capacity of authorised signatory*

…… ……

As witness *for and on behalf of the **insurer** who by signature hereof warrants authorisation hereto*

Proof of Registration with the CIDB

The tenderer is to affix to this page either:

- Written proof of his registration with the CIDB as a Category **7ME** or higher

OR

- Written proof of his application to the CIDB for registration as a contractor in the category listed above.

Notes:

- Failure to affix such documentation as prescribed to this page **shall** result in this tender not being further considered for the award of the contract.
- Should this tender be considered for award of the contract, based on proof of submission of application for registration in the appropriate category with the CIDB, and should proof of such subsequent registration not be forthcoming to the Department by the time of award of the contract, then this tender will no longer be considered for the award of the contract.
- The Department will verify the certificate on the CIDB's website.

Share Certificate of Company

The tenderer is to affix to this page:

- Copies of the Share Certificates of all the Shareholders of the Company.

Notes:

Failure to affix such documentation as prescribed to this page **shall** result in this tender not being further considered for the award of the contract.

Particulars of Mechanical Contractors

Name of Specialist Contractor

Address ……

Particulars of Specialist Contractors

Name of Specialist Contractor

Address ……

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Mechanical Material and Equipment Schedule

ITEM	MATERIAL	MAKE OR TRADE NAME	COUNTRY OF ORIGIN
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
NB:	Only one manufacturer's name to be inserted for each item		

Schedule for Imported Materials and Equipment

Item	Material / Equipment	Rand (R) excluding Vat	Currency	Exchange Rate
1				
2				
3				
4				
5				
6				

Attach additional pages if more space is required

The Tenderer shall list imported items, materials and/or equipment which shall be excluded from the Contract Price Adjustment Provisions (if applicable) and shall be adjusted in terms of currency fluctuations only. Copies of the supplier's quotations for the items, materials or equipment (provided that such costs shall not be higher than the relevant contract rate as listed above) should be lodged with the Project Manager within three (3) weeks of the starting date. No adjustment of the local VAT amount, nor the contractor's profit, discount, mark-up, handling costs, etc shall be allowed.

These net amounts will be adjusted as follows:

FORMULA FOR ADJUSTING IMPORTED MATERIAL/EQUIPMENT TO CURRENCY

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

$$A = V\left(\frac{Z}{Y} - 1\right)$$

A = the amount (R) of adjustment

V = the net amount (supplier's quotation) (R) of the imported item (material or equipment)

Y = official exchange rate at the closing date of tender submission

Z = official exchange rate on the date of payment

PART VI

BILLS OF QUANTITIES

JST HOSPITAL INTENSIVE CARE UNIT BLOCK
MECHANICAL SERVICES INSTALLATIONS

Item	Description	No. - Pages
D	**PART 6 - Bills of Quantities**	
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	Bills of Quantities	38

6. BILLS OF QUANTITIES

6.1 General

The following is the provisional bills of quantities for the works and is to be the basis of the tender**.**

6.1.1. These bills of quantities contain pages numbered consecutively in each bill as indicated in the Master Index. Before the tenderer submits his tender, he should check the number of pages, and if any are found missing or duplicated or the figures or writing indistinct, or the bill of quantities contain any obvious errors, he should apply to the Engineer at once and have same rectified, as no liability whatsoever will be admitted by the Engineer in respect of errors in the Tender due to the foregoing.

6.1.2 These Bills of Quantities form part of and must be read in conjunction with the specifications and drawings which contain the full description of the work to be done and material and equipment to be used

6.1.3. Tenders shall be submitted for initial consideration on the declaration of the total value of the bills. Subject to declaration of intent to enter into a contract, the bills priced in detail shall be made available upon request within 7 days after the closing date of tenders.

6.1.4. The total tender sum in the tender form shall constitute the contract price of the successful tenderer. Tenderers are advised to check their item extensions and total additions, as no claim for arithmetical errors will be considered.

6.1.5. No alteration, erasure or addition is to be made in the text of the bill of quantities. Should any alterations, erasure or addition be made, it will not be recognized, but the original wording of the bill of quantities will be adhered to.

6.1.6. The priced bills of quantities of the successful tenderer will be checked. The Engineer reserves the right to call for adjustments to any individual price and to rectify any discrepancy whilst the total tender price, as submitted remains unaltered.

6.1.7. The responsibility for the accuracy of the quantities written into the bills remains with the party who prepared the bills. The tenderer shall be relieved of the responsibility of measuring quantities at the tender stage, and the tender sum submitted shall be in respect of the quantities set out in the bills, although he will be required to make his assessment of items as brackets, fixings, etc. from details stated in the bills and shall include in the item prices small installation materials as are required for the complete installation in accordance with the Specification.

6.1.8. The Contractor and the Employer or his Agent may agree that the total of any bill or bills, including any variations by way of additions thereto or deductions therefrom, represents a fair and accurate quantification of the items set out in the bills and the parties may agree final payment on that basis. In the event of any dispute as to the quantities, then the disputed item or items shall be adjusted where necessary.

6.1.9. The quantities in these bills of quantities are not to be used for ordering purposes.

6.1.10. Variations in the scope and extent of the work included in the bills shall be allowed to meet the Employer's requirements.

The rules governing the extent and valuation of variations shall be those provided for in the conditions of contract.

6.1.11. Unless separate rates for the supply and for the installation of any item is specifically called for, the supply and installation costs of any item shall be fully included in the unit price.

The description of each item shall, unless otherwise stated herein, be held to include making, conveying and delivering, unloading, storing, unpacking, hoisting, setting, fitting and fixing in position, cutting and waste, patterns, models and templates, plant, temporary works, return of packings, establishment charges, profit and all other obligations arising out of the conditions of contract.

6.1.12. The quantities and rates included for day works shall form part of the tender price, but tenderers shall

note that this item must be regarded as indicative and will only be payable to the Contractor if and when covered by a Variation Order.

6.1.13. Tenderers shall price the Preliminaries under any or all of three groups, viz:

(a) a fixed amount
(b) an amount varied in proportion to the final contract value as compared to the tender price
(c) an amount varied in proportion to the final contract period as compared to the originally specified contract period

The allocation of prices to the three categories listed above must be realistic and the Contractor may be required to justify the allocation of the prices. Attention is particularly drawn to the right reserved in terms of Clause 6 above.

6.1.14. All provisional sums shall be expended as directed by the Engineer and any balance remaining shall be deducted from the amount of the contract sum.

6.1.15. The quantities in these bills of quantities are measured provisionally. All work executed in accordance with the drawings approved by the Engineer shall be re-measured and priced at rates contained in, or based on, the priced bills of quantities.

6.1.16. Provision is made on the final summary of the main contractors bills of quantities for the applicable Tax to be added.

NORTH WEST DEPARTMENT OF HEALTH
JST NEW ICU UNIT
SECTION 1M - ICU (MECHANICAL INSTALLATIONS)
SCHEDULE 1 - ADDITIONAL P&G

Item	Description	Unit	Amount	
	Additional P & G in accordance with the Standard and Detailed specification			
1	**Site Establishment and site security and storage**			
	Fixed	Item		
	Value related	Item		
	Time related	Item		
2	**Preparation of O & M manuals and re-commissioning reports**	Sum		
3	**Preparation of shop drawings samples etc.**	Sum		
4	**Provision of As Built Drawings As specified**	Sum		
5	**Testing, Commissioning, Balancing & Handing over**	Sum		
6	**Maintenance of complete installation for 12 months Supervision and Attendance**	Sum		
7	**Location and protection of existing services**			
	Water and sewer pipes	Psum	R	65 450,00
	Electrical and other cables	Psum	R	35 400,00
8	**Engineering, Submissions & Approvals**	Sum		
9	**Additional tests required by the engineer**	PC Sum	R	50 000,00
10	**Occupational Health and Safety**			
PSA	**Compliance with OHS Act and Construction Regulation 153**	Sum		
11	**Decommissioning of Existing equipments and making the area safe.**	PC Sum	R	350 000,00
12	**Comissioning of the following in the presence of Engineer, client and user client**			
	HVAC installation	Item		
	Hotwater Installation	Item		
	Fire Installation	Item		
	Medical gas installation	Item		
	Steam reticulation			
13	**Additional Training**			
a	Development of training syllabus and manuals	Item		
b	Training courses	Item		
	Total carried to Summary Page			

NORTH WEST DEPARTMENT OF HEALTH

JST NEW ICU UNIT

SCHEDULE 2 -HVAC INSTALLATION

CHILLER PLANT

Item No	DESCRIPTION OF WORK	UNIT	QTY	RATE (R)	AMOUNT (R.)
	Supply,Deliver to site, Put in position, Installation, Testing & Commissioning of following:				
1	**Air Cooled Water Chillers**				
1,2	**Air cooled Revesible Heat Pump water chiller**				
	Clivet or equally approved Air cooled reversible heat pump cooling capacity 80KW and Heating capacity 90Kw : Unit to come with fully factory charged refrigerant (R410A) or any other environmentally friendly refrigerant. Unit to come inclusive of LCD control Unit and must be Designed for outdoor installation. Unit must employ modular Scroll technology with several compressors, electronic expansion valves and plate evaporators with highly efficient heat exchange. Installed complete with all appurtenances for the safe and efficient operation of the chiller including connections to the pipework and electrical systems and all interlocks between chiller and pumping equipment to ensure the systems operate safely and efficiently. COP should not lower than 3.1 and IPLV not lower than 4.0, Unit to be supplied complete with Antivibration pads and spring Isolator. Maximum acceptable unit dimension as follows 6400(L)x 2400(w)x 2700(H), Maximum operating weight 5300kg. Maximum Power 380V/3/50Hz/310Kw	No			
01	Supply, Deliver to site and rigg into position 80Kw Air cooled reversable heat pump water Chiller as specified	Nos	3		
02	Installation of the above	Nos	3		
2	**Chilled water Pumps**				
	Supply,Deliver to site, Put in position, Installation, Testing & Commissioning of following:				
	Single stage centrifugal coupled horizontal type pumpset with axial suction port and radial discharge port,with EFF1 drive motor, bronze impeller mechnical seal, three phase TEFC squirrel cage motor with IP55 protection, class F insulation having a speed of 1440 rpm with inertia base, vibration isolation springs, rubber isolation bellows, flexible coupling for chilled water circulation having the following duty conditions as per specifications. System to be compartible with BACNET BMS system				
2,1	**Primary Chilled Water pump,**				
01	8,5l/s @ 170kPA with EFF1 motor complete with all ancillaries and accessories for a complete efficient operation	Nos	4		
02	14,6l/s @ 170kPA with EFF1 motor complete with all ancillaries and accessories for a complete efficient operation	Nos	5		
2,2	**Secondary Chilled Water pump,**				
01	8,5l/s @ 450kPA with EFF1 motor complete with all ancillaries and accessories for a complete efficient operation	Nos	4		
02	20,25l/s @ 450kPA with EFF1 motor complete with all ancillaries and accessories for a complete efficient operation	Nos	3		
2,3	**Heat Pump Condenser Water pump,**				
	Supply,Deliver to site, Put in position, Installation, Testing & Commissioning of following:				
	Single stage centrifugal coupled horizontal type pumpset with axial suction port and radial discharge port,with EFF1 drive motor, bronze impeller mechnical seal, three phase TEFC squirrel cage motor with IP55 protection, class F insulation having a speed of 1440 rpm with inertia base, vibration isolation springs, rubber isolation bellows, flexible coupling for chilled water circulation having the following duty conditions as per specifications				
01	4,5l/s @ 450kPA with EFF1 motor complete with all ancillaries and accessories for a complete efficient operation	Nos	3		
2,4	**Variable speed drives**				
	Supply,Deliver to site, Put in position, Installation, Testing & Commissioning of following variable speed drive for above pumps VSD:				
01	0,37Kw 4 Pole Motor with overload and accessories	No.	3		
02	0,75Kw 4 Pole Motor with overload and accessories	No.	3		
03	1,1Kw 4 Pole Motor with overload and accessories	No.	2		
04	SHWP 8.5l/s -4.5KW	No.	8		
	Total carried forward				

NORTH WEST DEPARTMENT OF HEALTH
JST NEW ICU UNIT
SCHEDULE 2 -HVAC INSTALLATION
CHILLER PLANT

Item	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	Total Brought forward				
3	**Buffer Tanks**				
	Supply,Deliver to site, Put in position, Installation, Testing & Commissioning of following:				
01	5KL Chiller Buffer tank	No	2		
4	Microprocessor based pump logic controller with adjustable frequency drive for motor, complete by pass starter with IP 55 Enclosure, Required quantity of differential pressure / temperature transmitter, incoming MCCB / ACB with control wirng for software integration, built in Software integrator suitable for BAS as per specifications				
01	For Secondary pumpset(2 +1) with differential pressure transmitter and wiring	Set	3		
5	**Booster Pressure set**				
	Flow up to 20,45l/s with a Maximum boost of 450Kpa. Installed complete with all appurtenances for the safe and efficient operation of the chiller distribution network including connections to the pipework and electrical systems and all interlocks between chiller and pumping equipment to ensure the systems operate safely and efficiently. System must have Pump run-out protection, Dry running protection and Programmable lead/lag alternation (duplex), Programmable system pressure starting (VS) and Fault detection and alarm notification. Liquid temperatures from 5 ^{0}C up to 65ºC	Set	1		
6,0	**Chilled water piping**				
	Chilled Water pipework installed complete including insulation, vapour seal, supports and brackets.MS pipes for chilled water applications above ground with 19 mm thick nitrile rubber which bonds to the pipe, the outer casing material shall be galvanized, stainless steel or high density polyethylene tubes with vapour barrier, comply to class O fire rating standards with comprehensive strength upto 275 kPa, the PU Foam shall be CFC Free agent finished with supports/hangers as per specifications				
6.1	ASTM Schedule 40 Black steel pipe with insulation as per specifications,				
01	150 mm dia	m	80		
02	100 mm dia	m	110		
03	80 mm dia	m	125		
04	65 mm dia	m	15		
05	50 mm dia	m	60		
06	40 mm dia	m	0		Rate only
07	32 mm dia	m	0		Rate only
08	25 mm dia	m	5		
6,2	**Bends 90°**				
01	80 mm dia	No	31		
02	65 mm dia	No	14		
03	50 mm dia	No	30		
6.3	**Bends 45°**				
01	80 mm dia	No	6		
02	65 mm dia	No	12		
03	50 mm dia	No	10		
6.4	**Reducers**				
01	100 - 80	No	4		
02	80 - 65	No	15		
03	65 - 50	No	15		
04	50 - 32	No	15		
05	32 - 25	No	4		
6.5	**Stub-In Welds**				
01	50dia	No	40		
02	80dia	No	12		
	Total carried forward				

Item	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	Total Brought forward				
6.6	**Tees**				
01	100 - 80	No	10		
02	100 - 100	No	2		
03	80 - 80	No	10		
04	80-65	No	5		
05	65-65	No	6		
06	65-50	No	10		
07	50-50	No	20		
08	50-32	No	4		
6.7	**End caps**				
01	80 mm dia	No	4		
02	50 mm dia	No	4		
7	**Piping routing and containment related to Hvac works**				
7.1	Pipe Brackets				
	All Types	Sum	1		
9	**Valves and Accessories**				
	All valves are to be insulated as per specifications				
9.1	**Butterfly valves with insulation as per specifications,**				
01	200 mm dia	Nos	10		
02	150 mm dia	Nos	5		
03	80 mm dia	Nos	16		
04	65 mm dia	Nos	16		
05	50 mm dia	Nos	32		
06	40 mm dia	Nos	2		
07	32 mm dia	Nos	2		
08	25 mm dia	No	2		
9,2	**Y type strainers with insulation as per specifications,**				
01	80 mm dia	Nos	20		
02	65mm dia	Nos	10		
03	50mm dia	Nos	25		
9.3	**Wafer type check valves with insulation as per specifications,**				
01	80 mm dia	Nos	20		
02	65mm dia	Nos	10		
03	50mm dia	Nos	25		
9.4	Three way motorised valve with actuator and transformer as per specifications having the following water flow, clearance, installation and with insulation as follows,				
01	8,5l/s	Nos	5		
9.5	Balancing valves with flow tapping insulated as per specifications				
01	80 mm dia	Nos	5		
06	Isolation Valves				
01	200 Dia	Nos	45		
02	125 Dia	Nos	25		
03	80 Dia	Nos	5		
04	50Dia	Nos	10		
9.6	**Heat Pump Isolation Valves**				
01	65dia open/close with feedback, fast acting	Nos	6		
	Total carried forward				

NORTH WEST DEPARTMENT OF HEALTH
JST NEW ICU UNIT
SCHEDULE 2 -HVAC INSTALLATION
CHILLER PLANT

Item	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	Total Brought forward				
9.7	**Bypass Valves**				
01	Chilled Water 80dia	Nos	1,00		
02	Hot Water 80dia	Nos	1,00		
10	**Accessories**				
01	Pressure gauge	Nos	60		
02	temperature thermometer	Nos	30		
03	flow switch	Nos	55		
04	temperature sensor	Nos	45		
05	pressure port	Nos	40		
06	**Flexible connections**				
a	80Dia	Nos	5		
b	50 Dia	Nos	5		
10	**Accessories**				
01	Pressure gauge	Nos	43		
02	temperature thermometer	Nos	17		
03	flow switch	Nos	55		
04	temperature sensor	Nos	45		
05	pressure port	Nos			Rate only
06	Drain Valve	Nos	8		
07	BMS/Binder Point	Nos	92		
08	Automatic Air Vents	Nos	20		
06	**Flexible connections**				
a	200Dia	Nos			Rate only
a	150Dia	Nos	6		
b	125 Dia	Nos	10		
10	Drain piping using HDPE pipe with fittngs and insulated with 6mm thick nitrile rubber insulation.				
a	65 mm dia	m	100		
b	50 mm dia	m	20		
c	40 mm dia	m	0		Rate only
d	32 mm dia	m	0		Rate only
e	25 mm dia	m	15		
11	Membrane type automatic expansion tank having a capacity of 1000 litres as per specifications	Nos	2		
12	**Condenser water pipes with black steel fittings, factory made supports as follows:**				
	ASTM Schedule 40 Black steel pipe with insulation as per specifications,				
a	200 mm dia	m	180		
b	150 mm dia	m	40		
b	125 mm dia	m	80		
c	100 mm dia	m	15		
d	80 mm dia	m	10		
e	65 mm dia	m	10		
f	50 mm dia	m	10		
g	40 mm dia	m	5		
h	32 mm dia	m	15		
i	25 mm dia	m	80		
13	**Piping routing and containment related to Hvac works**				
01	**Ladder/ Perforated type Heavy duty tray**				
	Supply and instllation of 2mm thick GI perforated/ ladder type cable tray with side rail using suitable revets, washers, bolts,supporting brackets of same make and all other accessories required for fixing the cable tray complete as required and as directed by the Engineer-in-charge.				
a	500 X 100 X 5mm cable tray	m	250,00		
	Total carried forward				

NORTH WEST DEPARTMENT OF HEALTH
JST NEW ICU UNIT
SCHEDULE 2 -HVAC INSTALLATION
CHILLER PLANT

Item	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	Total Brought forward				
14	**ELECTRICAL RELATED HVAC WORKS**				
01	**Motor Control Centres**				
	Design and Supply and install Motor control Centre for the above equipment complete with all ancillaries and appurtinancies for a complete installation as per the control strategy	Pc Sum	1		R 850 000,00
	Cable ladder supply and install for plant				
	1. 100mm cable ladder (x16)	No.	50		
	2. 200mm cable ladder (x6)	No.	20		
	3. 400mm cable ladder (x5)	No.			Rate only
	4. 600mm cable ladder (x7)	No.			Rate only
	5. 800mm cable ladder (x7)	No.			Rate only
	6. 100mm bends (x7)	No.			Rate only
	7. 200mm bends (x7)	No.			Rate only
	8. T piece 600 to 200 (x2)	No.			Rate only
	9. 800mm bends (x2)	No.			Rate only
	10. 600mm bends (x2)	No.			Rate only
02	Supply and Installation of power supply and control cables for all above equipment complete with all ancillaries and appurtinancies	Sum	1		
15	**Provisional Amounts**				
01	Platform for Chillers equipment and pumps	PC	1		R 685 000,00
16	**REFRIGERANT LEAK DETECTION**				
	Supply and install 4 point refrigerant leak detection system must be suitable for refrigerant R134a and R410a. The system must be ideal tool for early detection of leaks from specific target areas such as chiller rooms and mechanical rooms	Sum	1		
	Total Carried to HVAC Summary				

SECTION 1M-INTENSIVE CARE UNIT (MECHANICAL INSTALLATIONS)
SECTION 1.2 - PART 1 (HVAC)
BILL 1 - ICU WARDS GROUND FLOOR

Item	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	GROUND FLOOR				
	Supply, installation and setting of the following.				
2.0	**Ventilation System Ducting**				
2,1	**EXTRACTION SYSTEM**				
2.1.1	**System1 Ducting(bed 15-20 & sluice)**				
a	**Un-insulated ductwork installed complete with fixing arrangements and hangers.**				
	1200x400	m	8		
	900x350	m	25		
	500x300	m	20		
	400x350	m	20		
	200dia	m	40		
	150dia	m	15		
b	**Flexible duct**				
	200 Dia	m	40		
	150 Dia	m	25		
c	**Un- insulated ductwork . Fittings**				
	Transformations				
	1200x400 to 900x350	No	4		
	900x350 to 500x300	No	3		
	500x300 to 200 x100	No	4		
d	**Bends 90°**				
	1200x400	No	6		
	900x350	No	6		
	500x300	No	6		
	200Dia	No	6		
e	**Double bend**				
	200x200	No	1		
f	**Shoes**				
	1200x400	No	2		
	900x350	No	4		
	500x300	No	3		
	200Dia	No	3		
g	**Spigots**				
	400dia	No	0		Rate only
	250dia	No	0		Rate only
	200dia	No	20		
	150dia	No	20		
h	**Stop Ends**				
	1200x400	No.	2		
	900x350	No.	0		Rate only
	500x300	No.	2		
	250x350	No	2		
	200dia	No.	0		Rate only
	150dia	No.	0		Rate only
	Total carried forward				

SECTION 1M-INTENSIVE CARE UNIT (MECHANICAL INSTALLATIONS)
SECTION 1.2 - PART 1 (HVAC)
BILL 1 - ICU WARDS GROUND FLOOR

Item	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	Total Brought forward				
i	**Velocity Control Dampers**				
	1200x400	No	4		
	900x350	No	2		
	500x300	No	2		
	400x350	No.	1		
	200dia	No	14		
	150dia	No	14		
j	**Curved blade extraction grille complete with OBD**				
	900x350	No	5		
	400x250	No	24		
k	**White polypropylene disc valve complete with OBD and flexible ducting.**				
	Ø 350	No	0		Rate only
	Ø 300	No	12		
	Ø 250	No	2		
	Ø 200	No	3		
	Ø 150	No	2		
2,2	**SUPPLY AIR SYSTEM**				
	Supply and installation of Externally insulated ductwork installed complete with fixing arrangements and hangers complete with all necessary appurtenances As Follows:				
2.2.1	**PAU 01 Ducting(ICU bed 15-20)**				
	1400x450	m	10		
	1200x300	m	10		
	800x580	m	10		
	400x250	m	15		
	350x300	m	16		
	250 Dia	m	20		
	250 Dia Flexible Ducting	m	60		
	Externally insulated ductwork . Fittings				
b.	**Transformations**				
	1400x450 to 1200x300	No	2		
	1200x300 to 800x580	No	4		
	800x580 to 300x350	No	4		
c.	**Bends 90°**				
	650x300	No	2		
	400x250	No	2		
	350x300	No	2		
	250 Dia	No	2		
	Door Grills				
	Supply and install extract air door transfer grilles complete with all necessary fixtures as specified and shown on the drawings				
	DG01 400x300 Aluminium natural anodised	No	10		
e	**Shoes**				
	650x300	No	1		
	400x250	No	1		
	350x300	No	2		
	275x300	No	6		
	250 Dia	No	2		
	Total carried forward				

SECTION 1M-INTENSIVE CARE UNIT & GYNAECOLOGY BLOCK (MECNAHINCAL INSTALLATIONS)
SECTION 1.2 - PART 1 (HVAC)
BILL 1 - ICU WARDS GROUND FLOOR

Item	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	Total Brought forward				
f	**Spigots**				
	650x300	No	5		
	400x250	No	5		
	350x300	No	30		
	250 Dia	No	40		
g	**Stop Ends**				
	580x300	No.	1		
	400x250	No.	1		
	350x300	No.	2		
	275x300	No.	6		
	250 Dia	No.	2		
h	**Velocity Control Dampers**				
	650x300	No	4		
	400x250	No	4		
	350x300	No	15		
	275x300	No	2		
	250 Dia	No	15		
h	**Fire Dampers with fusible links**				
	1400x450	No	2		
	500x350	No	2		
i	**White epoxy powder coated Supply Air constant volume diffuser complete with flexible, plenum box, butterfly damper and mounted controllers and all appurtenances related.**				
	Ø 350	No	10		
	Ø 300	No	2		
	Ø 250	No	3		
	Ø 200	No	2		
3.0	**Split Air condition Unit**				
a.	Midwall Type split Units installed complete with, low sound level centrifugal condensate pump (max 650mm pump head), The units should be installed on galvanised steel cantilever brackets and on vibration padding. The LCD wired remote controller should be in a suitable position as per drawing. Condensate pipes are to be routed to the nearest drain, sloped and fitted with a 'p' trap.				
	18000Btu	No	1		
b	**Supply and installation of following: Complete with fittings and ancillaries for a complete installation**				
	Copper piping				
	5/8"	m	5		
	1/2"	m	5		
	3/8"	m	5		
c	**Supply and installation of following complete with couplings and accessories for a complete installation:**				
	PVC piping for drainage				
	22mm	m	5		
	Total carried forward				

SECTION 1M-INTENSIVE CARE UNIT & GYNAECOLOGY BLOCK (MECNAHINCAL INSTALLATIONS)
SECTION 1.2 - PART 1 (HVAC)
BILL 1 - ICU WARDS GROUND FLOOR

Item	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	Total Brought forward				
5.0	**Electrical Supply and controls**				
a	Electrical Material and labour work to provide power from units to isolator point which will be supplied by Electrical contractor	Sum	1		
b	All control cabling associated with the above units,	sum	1		
c	The LCD wired remote controller remote/wall mounted control unit in a suitable position to be specified by the engineer	No	1		
16	**Comissioning of the following in the presence of Engineer, client and user client**	Item	1		
	HVAC installation				

SECTION 1M-INTENSIVE CARE UNIT (MECHANICAL INSTALLATIONS)
SECTION 1.2 - PART 1 (HVAC)
BILL 1 - ICU FIRST FLOOR

Item	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	FIRST FLOOR				
	Supply, installation and setting of the following.				
2,1	**EXTRACTION SYSTEM**				
2.1.1	**EFU 1 System Ducting(Beds 5-14)**				
a	**Un-insulated ductwork installed complete with fixing arrangements and hangers.**				
	350X350	m	30		
	350X300	m	5		
	800X350	m	45		
	650x350	m	10		
	1200X350	m	5		
	550X350	m	5		
	150dia	m	70		
	150 Dia Flexible duct	m	80		
b.	**Un- insulated ductwork . Fittings**				
	Transformations				
	1200x350 to 800x350	No	4		
	1200x350 to 650x350	No	4		
	800x350 to 350x350	No	3		
	650x350 to 550x350	No	2		
	550x350 to 450x350	No	2		
	450x350 to 350x300	No	2		
c.	**Bends 90°**	m			
	1200x350	No	2		
	350x350	No	5		
	650x350	No	5		
	800x350	No	5		
	150Dia	No	15		
d	**Double bend**				
	200x200	No	1		
e	**Shoes**				
	1200x350	No	2		
	350x350	No	4		
	650x350	No	3		
	800x350	No	3		
	150Dia	No	3		
f	**Spigots**				
	400dia	No	0		Rate only
	250dia	No	0		Rate only
	200dia	No	10		
	150dia	No	20		
	100dia	No	0		Rate only
g	**Stop Ends**				
	1200x350	No.	2		
	350x350	No.	2		
	350x300	No.	2		
	650x350	No.	1		
	800x350	No	1		
	150dia	No.	5		
	Total carried forward				

SECTION 1M-INTENSIVE CARE UNIT (MECHANICAL INSTALLATIONS)
SECTION 1.2 - PART 1 (HVAC)
BILL 1 - ICU FIRST FLOOR

Item	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	Total Brought forward				
h	**Velocity Control Dampers**				
	1200x350	No	1		
	350x350	No	1		
	350x300	No	1		
	650x350	No.	1		
	800x350	No	1		
	150dia	No	20		
i	**Curved blade extraction grille complete with OBD**				
	900x350	No	5		
	300x600	No	20		
j	**White polypropylene disc valve complete with OBD and flexible ducting.**				
	Ø 350	No	0		Rate only
	Ø 300	No	0		Rate only
	Ø 250	No	0		Rate only
	Ø 200	No	5		
	Ø 150	No	2		
h	**Fire Dampers with fusible links**				
	1200x350	No	2		
	500x350	No	0		Rate only
2.1.2	**EFU2 System Ducting(Beds 1-4 & Entire wing)**				
	Un-insulated ductwork installed complete with fixing arrangements and hangers.				
	350X350	m	40		
	400X350	m	10		
	800X350	m	10		
	1200x350	m	10		
	300X350	m	25		
	250X350	m	30		
	650X300	m	12		
	250X200	m	9		
	300 Dia	m	10		
	250 Dia	m	15		
	150 Dia	m	72		
	Un- insulated ductwork . Fittings				
b.	**Transformations**				
	1200x350 to 800X350	No	5		
	800X350 to 400X350	No	2		
	800X350 to 350X350	No	2		
	1200x350 to 300X350	No	2		
	1200x350 to 400X350	No	2		
	300X350 to 250X350	No	4		
	400X350 to 300X350	No	2		
c.	**Bends 90°**				
	800x350	No	6		
	350x350	No	3		
	250Dia	No	5		
	300Dia	No	3		
d	**Bend offset**				
	800x350	No	1		
	Total carried forward				

SECTION 1M-INTENSIVE CARE UNIT (MECHANICAL INSTALLATIONS)
SECTION 1.2 - PART 1 (HVAC)
BILL 1 - ICU FIRST FLOOR

Item	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	Total Brought forward				
e	**Shoes**				
	1200x350	No	2		
	350X350	No	3		
	250X350	No	3		
	250 Dia	No	6		
f	**Spigots**				
	300dia	No	8		
	250dia	No	10		
	200dia	No	5		
	150dia	No	15		
g	**Stop Ends**				
	1200x350	No	2		
	350X350	No	3		
	250X350	No	3		
	250 Dia	No	6		
h	**Fire Dampers with fusible links**				
	1200x350	No	2		
	500x350	No	0		Rate only
h	**Velocity Control Dampers**				
	300dia	No	8		
	250dia	No	10		
	200dia	No	5		
	150dia	No	15		
i	**Curved blade extraction grille complete with OBD**				
	600x600	No	5		
	1200x300	No	5		
j	**White polypropylene disc valve complete with OBD and flexible ducting.**				
	Ø 350	No	0		Rate only
	Ø 300	No	0		Rate only
	Ø 250	No	0		Rate only
	Ø 200	No	25		
	Ø 150	No	2		
	Flexible ducting				
	Ø 250	m	10		
	Ø 200	m	25		
	Ø 150	m	36		
2.2	**Fresh air System**				
2.2.1	**FA 1 System Ducting(Passage)**				
a	**Un-insulated ductwork installed complete with fixing arrangements and hangers.**				
	600X400	m	15		
	500X400	m	10		
	400x350	m	10		
	350x250	m	5		
	Ø 200	No	25		
	Total carried forward				

SECTION 1M-INTENSIVE CARE UNIT (MECHANICAL INSTALLATIONS)
SECTION 1.2 - PART 1 (HVAC)
BILL 1 - ICU FIRST FLOOR

Item	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	Total Brought forward				
	Un- insulated ductwork . Fittings				
b.	**Transformations**				
	600X400 to 500x400	No	2		
	500x400 to 400X350	No	2		
	400X350 to 300X250	No	2		
h	**Velocity Control Dampers**				
	200dia	No	7		
	Flexible ducting				
	Ø 250	m	10		
	Supply Air grills				
	600x600	No	7		
g	**Stop Ends**				
	350x250	No	2		
h	**Fire Dampers with fusible links**				
	600x400	No	2		
2,2	**SUPPLY AIR SYSTEM**				
	Supply and installation of Externally insulated ductwork installed complete with fixing arrangements and hangers complete with all necessary appurtenances As Follows:				
2.2.1	**PAU 2 System Ducting(Beds 5-14)**				
	1400x350	m	3		
	1200x350	m	5		
	800x550	m	5		
	350x350	m	10		
	Ø 300	m	40		
	Insulated Flexible ducting				
	Ø 300	m	25		
	Externally insulated ductwork . Fittings				
b.	**Transformations**				
	1400x350 to 1200x350	No	2		
	1200x350 to 800x550	No	4		
	800x550 to 350x350	No	4		
c.	**Bends 90°**				
	1400x350	No	2		
	1200x350	No	2		
	800x550	No	2		
	350x350	No	2		
	Ø 300	No	2		
d	**Shoes**				
	1400x350	No	1		
	1200x350	No	1		
	800x550	No	3		
	350x350	No	2		
	Ø 300	No	2		
	Total carried forward				

SECTION 1M-INTENSIVE CARE UNIT (MECHANICAL INSTALLATIONS)
SECTION 1.2 - PART 1 (HVAC)
BILL 1 - ICU FIRST FLOOR

Item	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	Total Brought forward				
f	**Spigots**				
	Ø 300	No	15		
g	**Stop Ends**				
	350x350	No.	2		
	1400x350	No.	1		
h	**Velocity Control Dampers**				
	800x550	No	4		
	350x350	No	4		
	300 Dia	No	15		
i	**Fire Dampers with fusible links**				
	1400x350	No	2		
j	White epoxy powder coated Supply Air 600x600 constant volume diffuser complete with flexible, plenum box, butterfly damper and mounted controllers and all appurtenances related. With neck size				
	Ø 350	No	5		
	Ø 300	No	10		
	Ø 250	No	1		
	Ø 200	No	1		
2.2.2	**PAU3 System Ducting(Beds 1-4 & Isolation Wards)**				
a	**Externally insulated ductwork**				
	250X400	m	10		
	500X400	m	10		
	600x400	m	5		
	750X400	m	5		
	1000X400	m	10		
	Ø 300	m	15		
	Insulated Flexible ducting				
	Ø 300	m	15		
	Externally insulated ductwork . Fittings				
b	**Transformations**				
	1000X400 to 750X400	No	2		
	750X400 to 600x400	No	2		
	600x400 to 500x400	No	2		
	500x400 to 250x400	No	2		
c	**Bends 90°**				
	250X400	No	4		
	500X400	No	6		
	600x400	No	4		
	750X400	No	2		
	1000X400	No	2		
	Ø 300	No	8		
d	**Double bend**				
	1000x400	No	2		
	Total carried forward				

SECTION 1M-INTENSIVE CARE UNIT (MECHANICAL INSTALLATIONS)
SECTION 1.2 - PART 1 (HVAC)
BILL 1 - ICU FIRST FLOOR

Item	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	Total Brought forward				
e	**Shoes**				
	1000x400	No	2		
	750X400	No	2		
	600x400	No	2		
	500X400	No	2		
	250X400	No	2		
f	**Spigots**				
	300dia	No	10		
	250dia	No	5		
	200dia	No	5		
g	**Stop Ends**				
	1000x400	No.	2		
	750X400	No.	1		
	600x400	No.	2		
	500X400	No.	2		
	250X400	No.	2		
h	**Velocity Control Dampers**				
	1000x400	No	2		
	750X400	No	2		
	600x400	No	3		
	500X400	No	2		
	250X400	No	2		
	350dia	No	9		
i	**Fire Dampers with fusible links**				
	1000x400	No	2		
j	White epoxy powder coated Supply Air 600x600 constant volume diffuser complete with flexible, plenum box, butterfly damper and mounted controllers and all appurtenances related. With neck size				
	Ø 350	No	15		
	Ø 300	No	2		
	Ø 250	No	2		
	Ø 200	No	1		
	Door Grills				
	Supply and install extract air door transfer grilles complete with all necessary fixtures as specified and shown on the drawings				
	DG01 400x300 Aluminium natural anodised	No	20		
	Total carried forward				

SECTION 1M-INTENSIVE CARE UNIT (MECHANICAL INSTALLATIONS)
SECTION 1.2 - PART 1 (HVAC)
BILL 1 - ICU FIRST FLOOR

Item	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	Total Brought forward				
3.0	**Fan Coil Units**				
a.	4 Way Blow Cassette Type Fan Coil Units (4 pipe system) installed complete with, low sound level centrifugal condensate pump (max 650mm pump head), 2 or 3 way valve kits provided with stop/balancing valves, hot and cold water pipes with terminating valves and unions. These units should be installed on galvanised steel cantilever brackets and on vibration padding. The LCD wired remote controller should be in a suitable position to be specified by the engineer. An auxillary drain pan should be included in this installation and condensate pipes are to be routed to the nearest drain, sloped and fitted with a 'p' trap.				
	3.5Kw	No	9		
	5,2Kw	No	8		
	7,2Kw	No	2		
	9,6Kw	No	10		
	Supply and installation of following: Complete with fittings and ancillaries for a complete installation				
	Copper piping				
	1 5/8"	m	65		
	5/8"	m	25		
	1/2"	m	50		
	3/8"	m	50		
	1/4"	m	110		
8.1	**Refnet Joints**	No	15		
8.2	**BS boxes**				
a	4 port	No	3		
b	2 port	No	2		
c	1 Port	No	3		
3.0	**Split Air condition Unit**				
a.	Midwall Type split Units installed complete with, low sound level centrifugal condensate pump (max 650mm pump head), The units should be installed on galvanised steel cantilever brackets and on vibration padding. The LCD wired remote controller should be in a suitable position as per drawing. Condensate pipes are to be routed to the nearest drain, sloped and fitted with a 'p' trap.				
	18000Btu	No	2		
b	**Supply and installation of following: Complete with fittings and ancillaries for a complete installation**				
	Copper piping				
	5/8"	m	10		
	1/2"	m	10		
	3/8"	m	10		
	Total carried forward				

SECTION 1M-INTENSIVE CARE UNIT (MECHANICAL INSTALLATIONS)
SECTION 1.2 - PART 1 (HVAC)
BILL 1 - ICU FIRST FLOOR

Item	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	Total Brought forward				
	Supply and installation of following complete with couplings and accessories for a complete installation:				
	PVC piping for drainage				
	50mm	m	25		
	22mm	m	50		
5.0	**Electrical Supply and controls**				
a	Electrical Material and labour work to provide power from units to isolator point which will be supplied by Electrical contractor	Sum	1		
b	All control cabling associated with the above units,	sum	1		
c	The LCD wired remote controller remote/wall mounted control unit in a suitable position to be specified by the engineer	No	34		
d	Provision of room motion Sensors			Pc Sum	R 450 000,00
16	**Comissioning of the following in the presence of Engineer, client and user client**	Item	1		
	HVAC installation				
17	**VRV CONDENSING UNIT**				
	Supply, Deliver to site Installation and commission of heat recovery VRV Outdoor Condensing unit of capacity as indicated below complete with plinth, vibration isolation pads and all necesary appurtenances for a complete installation.				
01	45Kw	No	1		
	Total carried to Summary Page				

SECTION 1M-INTENSIVE CARE UNIT (MECHANICAL INSTALLATIONS)
SECTION 1.2 - PART 1 (HVAC)
BILL 1 - ICU ROOF

Item	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	ROOF PLANT				
	Supply, installation and setting of the following.				
1.0	**Extraction Fan Unit**				
01	EFU1 (through shaft 1), centrifugal exhaust dual fans for 2576.6L/s @ 300 Pa static pressure, installed complete with 2 off 1.5D Melanex lined attenuator, 3m riser, vibration isolation, square to round transformation, supports, bird screens, weather skirts, electric controls,3 stage filters and safeties and all appurtenances related.	No	1		
02	EFU2 (through shaft 2), centrifugal exhaust dual fans for 5945.5L/s @ 300 Pa static pressure, installed complete with 2 off 1.5D Melanex lined attenuator, 3m riser, vibration isolation, square to round transformation, supports, bird screens, weather skirts, electric controls ,3 stage filters and safetiesand safeties and all appurtenances related.	No	2		
03	EFU3 (through shaft 3), centrifugal exhaust dual fans for 4892.5L/s @ 300 Pa static pressure, installed complete with 2 off 1.5D Melanex lined attenuator, 3m riser, vibration isolation, square to round transformation, supports, bird screens, weather skirts, electric controls ,3 stage filters and safetiesand safeties and all appurtenances related.	No	1		
04	EFU4 (through shaft 3), centrifugal exhaust dual fans for 14892.5L/s @ 300 Pa static pressure, installed complete with 2 off 1.5D Melanex lined attenuator, 3m riser, vibration isolation, square to round transformation, supports, bird screens, weather skirts, electric controls ,3 stage filters and safetiesand safeties and all appurtenances related.	No	1		
05	EFU5 (through shaft 3), centrifugal exhaust dual fans for 14892.5L/s @ 300 Pa static pressure, installed complete with 2 off 1.5D Melanex lined attenuator, 3m riser, vibration isolation, square to round transformation, supports, bird screens, weather skirts, electric controls ,3 stage filters and safetiesand safeties and all appurtenances related.	No	1		
2,0	**Variable speed Drive**				
	Supply and installation and comissioning of variable speed drives as follows				
01	4,5Kw 4 Pole Motor with overload and accessories	No.	2		
02	2,5Kw 4 Pole Motor with overload and accessories	No.	2		
3,0	**Electrical works for above installation**				
01	Electrical Material and labour work to provide power from units to isolator point which will be supplied by Electrical contractor	Sum	1		
02	All control cabling associated with the above units,	sum	1		
03	Wired remote controller Wall mounted control unit in a suitable position to be specified by the engineer	No	4		
	Total carried forward				

SECTION 1M-INTENSIVE CARE UNIT (MECHANICAL INSTALLATIONS)
SECTION 1.2 - PART 1 (HVAC)
BILL 1 - ICU ROOF

Item	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	Total Brought forward				
4	**Ventilation System Ducting**				
4.1	**EXTRACTION SYSTEM**				
4.1.1	**Shaft 1 System Ducting**				
4.1.1.1	**Un-insulated ductwork installed complete with fixing arrangements and hangers.**				
01	900x1000	m	40		
4.1.1.2	**Un- insulated ductwork . Fittings**				
01	**Transformations**				
	900x1000 to 900x350	No	4		
02	**Bends 90°**	m			
	900x1000	No	4		
03	**Shoes**				
	900x1000	No	4		
04	**Velocity Control Dampers**				
	900x1000	No	4		
4.1.2	**Shaft 2 System Ducting**				
4.1.2.1	**Un-insulated ductwork installed complete with fixing arrangements and hangers.**				
	800x800	m	15		
4.1.2.2	**Un- insulated ductwork . Fittings**				
01	**Transformations**				
	800x800 to 700x650	No	2		
02	**Bends 90°**	m			
	800x800	No	2		
03	**Shoes**				
	800x800	No	2		
04	**Velocity Control Dampers**				
	800x800	No	4		
4.1.3	**Shaft 3 System Ducting**				
4.1.3.1	**Un-insulated ductwork installed complete with fixing arrangements and hangers.**				
	1400x950	m	28		
4.1.3.2	**Un- insulated ductwork . Fittings**				
01	**Transformations**				
	1200x400 to 900x350	No	2		
02	**Bends 90°**				
	1200x400	No	3		
03	**Bends 45°**				
	1200x400	No	4		
	Total carried forward				

SECTION 1M-INTENSIVE CARE UNIT (MECHANICAL INSTALLATIONS)
SECTION 1.2 - PART 1 (HVAC)
BILL 1 - ICU ROOF

Item	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	Total Brought forward				
	Un- insulated ductwork . Fittings				
04	**Double bend**				
	1200x400	No	1		
05	**Shoes**				
	1200x400	No	2		
06	**Spigots**				
	400dia	No	5		
	250dia	No	5		
07	**Velocity Control Dampers**				
	1200x400	No	4		
08	**Weather Louvre**				
	2500x1000	No	1		
5.0	**SUPPLY AIR SYSTEM**				
	Supply and installation of Externally insulated double skin ductwork installed complete with fixing arrangements and hangers complete with all necessary appurtenances As Follows:				
5.1	**Shaft 1 System Ducting**				
5.1.1	**Ducting**				
01	1200x500	m	15		
02	900x800	m	15		
03	600x700	m	15		
04	600x600	m	15		
5.1.2	**Externally insulated double skin ductwork . Fittings**				
01	**Bends 90°**				
	700x600	No	4		
	1200x500	No	5		
5.2	**Shaft 2 System Ducting**				
5.2.1	**Externally insulated double skin ductwork . Fittings**				
01	900x500	m	15		
02	600x400	m	10		
03	600x800	m	15		
5.2.2	**Externally insulated double skin ductwork . Fittings**				
1	**Bends 90°**				
	900x600	No	4		
5.3	**Shaft 3 System Ducting**				
5.3.1	**Externally insulated double skin ductwork . Fittings**				
01	1000x600	m	35		
	Total carried forward				

SECTION 1M-INTENSIVE CARE UNIT (MECHANICAL INSTALLATIONS)
SECTION 1.2 - PART 1 (HVAC)
BILL 1 - ICU ROOF

Item	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	Total Brought down				
5.3.2	**Externally insulated double skin ductwork . Fittings**				
01	**Bends 90°**				
	700x600	No	4		
6	**Air Handling Units (AHU)**				
6.1	Supply, deliver to site, and installation of following fully automatically controlled air handling unit suitable for outdoor use complete with 3 stage (primary-G3, secondary-F8 and HEPA-H13) filters,Hepa Partitions are sealed to the internal side of the exterior wall, roof and floor panels to ensure zero air by-pass. 50 mm thickness of insulation •The AHU must be the heat recovery type with a Heat recovery wheel, it must come complete with pressure switches for filters and fans, fan motors and inverters. •Electrical control panel complete with Direct Digital Control (DDC) controller › Internal fitting of all sensors and pressure measurement devices › Built-in temperature, humidity and CO2 sensors › Internal electrical wiring for all components. Mixing box with damper and factory-mounted actuators. Supports and fixings, Magnehelic gauges across filter bank, 1.5D Eurolon infill, Return air fans, vibration isolation, supports, , variable speed drive, Plenum lights in each chamber with light switch per light, Damper motors on mixing box dampers and bypass dampers, Intake Weather louvres on plenum boxes or fresh air units, pressure gauges and thermometers and all appurtenances necessary for the safe and efficient operation of the system. Installed				
01	AHU1 (1st Floor beds 6 to15) Supply Air Quantity : 4,125m³/sec Percentage Fresh Air : 100% Cooling Capacity : 80 kW Type : horizontal	No	1		
02	AHU2 (Ground floor beds 15 -20) Supply Air Quantity : 4,125m³/sec Percentage Fresh Air : 100% Cooling Capacity :80 kW Type : Horizontal	No	1		
03	AHU03 (1st Floor bed 1-4 & Isolation wards) Supply Air Quantity : 2.4m³/sec Percentage Fresh Air : 100% Cooling Capacity : 45kW Type : Horizontal	No	1		
6.2	**Ducting Accessories**				
6.2.1	**Plenum**				
01	3000x2000x500mm	m	3		
	Total carried forward				

SECTION 1M-INTENSIVE CARE UNIT (MECHANICAL INSTALLATIONS)
SECTION 1.2 - PART 1 (HVAC)
BILL 1 - ICU ROOF

Item	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	Total Brought down				
6.2.2	**Filter box**				
	with 3 stage (primary-G3, secondary-F8 and HEPA-H13) filters, supports and fixings, Magnehelic gauges across filter bank, 1.5D Eurolon infill, Return air fans, vibration isolation, supports, , variable speed drive, Plenum lights in each chamber with light switch per light, Damper motors on mixing box dampers and bypass dampers, Intake Weather louvres on plenum boxes or fresh air units, pressure gauges and thermometers and all appurtenances necessary for the safe and efficient operation of the system. Installed	No	3		
6.3	Installation and commisisioning of the Units above and making good	Item	5		
7.0	**Accessories**				
01	Themometer	No	12		
02	Pressure Gauge	No	24		
03	Test Sockets	No	15		
04	Air Vent	No	6		
05	BMS Temperature point	No	12		
02	Pressure Sensors	No	24		
8.0	**Valves**				
	All valves are to be insulated with nitrile rubber insulation finished with polyshied as per specifications				
8.1	**Butterfly valves with insulation as per specifications,**				
01	200 mm dia	Nos	0		Rate only
02	150 mm dia	Nos	0		Rate only
03	80 mm dia	Nos	4		
04	65 mm dia	Nos	4		
05	50 mm dia	Nos	24		
06	40 mm dia	Nos			Rate only
01	32 mm dia	Nos			Rate only
02	25 mm dia	No			Rate only
8.2	**Y type strainers with insulation as per specifications,**				
01	25 mm dia	Nos			Rate only
02	32 mm dia - cladded	No	6		
03	50 mm dia - cladded	No	24		
8.3	Wafer type check valves with insulation as per specifications,				
01	50 mm dia	Nos	24		
	Total carried forward				

SECTION 1M-INTENSIVE CARE UNIT (MECHANICAL INSTALLATIONS)
SECTION 1.2 - PART 1 (HVAC)
BILL 1 - ICU ROOF

Item	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	Total Brought down				
8.4	**AHU Pressure Independent Control Valves (PICV) with insulation as per specifications**				
01	FAU01 CHW Ø50	No	24		
02	FAU01 HW Ø25	No	6		
9.0	**Electrical works for above installation**				
01	Electrical Material and labour work to provide power from units to isolator point which will be supplied by Electrical contractor	Sum	1		
02	All control cabling associated with the above units,	sum	1		
03	Wired remote controller Wall mounted control unit in a suitable position to be specified by the engineer	No	4		
10	**BUILDING MANAGEMENT SYSYEM**				
01	Supply and installation of Building management system, Interlock all HVAC equipment with BMS system and control of primary and secondary chilled water circulation including all control monitoring and measuring equipment, interconnecting wiring and all items necessary for the efficient operation of the equipment.	Psum	1	Psum	R 1 500 000,00
11	Comissioning of the following in the Entire System in presence of Client and User client	Item	1		
	Total carried to Summary Page				

SECTION 1M - ICU (MECHANICAL INSTALLATIONS)
SECTION 2.2 - PART 1(HVAC)

Bill No.	Description	Amount
1,0	**INTENSIVE CARE UNIT**	
01	Chiller Plant	
02	Ground Floor	
03	First Floor	
04	Roof Plant	

SECTION 1M - ICU (MECHANICAL INSTALLATIONS)
MECHANICAL INSTALLATION
Bill No.1 - Plumbing ICU
Hot and Cold water reticulation

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	Supply, Deliver to site install the following steam heated hotwater calorifier				
5	Capacity Range: 2500L	ITEM	2		
(i)	Connect to the existing steam and condensate line including re-lagging, gladding and isolation valves				
	Schedule 40 stream pipe line including lagging and gladding				
	40mm dia	m	20		
	32mm dia	m	25		
	25mm dia	m	15		
	15mm dia	m	20		
(ii)	Sterilise the complete water side of the installation.	SUM	1		
(iii)	Supply and installation of lagging and	ITEM	1		
	cladding of the steam and hot-water piping.				
(iv)	Supply and install steam PRV set arrangement consisting of the following:Pressure reducing valve, 2x Isolating Valves, 1x Steam separator, 2x Pressure gauges, 1x strainer, 1x Steam trap arrangement and 1x safety valve	Item	1		
(v)	Supply and installation of steam trap arrangement consisting of steam trap, strainers, non-return valves, sight glasses, steam & condensate isolating valves	Item	3		
6	**Hot water circulating Pumps**				
	Supply, deliver, off-load and store on site and install hot water circulation pumps as specified				
	Flow: 4.32 m^3/h ; Head : 5m	No	2		
2,9	**CONTROL PANEL**				
	Supply deliver, off-load , store on sit and install control				
	panel including accessories as specified	No	1		
2,10	**ELECTRICAL WORK**				
	Supply and install electrical work including power and control cabling and connections as specified for above installation	Item	1		
2,1	**HOT WATER PIPEWORK**				
	Supply, deliver, off-load, store on site copper pipes class 2 SANS 460 including all fittings and other accessories for the plumbing work as specified and shown on the drawings sizes as follows including hangers, supports, anchors and fittings;				
	Class 0 copper pipes : 15mm - 28mm Pipes chased into brick walls where possible and all other pipes fixed to walls in ducts with M10 rubber lined hanger brackets including M10 threaded rod not exceeding 500mm long and M10 drop-in anchor				
(i)	Ø42mm	m	20		
(ii)	Ø35mm	m	100		
(iii)	Ø28mm	m	55		
(iv)	Ø22mm	m	110		
(v)	Ø15mm	m	165		
	Total carried forward				

SECTION 1M - ICU (MECHANICAL INSTALLATIONS)
MECHANICAL INSTALLATION
Bill No.1 - Plumbing ICU
Hot and Cold water reticulation

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	Total Brought forward				
2,2	**INSULATION AND CLADDING**				
	Supply, deliver, off-load, store on site and install close cell polythene insulation complete with galvanized metal cladding for hot water pipes as specified and shown on the drawings sizes as follows:				
(i)	Ø42mm (25mm thick)	m	20		
(ii)	Ø35mm (20mm thick)	m	100		
(iii)	Ø28mm (15mm thick)	m	55		
(iv)	Ø22mm (15mm thick)	m	20		
(v)	Ø15mm (10mm thick)	m	20		
2,13,1	Extra over class 0 copper pipes for capillary fittings				
	15mm Fittings	No	85		
	22mm Fittings	No	65		
	28mm Fittings	No	90		
2,15	**ISOLATION VALVES**				
	Supply, delivery and installation of isolation valves on hot water pipes including all fitting and accessories				
	Ø42mm	no.	8		
	Ø35mm	no.	10		
	Ø28mm	no.	15		
	Ø22mm	no.	15		
	Ø15mm	no.	22		
2,4	**PRESSURE REDUCING VALVES**				
	Supply deliver, off-load , store on sit and install pressure				
	reducing valves on the cold water supply pipes to the				
	hot water storage cylinders including all fittings				
	and accessories	Item	1		
2,5	**EXPANSION RELIEF VALVES**				
	Supply deliver, off-load , store on sit and install expansion				
	relief valves on the hot water storage cylinders				
	including all fittings and accessories	Item	1		
2,6	**VACUUM BREAKERS/ AIR RELEASE VALVES**				
	Supply deliver, off-load , store on sit and install vacuum				
	breakers/air release valves on hot water storage				
	cylinders including all fittings and accessories	Item	2		
2,7	**VACUUM BREAKERS/ AIR RELEASE VALVES**				
	Supply deliver, off-load , store on sit and install vacuum				
	breakers/air release valves on hot water storage				
	cylinders including all fittings and accessories				
2,8	**BALANCING VALVES**				
	Supply deliver, off-load , store on sit and install balancing valves on primary circuit including all fittings and	Item	1		
2,11	**TEST AND COMMISSIOM**				
	Test and commission all the water heating systems including pressure test of all system components and performance test of the systems.	Item	1		
	Ditto but in the presence of and to the entire satisfaction of the consulting engineer	Item	1		
	Total carried forward				

SECTION 1M - ICU (MECHANICAL INSTALLATIONS)
MECHANICAL INSTALLATION
Bill No.1 - Plumbing ICU
Hot and Cold water reticulation

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	Total Brought forward				
2,12	**WATER SUPPLIES**				
	Sterilizing all water pipes prior to installation in strict accordance to the methods and specifications in	Sum	1		
2,13	Class 0 copper pipes : 15mm - 28mm Pipes chased into brick walls where possible and all other pipes fixed to walls in ducts with M10 rubber lined hanger brackets including M10 threaded rod not exceeding 500mm long and M10 drop-in anchor				
(i)	15mm Pipes	m	110		
(ii)	22mm Pipes	m	55		
(iii)	28mm Pipes	m	55		
(iv)	35mm Pipes	m	100		
(v)	42mm Pipes	m	20		
2,13,1	Extra over class 0 copper pipes for capillary fittings				
	15mm Fittings	No	85		
	22mm Fittings	No	65		
	28mm Fittings	No	90		
2,13,2	Testing : Pressure testing water pipe system	Item	1		
2,14	**PIPE PROTECTION**				
2,14,1	Thermal cross-linked polyethylene foam pipe insulation minimum 20mm thick				
	Insulation to 15mm pipe and couplings	m	110		
	Extra for wrapping around 15mm fittings	m	110		
	Insulation to 22mm pipe and couplings	m	55		
	Extra for wrapping around 22mm fittings	m	55		
	Insulation to 28mm pipe and couplings	m	55		
	Extra for wrapping around 28mm fittings	m	55		
	Extra for wrapping around 15mm valve	m	110		
	Extra for wrapping around 28mm valve	m	55		
3,1	**DRAINAGE PLUMBING**				
3,1,1	uPVC pipes				
(i)	50mm pipes	m	135		
(ii)	110mm pipes	m	210		
3,2	**Extra over uPVC pipes for fittings**				
(i)	50mm Bend	No	85		
(ii)	50mm Access bend	No	65		
(iii)	50mm access junction	No	20		
(iv)	110mm Pan connector	No	55		
(v)	110mm Bend	No	65		
(vi)	110mm Access bend	No	45		
(vii)	110mm Access junction	No	35		
3,3	**WASTE UNIONS, ETC.**				
(i)	Sink waste code to Franke kitchen system refer to sink code	No	25		
(ii)	303 Basin waste, without chain and stay, slotted and supplied with flanged , washer, plug with stirrup, without chain and stay 62mm diameter flange, 80mm long shrank G11/2" MI inlet, chrome plated	No	35		
	Total carried summury				

MECHANICAL INSTALLATION
Bill No.3 - Plumbing
Drainage Installation

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
(ii)	323CP Shower waste, rough brass and chrome plated, with 75mm diameter shower grating and RB body G1/2" MI inlet, RB/CP shower "P" trap, rough brass, with shallow seal and chrome plated grating G1/2" FI outlet, RB	No	12		
3,4	**TRAPS, ETC.**				
(i)	38 x 38mm bottle-trap	No	18		
(ii)	50mm Shower "P" trap	No	16		
3,5	**Testing**				
(i)	Pressure testing drainage pipe system	Item	1		

JST NEW ICU UNIT

PLUMBING, HOT WATER, COLD WATER AND DRAINAGE SUMMARY
MECHANICAL INSTALLATION

ITEM	DESCRIPTION	AMOUNT
	ICU	
Bill No.1	Hot and Cold water reticulation, Drainage Installation, Plumbing Accessories & other Equipment	

JST NEW ICU UNIT
SECTION 2.2 - PART 3 (MEDICAL GAS INSTALLATION)
BILL 1 -ICU - GROUND FLOOR

Item	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	Supply, deliver, install, test and commission complete medical piped gases installation in the hospital as detailed below.				
1,1	Vacuum Moisture Traps				
1.1.1	Vacuum moisture trap set consisting of moisture trap, brackets etc.	No.	6		
1,2	**Pipework**				
	Medical grade copper tubes with brazed joints in accordance with BS EN 737-1 and BS EN 13348, complete with all necessary clamping and support				
1.2.1	42 mm NB	m	144		
1.2.2	35 mm NB	m	130		
1.2.3	28 mm NB	m	260		
1.2.4	22 mm NB	m	730		
1.2.5	15 mm NB	m	840		
1.2.6	12 mm NB	m	670		
1.2.7	10 mm NB	m	200		
1,3	**Pipework fittings – elbows**				
	Medical grade copper brazed joints in accordance with BS EN 737-1 and BS EN 13348				
1.3.1	OD 42mm	No.	20		
1.3.2	OD 35mm	No.	20		
1.3.3	OD 28mm	No.	20		
1.3.4	OD 22mm	No.	60		
1.3.5	OD 15mm	No.	65		
1.3.6	OD 12mm	No.	90		
1.3.7	OD 10mm	No.	80		
1,4	**Pipework fittings – tees**				
	Medical grade copper brazed joints in accordance with BS EN 737-1 and BS EN 13348				
1.4.1	OD 42mm	No.	5		
1.4.2	OD 35mm	No.	10		
1.4.3	OD 28mm	No.	10		
1.4.4	OD 22mm	No.	15		
1.4.5	OD 15mm	No.	45		
1.4.6	OD 12mm	No.	25		
1.4.7	OD 10mm	No.	35		
1,5	**Pipework fittings – couplings**				
	Medical grade copper brazed joints in accordance with BS EN 737-1 and BS EN 13348				
1.5.1	OD 42mm	No.	10		
1.5.2	OD 35mm	No.	10		
1.5.3	OD 28mm	No.	10		
1.5.4	OD 22mm	No.	55		
1.5.5	OD 15mm	No.	90		
1.5.6	OD 12mm	No.	55		
	Total carried forward				

JST NEW ICU UNIT
SECTION 2.2 - PART 3 (MEDICAL GAS INSTALLATION)
BILL 1 -ICU - GROUND FLOOR

Item	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	Total Brought forward				
1,6	**Pipework fittings – reducers**				
	Medical grade copper brazed joints in accordance with BS EN 737-1 and BS EN 13348				
	Medical grade copper brazed joints in accordance with BS EN 737-1 and BS EN 13348				
1.6.1	42x35mm	No.	1		
1.6.2	35x28mm	No.	2		
1.6.3	28x22mm	No.	5		
1.6.4	22x15mm	No.	15		
1.6.5	15x12mm	No.	10		
1.6.6	12x10mm	No.	35		
1,7	**Bedhead Units, Pendants & Panels**				
1.7.1	**Ground Floor**				
a	**1-Bed Vertical Bedhead Unit** approxiamately 2000mm in length and **560mm wide** complete with 8 x 16A SW/SO D/pole (blue - UPS Supply); 4 x 16A SW/SO D/Pole (Red) (Essential Supply); 1 x 50W reading light (relay switched); 1 x 5W LED night light (switch at door); 8 off medical gas installed; 1 x medical rail @ 600mm; 1 x nurse call (only provision); 1 x emergency call (only provision); 1 x RJ45 Data point/monitor point installed	No.	6		
b					
1.7.2	**First Floor**				
	ICU				
a	**1-Bed Vertical Bedhead Unit** approxiamately 2000mm in length and **560mm wide** complete with 8 x 16A SW/SO D/pole (blue - UPS Supply); 4 x 16A SW/SO D/Pole (Red) (Essential Supply); 1 x 50W reading light (relay switched); 1 x 5W LED night light (switch at door); 8 off medical gas installed; 1 x medical rail @ 600mm; 1 x nurse call (only provision); 1 x emergency call (only provision); 1 x RJ45 Data point/monitor point installed	No.	4		
1.7.3	**Isolation rooms**				
a	**1-Bed Vertical Bedhead Unit** approxiamately 2000mm in length and **560mm wide** complete with 4 x 16A SW/SO D/pole (blue - UPS Supply); 1 x 50W reading light (relay switched); 1 x 5W LED night light (switch at door); 7 off medical gas installed; 1 x medical rail @ 600mm; 1 x nurse call (only provision); 1 x emergency call (only provision); 1 x RJ45 Data point/monitor point installed	No.	2		
	Total carried forward				

JST NEW ICU UNIT
SECTION 2.2 - PART 3 (MEDICAL GAS INSTALLATION)
BILL 1 -ICU - GROUND FLOOR

Item	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	Total Brought forward				
1.7.4	**High Care Ward**				
	1-Bed Vertical Bedhead Unit approxiamately 2000mm in length and **560mm wide** complete with 8 x 16A SW/SO D/pole (blue - UPS Supply); 4 x 16A SW/SO D/Pole (Red) (Essential Supply); 1 x 50W reading light (relay switched); 1 x 5W LED night light (switch at door); 8 off medical gas installed; 1 x medical rail @ 600mm; 1 x nurse call (only provision); 1 x emergency call (only provision); 1 x RJ45 Data point/monitor point installed	No.	10		
	Isloation Rooms				
a	**1 x Fixed Pendant Unit** complete with 1 x pillar assebly - 600mm (service column & 4 x grabtubes); 6 x 16A SW/SO D/pole (red-essential supply); Medical gases - 2 off oxygen; 2 off vacuum; 1 off vacuum; 2 off LPA; 2 emergency call provision; 1 x RJ45 data point/monitor point installed; 7 engraving/labels per item; 1 x 3A three pin euro socket with switch	No	2		
1,8	**Valves and valve boxes**				
1.8.1	Flush-mounted 3 gas valve type complete with valves	No.	3		
1.8.2	Flush-mounted 2 gas valve type complete with valves	No.	1		
1.8.3	Flush-mounted 1 gas valve type complete with valves	No.	2		
	Isolation valves proprietary for the gas line pressure at entrance to each building, for:				
1.8.3	Oxygen on pipe size 28mm NB(set)	No.	1		
1.8.4	Vacuum on pipe size 42mm NB (set)	No.	1		
1.8.5	Medical air (400 kPa) on pipe size 28mm NB(set)	No.	1		
1.8.6	Nitrous oxide (400 kPa) on pipe size 15mm NB(set)	No.	1		
1,9	**Terminal units**				
	Medical gas specific terminal units to Eminence, labelled, including guide end piece valve filter, fixed on to the provided bed head trunking and final termination of pipes to the terminal units				
1.9.1	Oxygen	No.	55		
1.9.2	Vacuum	No.	55		
1.9.3	Medical air	No.	25		
1,10	**Alarms**				
1.10.1	Slave alarm panel installed complete with line pressure sensors and & vacuum stats.	No.	5		
1.10.2	Alarm cabling	m	100		
1.10.3	20mm Diameter Galvanised steel conduit for control wiring.	m	100		
1,12	**PIPEWORK**				
	Supply and install all interconnecting pipework including requisite valves within the plant room from vacuum pump to the main supply pipe as specified and shown on the drawings.	Sum	1		
	Total carried forward				

JST NEW ICU UNIT
SECTION 2.2 - PART 3 (MEDICAL GAS INSTALLATION)
BILL 1 -ICU - GROUND FLOOR

Item	DESCRIPTION	UNIT	QTY	RATE	
	Total Brought forward				
1,17	**OXYGEN GAS INSTALLATION**				
1.17.1	**OXYGEN MANIFOLD**				
a	Supply, deliver, off load and store on site a two bank x 2 cylinder, 13kg oxygen cylinder manifold complete with supports and tail pipe connections to the BS1319. the manifold shall be capable of automatic changeover and shall be supplied complete with wiring to a monitoring and indicating system as specified and detailed on the drawings.	Item	1		
b	Install Item B	Item	1		
1.17.2	**OXYGEN CYLINDERS**				
a	Supply, deliver, off load and store on site 13kg oxygen cylinder complete with oxygen gas.	No.	6		
b	Install Item D (2 to be kept in storage)	No.	4		
1.17.3	**PIPEWORK**				
	Supply and install all interconnecting pipework within the plant room including requisite valves, from oxygen gas manifold to the supply pipe as specified and shown on the drawings.	Sum	1		
1.17.4	**ELECTRICAL WORK**				
	Supply and install cabling and connections from the isolator to the panel and from the panel to repeater panels remotely connected in positions detailed on the drawings.	Sum	1		
1.17.5	**PIPEWORK & FITTINGS OXYGEN GAS**				
	INSTALLATION				
	Supply and install pipework and fittings for oxygen gas which shall be half hard copper and coded to indicate that it has been specifically manufactured for medical gas pipeline installation. The pipes shall be to A.S.M.B88 or BS2871 coper type C106.				
a	Ø15mm	m	35		
b	Ø12mm	m	25		
c	Ø10mm	m	140		
1.17.6	**ISOLATING VALVE**				
	Supply and Install isolating valve for oxygen distribution system to be installed in isolation valve boxes as specified and shown on the drawings.	No.	1		
	Total carried forward				

JST NEW ICU UNIT
SECTION 2.2 - PART 3 (MEDICAL GAS INSTALLATION)
BILL 1 -ICU - GROUND FLOOR

Item	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	Total Brought forward				
1.17.7	**PIPEWORK & FITTINGS VACUUM INSTALLATION**				
	Supply and install pipework and fittings for oxygen gas which shall be half hard copper and coded to indicate that it has been specifically manufactured for medical gas pipeline installation. The pipes shall be to A.S.M.B88 or BS2871 coper type C106.				
a	Ø28mm	m	25		
b	Ø22mm	m	50		
c	Ø15mm	m	204		
d	Ø12mm	m	65		
1.17.8	**ISOLATING VALVE**				
	Supply and Install isolating valve for vacuum distribution system to be installed in isolation valve box as specified and shown on the drawings.	No.	1		
1.17.9	**VACUUM TRAP**				
	Supply and install a vacuum trap as specified and installed in the position shown on the drawings.	No.	1		
1.17.10	**ISOLATION VALVE BOX**				
	Supply and Install and isolation valve box complete with the legend as specified and installed in the location shown on the drawings. (At nurses station)	No.	2		
1.17.11	**PVC TRUNKING (SLIMLINE)**				
	Supply and install PVC trunking to run all droppers from the bedhead trunking level. The trunking will accommodate the oxygen and vacuum as required.	Item			
1.17.12	**WARNING LIGHT ALARM PANEL**				
	Supply and install a warning light alarm repeater panel as specified and in the position shown on the drawings.	No.	1		
1.17.13	**TEST & COMMISSION**				
	Test and commission the entire pipework to the satisfaction of the Consulting Engineer.	Item	1		
	System Validation				
a	Validation of installation as necessary	item	5		
1,18	**Provisonal Sum**				
a	Additional Testing and validation as necessary	Psum		Psum	R 80 000,00
b	Colour coding of Installation	Psum		Psum	R 120 000,00
c	Pipiping from Main supply line to ICU	Psum		Psum	R 325 000,00
	Total carried forward				

JST NEW ICU UNIT

MEDICAL GAS
MECHANICAL INSTALLATION

ITEM	DESCRIPTION	AMOUNT
	ICU	
Bill No.1	Medical gas and Accessories	

SECTION 1M - ICU (MECHANICAL INSTALLATIONS)

LIFT INSTALLATIONS

Item	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
1.1	In accordance with the Conditions of Contract,				
	provide for all expenses, obligations and general				
	items pertaining to such conditions and all items				
	not specifically specified or mentioned to enable				
	the works to be completed in a satisfactory manner.				
1.1.1	Fixed Portion	Item	1		
1.1.2	Variable with contract Time	Item	1		
1.1.3	Variable with contract price	Item	1		
1.1.4	State forward cover cost for imported materials at the current rate at the time of tender.	Item	1		
	Total carried forward to summary				

SECTION 1M - ICU (MECHANICAL INSTALLATIONS)
SECTION 2.2 - PART 4 (LIFT INSTALLATIONS)
BILL 1 - ICU & Gynae

Item	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	Supply, installation and setting of the following.				
	Supply Deliver, Install,				
	Including 12 Month Free Guarantee and Service Period.				
1	**ICU (INTENSIVE CARE UNIT)**				
1,1	Lift No 1& 2, MRL Duplex Electric Traction Steetcher Bed Lift - 24 persons / 2500kg	Item	1		
1,2	Supply and install dewatering sump pump as specified	Item	1		
3	Test, Commission of lift	Item	1		
3.1	Ditto but in the presence of and to the entire satisfaction of the Consulting Engineer & Handover.	Sum	1		

SECTION 1M - ICU (MECHANICAL INSTALLATIONS)

SUMMARY

Bill No.	Description	Amount
1,0	Preliminary and General	
2,0	Lift installation	
	CARRIED FORWARD TO MAIN CONTRACT SUMMARY	

MECHANICAL INSTALLATION
Bill No. - TRANSFER COVERED WALKWAY

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	Provisional Sums				
a	Covered walkway Relocation of services			Psum	R 465 000,00
b	Specialist services document transfer system			Psum	R 1 265 000,00

Total carried to Summary R 1 730 000,00

SECTION 1M - ICU (MECHANICAL INSTALLATIONS)
SECTION 2.2 - PART 1 MEDICAL EQUIPMENT)
BILL 2 - MEDICAL EQUIMENT

Item	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	Supply, installation and setting of the following.				
1	**AUTOMATIC BEDPAN WASHERS**				
a	Supply, deliver, offload and store on site automatic bedpan washers as specified.	No.	2		
b	Install Item 1a	No.	2		
2	**AUTOMATIC SLUICE MACHINE**				
a	Supply, deliver, offload and store on site automatic sluice machine as specified and shown on the drawings.	No.	2		
b	Install Item 2a	No.	2		
c	Provision of Ventilators	Psum			R 1 250 650,00
	Total carried to Summary Page				

SECTION 1M - ICU (MECHANICAL INSTALLATIONS)

SUMMARY

Bill No.	Description	Amount
1,0	Preliminary and General	
2,0	HVAC installation	
3,0	Plumbing and wet services	
4,0	Medical gas installation	
5,0	Lift Installation	
6,0	Transfer Covered Walkway	R 1 730 000,00
7,0	Medical Equipment	

PART IV

STANDARD TECHNICAL SPECIFICATIONS

INTENSIVE CARE UNIT
MECHANICAL SERVICES INSTALLATIONS

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PART IV

STANDARD TECHNICAL SPECIFICATIONS
HVAC

PART IV

STANDARD TECHNICAL SPECIFICATIONS

for

AIR CONDITIONING AND VENTILATION INSTALLATIONS

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4.1. GENERAL

4.1.1. The Standard Technical Specifications are to be read in conjunction with the Detailed Technical Specifications as the latter are intended to amplify the former; only those portions of the Standard Technical Specification which apply to the actual project involved shall be pertinent.

4.1.2. Where Detailed Technical Specifications are at variance with Standard Technical Specifications the former shall prevail as its contents relate directly to the specific project.

4.1.3. Where reference is made to the sub-contractor, this shall be the contractor or sub-contractor appointed in terms of this contract or sub-contract as the case may be. All other specialist contractors or principle contractors associated on the project are defined specifically.

4.1.4. It is in the interests of the Sub-contractor to notify the Engineer when the installation reached various stages of completion in order that the Engineer may inspect the installation and point out discrepancies. These inspections shall be considered informal and under no circumstances shall they, in part or in whole, invalidate the requirements of the documents. Any costs incurred in correcting discrepancies shall be for the Sub-contractor's account.

4.2 CODES OF PRACTICE, LAWS AND STANDARDS

4.2.1 All workmanship and materials used in the execution of the works shall be of the highest class and, where not fully covered by the Specification, shall be carried out in conformity 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 whose jurisdiction embraces the location of the Site of the Works and the equipment provided for these installations which shall comply in every respect with:

a) National Building Regulations and Building Standard Act (Act 103 of 1977) as amended

b) Occupational Health and Safety Act (Act 85 of 1993) as amended

c) The relevant and applicable specifications and standards of the South African National Standards (SANS).

excepting only where exemption from any such regulations has first been obtained in writing from the said Authorities, provided that the prior approval of the Engineer has been obtained for the application for any exemption.

4.2.3 All electrical wiring shall comply fully with the latest edition of the Standard Regulations for the Wiring of Premises SANS 10142 and the additional requirements of any local authority that has jurisdiction over the Site of Works, as well as being in accordance with the best modern practice.

4.2.4 Wherever relevant, this Specification shall be understood to be amplified to embrace Codes of Practice and Standards promulgated by recognised authorities in the field of Air Conditioning, Refrigeration, Piping, Ventilation, Electrical Technology and all other branches of engineering science applicable to this project.

4.2.5 Standards referred to in this specification are the latest edition, including all amendments, published three calendar months or longer before the closing date of tender

4.2.6 It shall be assumed that the Subcontractor is conversant with the abovementioned requirements. Should any requirement, bylaw, or regulation, which contradicts the requirements of this document, apply or become applicable during the erection of the installation, such requirement, bylaw, or regulation shall overrule this document and the Subcontractor shall immediately inform the Engineer of such a contradiction. Under no circumstances shall the Subcontractor carry out any variations to the installation in terms of such contradictions without obtaining the written permission to do so from the Engineer.

4.2.7 It shall be the responsibility of the Subcontractor to make the necessary arrangements at his own expense with the local supply authority and to supply the labour, equipment and means to inspect, test, commission and to hand over the installation.

4.2.8 The Subcontractor shall supply and install all Notices and Warning signs that are required by the appropriate laws, regulations and/or by this document. . In addition a conformity plaque must be attached to each machine, with the following information written in English:

- Name and address of the Contractor
- Type of material
- Serial number in the type
- Date of manufacture
- Indication of conformity to the legislation of the country (*ce marking)*

4.2.9 The installation must not produce any risks, even potentially, with regard to the safety of the people, the goods and the environment, and in particular:

- Mechanical risks related to mobile moving elements
- Risk of fire and explosion
- Risk of burns related to the use of steam, refrigerant and hot water
- Risk of overpressure related to the use of steam and refrigerant
- Risk of overflow
- Electrical / electrostatic / lightning risks
- Risks of falling of persons or objects
- Risks of pollution
- Risks related to vibrations
- Risks related to noise
- Risks related to hazardous materials used
- Risk related to any of the surfaces finish (cuts, …) on all areas of implementation.
- The use of hazardous consumable materials must be kept to a minimum.

4.2.10 When so requested by the Engineer, provide evidence in the form of certificates, test reports or other written proof that material or components comply with the standards laid down in this specification.

4.2.11 Products that are specified as mark-bearing must bear the mark of the relevant standards body

4.3 CHILLED WATER GENERATORS

4.3.1 Chilled Water Generators shall be of the package type with rated capacity at site conditions at least as specified. The units shall be a standard catalogued item of the manufacturer with the performance tested

in accordance with a recognised authority. Full details of the equipment offered shall be submitted with the Tender.

4.3.2 Chillers shall be provided with a least two completely separate refrigeration circuits which can operate independently of each other.

4.3.3 Refrigerant circuits shall each be provided with a hot gas muffler, combination moisture indicator and sight glass, refrigerant filter drier, liquid line solenoid valve, thermal expansion valve and charging valve. The suction lines shall be insulated with close fitting cellular insulation.

4.3.4 Compressors shall be of the semi-hermetic type and shall have capacity control, self reversing positive displacement oil pump, serviceable oil filters, oil level sight glass and crankcase heater. The compressors shall be fully accessible and completely rebuildable locally.

4.3.5 Compressors shall be driven by a built-in three phase motors. Motors shall be cooled by suction gas passing around the motor windings and shall be thermally protected by embedded thermostats in the motor windings.

4.3.6 Condensers shall be of the shell and tube design and two separate refrigerant circuits. Water heads shall be removable to permit cleaning and replacing of tubes. Water connections shall be flanged. Condensers shall be constructed to provide positive sub-cooling of the liquid refrigerant and shall be complete with safety relief valves, purge cocks and liquid line shut off valves. The condenser capacities shall be sufficient to hold the full system refrigerant charge for pump down.

4.3.7 Water coolers (evaporators) shall be of the shell and tube type construction with removable heads and shall contain two direct expansion refrigerant circuits. Tubes shall be integrally finned seamless copper rolled into ground tube sheets. Shells shall be suitably insulated and vapour sealed.

4.3.8 Machines shall be fully factory wired, piped and charged. Control panels shall include all operating and safety controls as well as terminal strips for external power and interlocking connections. Panels shall incorporate suction and discharge pressure gauges, an oil pressure gauge, suction and discharge switches, oil pressure switch, low chilled water temperature cut-out and temperature controller controlling compressors and unloader sequential operation. Refrigerant connections to devices on the panels shall be flexible enough to prevent transmission of vibration and shall have shut-off valves.

4.3.9 Capacity control systems shall modulate compressor capacities automatically by means of built in chilled water temperature actuated controls. The compressors shall start by a sequence programmed start.

4.3.10 Reciprocating compressors shall be provided with stepped capacity control by cylinder unloading with at least four steps per compressor as well as hot gas bypass control.

4.3.11 Screw type compressors shall be provided with fully modulating control.

4.4 PACKAGED AIR CONDITIONING UNITS - WATER COOLED

4.4.1 Water cooled packaged air conditioning units shall consist of the following components all housed within, or forming part of, their steel cabinets:

Refrigeration compressor(s)
Water-cooled condenser(s)
Refrigeration pipework and controls
Refrigerant gas charge
Direct expansion cooling coil
Centrifugal supply air fans
Motor and vee-belt drive to fans
Cleanable air filters
Electrical switchpanel
Internal electrical wiring.

4.4.2 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 serve the purpose of holding all internal equipment in position. The casing panels shall be internally insulated with `Fibreglass' or equivalent non-combustible material, such insulation being adequately secured to the internal surface of the cabinet with a non-combustible adhesive, whilst exposed surfaces of the insulating material shall be coated or covered with a suitable bonding agent to disallow shedding of the material into the packaged unit. The casing and framework shall be thoroughly degreased and then painted with a suitable rust proofing primer prior to the application of two finishing coats of good quality enamel or lacquer in the standard colour of the manufacturer. Openings for condenser water lines, condensate drain lines and power supply lines, shall be provided on one side of the cabinet. The openings shall be provided with rubber grommets.

4.4.3 Compressors shall be of the serviceable hermetic type equipment with suitable type vibration isolators and crank case heater. Compressors shall be located in a sound attenuating compartment located in the unit cabinet. The compressor shall be protected against low oil pressure and excessive winding temperature.

4.4.4 Water cooled condensers of the tube in tube, shell and tube or shell and coil type shall be provided on each refrigerant circuit. The condenser shall incorporate a pressure relief device to comply with Government regulations. All tubing within the condensers shall be copper. Unless otherwise specified, the condenser shall be selected for a fowling factor of not less than 0,000176 m^2C/w. Threaded pipe connections shall be provided for water supply and return line.

4.4.5 Refrigeration pipework shall be carried out in seamless refrigeration quality copper tubing, suitable provision being made that the piping is not subjected to any stresses by vibration from the compressor(s). Refrigerant circuits shall incorporate replaceable type filter-dryers, sight glasses and thermostatic expansion valves and shall be factory charged with Refrigerant 22.

4.4.6 Automatic controls within the unit shall include a dual pressure refrigerant switch with manual reset on the high pressure side. Units which do not incorporate pump-down control shall incorporate timing devices to delay starting of compressors in such a manner that refrigerant pressures may first balance between stopping and starting of same.

4.4.7 Supply fans shall be of double inlet forward-curved centrifugal type with their impellers running in sealed, permanently lubricated, ball-bearing plumber blocks located in the suction eye on each side 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 packaged conditioner 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.

4.4.8 Fan motors shall be three-phase squirrel cage type and run at not exceeding four-pole synchronous speed. The motor shall drive the fans via vee belt drive(s), each drive having not less than TWO vee belts.

4.4.9 Direct expansion cooling coils shall comprise of aluminium plate fins mechanically bonded to seamless copper tubing. The coils shall be encased in heavy gauge galvanised steel casing and fitted with a 1,4mm thick rust proofed steel condensate pan so sized and located as to prevent entrainment of condensed moisture into the air stream whilst also ensuring positive drainage of condensate to the drain connection point of adequate size.

4.4.10 Air Filters shall be equal to WASHPLEAT high performance washable pleated panel type housed in adequate holding frames fitted with gaskets to ensure a positive airtight seal around them. Should throw-away filters be the standard of the manufacturer of the packaged conditioner, they shall be discarded, and the foregoing specified type provided in their place.

4.4.11 Electrical Switch panels shall be incorporated to house all switchgear required to operate the various components within the unit. The switch-panel shall comply with best modern practice and incorporate all

necessary protection against overload or short-circuit, being fitted also with a main incoming isolator of sufficient capacity. The electrical equipment shall be fully interlocked so that the compressor cannot operate unless the remote condenser water pump is first operational and the supply air fans are running.

4.4.12 Compressor motors up to, but not exceeding 15 kW each may be started direct-on-line on application to the local authorities. Tenderers shall therefore base their pricing on the assumption that the local authority will grant an application to start compressor motors up to 15 KW each direct-on-line.

4.4.13 Compressor motors above 15 kW will have to be part-winding started and fan motors above 3,7 kW will have to be star-delta started.

4.4.14 Should the standard electrical motor starting arrangements provided by the manufacturer of the packaged air conditioning units not comply with the foregoing, the Contractor will be required to make the necessary modifications to the units to meet these requirements.

4.4.15 Internal electrical wiring shall comply fully with wiring regulations, as relevant, and be adequately secured such that it does not hang loose or exposed where it could be damaged. Adequate earthing shall be allowed.

4.5 PACKAGED AIR CONDITIONING UNITS - AIR COOLED

4.5.1 Air Cooled packaged air conditioning units shall be suitable in all respects for the unprotected outdoor location.

4.5.2 Unit(s) shall consist of the following components all housed within, or forming part of, its steel cabinet:

Refrigeration Compressor(s)

Air-cooled condenser coil(s)

Condenser fans and motors

Refrigeration pipework and controls

Refrigerant gas charge

Direct expansion cooling coil(s)

Centrifugal supply air fans

Motor and vee-belt drive to fans

Electrical heater elements

Cleanable air filters

Electrical switchpanel

Internal electrical wiring

4.5.3 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 serve the purpose of holding all internal equipment in position. The casing panels shall, unless otherwise specified, be double skin internally insulated with `Fibreglass' or equivalent non-combustible material, such insulation being adequately secured to the internal surfaces of the cabinet with a non-combustible adhesive. Exposed surfaces of the insulating material shall be coated or covered with a suitable bonding agent to disallow shedding of the material into

the packaged unit. All mild steel casing panels and framework shall be thoroughly degreased and then painted with a suitable rust proofing primer prior to the application of two finishing coats of good quality enamel or lacquer in the standard colour of the manufacturer.

4.5.4 Units shall contain either a single refrigeration compressor or may be fitted with multiple compressors. Refrigeration compressors shall be of the hermetic or the accessible hermetic type direct driven by integral suction gas cooled squirrel cage motors at the rotational speed of not exceeding 1500 R.P.M. Compressors shall be mounted on helical spring type vibration mountings. Hermetic motors shall be protected against excessive winding temperatures. The compressors shall be complete with positive displacement reversible force-feed lubrication systems, have low oil pressure protection devices and contain crankcase oil heaters to ensure boil-off of dissolved refrigerant from lubricating oil at such times as when the compressors are stationary.

4.5.5 Units incorporating only one compressor shall be provided with at least two stages of capacity modulation other than full load and shall also be arranged to start in an unloaded position.

4.5.6 Condenser coil(s) shall, unless otherwise specified, consist of copper tubes fitted with mechanically bonded aluminium plate fins, all housed in a robust galvanised steel frame and protected with a suitable galvanised wire mesh screen to prevent mechanical damage to the coil due to hail.

4.5.7 Condenser fans shall be of the slow-running propeller type direct or belt driven by squirrel cage electric motors. The unit shall be provided with a minimum of four or more propeller fans which shall be arranged for vertical discharge through suitably weather-proofed protective wire guards which guard shall provide adequate hail protection. The fan and motor bearings shall be of the permanently lubricated sealed type and the motors shall be resiliently mounted so as not to transmit vibrations to the unit casing.

4.5.8 Condenser air intake and discharge arrangements shall be such that no short-circuited discharge air can be drawn back into the air intake.

4.5.9 Refrigeration pipework shall be carried out in seamless refrigeration quality copper tubing, suitable provision being made that the piping is not subjected to any stresses by vibration from the compressor(s). The refrigeration system shall be split into at least two stages on the liquid side for adequate capacity control. Refrigerant circuits shall incorporate replaceable type filter-dryers, sight glasses, thermostatic expansion valves as well as vapour-proof insulation on the suction lines. The unit shall be factory-charged with refrigerant.

4.5.10 Automatic controls within the unit shall include a dual pressure refrigerant switch with manual reset on the high pressure side and an oil pressure switch with manual reset.

4.5.11 Provision shall be made for pressure relief of the high side refrigerant piping in compliance with government regulations. Provision shall also be made for cycling the condenser fans so that the unit may be capable for operating at full load, down to an ambient temperature of 5ºC db.

4.5.12 Direct expansion cooling coils shall consist of at least two separate refrigerant circuits and shall comprise copper tubes with mechanically bonded aluminium fins. The coil shall be encased in a heavy gauge galvanised shell casing and fitted with a 1,4mm thick rust proofed steel condensate pan so sized and located as to prevent entrainment into the air stream of condensed moisture, whilst also ensuring positive drainage of condensate to a drain connection point of adequate size.

4.5.13 An anti freeze thermostat shall be provided to sense the return air temperature and arranged to reduce the cooling steps available on the compressor and prevent icing of the evaporator coil when the return air temperature is low.

4.5.14 Supply fans shall be of double inlet forward-curved centrifugal type with their impellers running in sealed, permanently lubricated, ball-bearing plumber blocks located in the suction eye on each side 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 packaged conditioner 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.

4.5.15 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 not exceeding four-pole synchronous speed. The motor shall drive the fans via a vee belt drive having not less than two vee belts.

4.5.16 Heater elements shall be of the factory-bent Incoloy type, rated for still air and fitted into the casing in such a manner as to ensure full air flow over each element. The heater elements shall be fitted into a withdrawable fabricated galvanised sheet metal channel frame. The side on which the terminals are located shall be fitted with a terminal box of sufficient size to contain all necessary electrical wiring, the terminal box being fitted with a removable weatherproofed cover so fastened that no screw shall project into the actual terminal box. The electrical wiring within the terminal box shall be effected in Asbestos-Insulated copper wiring capable of withstanding the temperatures to be encountered without breakdown of the insulation.

4.5.17 Air Filters shall be equal to WASHPLEAT high performance washable pleated panel type housed in adequate holding frames fitted with gaskets to ensure a positive airtight seal around them. Should throw-away filters be the standard of the manufacturer of the packaged conditioner, they shall be discarded and the foregoing specified type provided in their place.

4.5.18 A weatherproof electrical switchpanel shall be incorporated to form part of the unit and shall house all switchgear required to operate the various components within the unit. The switchpanel shall comply with best modern practice and incorporate all necessary protection against overload or short-circuit, being fitted also with a main incoming isolator of sufficient capacity. The electrical equipment shall be fully interlocked so that cooling and heating cannot operate simultaneously and so that the compressor cannot operate unless the condenser fans are first operational and the supply air fans are running.

4.5.19 Wiring within the panel and the unit shall comply with wiring regulations as relevant and shall be neatly grouped to horizontal and vertical runs and bound with P.V.C. tape. All wiring shall also be colour-coded in the colours red, yellow and blue for the relevant phases and black for neutral, and 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, connection strips, etc., must be fully insulated in P.V.C. tape of the colours mentioned above. All outgoing leads shall be connected to a marked terminal strip.

4.5.20 Panels shall be fully labelled with black Ivorine labels having 5mm high white lettering and riveted to the cover plates previously referred to. Labels which are merely affixed with adhesive will NOT be acceptable.

4.6 REFRIGERATION CONDENSING UNITS - AIR COOLED

4.6.1 Air Cooled refrigeration condensing units shall be suitable in all respects for the unprotected outdoor location and shall comprise essentially of the following components all factory assembled onto a rigid framework constructed of mild steel sections, and housed within, or forming part of its steel or fibreglass cabinet:

Refrigeration Compressor(s)

Air-cooled condenser coil(s)

Condenser fans and motors

Refrigeration pipework and controls

Refrigerant gas charge

Electrical switchpanel

Internal electrical wiring.

4.6.2 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 serve the purpose of holding all internal equipment in position. All mild steel casing panels and framework shall be thoroughly degreased and then painted with a suitable rust-proofing primer prior to the application of two finishing coats of good quality enamel or lacquer in the standard colour of the manufacturer.

4.6.3 Units shall contain either a single refrigeration compressor or may be fitted with multiple compressors. Refrigeration compressors shall be of the serviceable hermetic type direct driven by integral suction gas cooled squirrel cage motors at a rotational speed of not exceeding 1500 R.P.M. Compressors shall be mounted on helical spring type vibration mountings. Hermetic motors shall be protected against excessive winging temperatures. The compressors shall be complete with positive displacement reversible force-feed lubrication systems, have low oil pressure protection devices and contain crankcase oil heaters to ensure boil-off of dissolved refrigerant from lubricating oil at such times as when the compressors are stationary.

4.6.4 Units incorporating only one compressor shall be provided with at least two stages of capacity modulation other than full load and shall also be arranged to start in an unloaded position.

4.6.5 Condenser coil(s) shall consist of copper tubes fitted with mechanically bonded aluminium plate fins, all housed in a robust galvanised steel frame and protected with a suitable galvanised wire mesh screen and hail guard.

4.6.6 Condenser fans shall be of the slow-running propeller type direct or belt driven by squirrel cage electric motors. The unit shall be provided with a minimum of four or more propeller fans which shall be arranged for vertical discharge through suitably weather-proofed protective wire guards. The fan and motor bearings shall be of the permanently lubricated sealed type and the motors shall be resiliently mounted so as not to transmit vibrations to the unit casing. The fans shall be protected against hail.

4.6.7 Refrigeration pipework shall be carried out in seamless refrigeration quality copper tubing, suitable provision being made that the piping is not subjected to any stresses by vibration from the compressor(s). The refrigeration system shall be split into at least two stages on the liquid side for adequate capacity control. Refrigerant circuits shall incorporate replaceable type filter-driers, sight glasses, thermostatic expansion valves as well as vapour-proof insulation on the suction lines.

4.6.8 The unit shall be factory-charged with a refrigerant acceptable in terms of the Montreal protocol and approved by the engineer.

4.6.9 Automatic controls within the unit shall include a dual pressure refrigerant switch with manual reset on the high pressure side and an oil pressure switch with manual rest.

4.6.10 A weatherproof electrical switchpanel shall be incorporated to form part of the unit and shall house all switchgear required to operate the various components within the unit. The switchpanel shall comply with best modern practice and incorporate all necessary protection against overload or short-circuit, being fitted also with a main incoming isolator of sufficient capacity. The electrical equipment shall be fully interlocked so that the compressor cannot operate unless the condenser fans are first operational.

4.6.11 Wiring within the panel and the unit shall comply with wiring regulations as relevant and shall be neatly grouped to horizontal and vertical runs and bound with P.V.C. tape. All wiring shall also 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 b copper of adequate cross-sectional area, suitably spaced and mounted on stand-off type porcelain insulators, all exposed current-carrying parts, connection strips, etc., must be fully insulated in P.V.C. tape of the colours mentioned above. All outgoing leads shall be connected to a marked terminal strip.

4.6.12 Panels shall be fully labelled with black ivorine labels having 5mm high white lettering and riveted to the cover plates previously referred to. Labels which are merely affixed with adhesive will NOT be acceptable.

4.7 ROOM AIR CONDITIONING UNITS

4.7.1 Room air conditioning units shall be self contained units consisting of unit casings, compressor, evaporator, evaporative fan, condenser, condenser fan, expansion device, refrigerant pipework and controls. The condensing unit shall either form an integral part of the unit for through the wall applications or be separate for split system applications.

4.7.2 Unit casings shall be of sheet metal construction with a baked enamel finish to give an aesthetically pleasing effect as well as ensuring corrosion resistance.

4.7.3 Evaporator fans shall be of the double inlet centrifugal type with integral motor centrally located on a common drive shaft. The motor fan assemblies shall be installed to provide an even air flow across the evaporators as well as the discharge grilles.

4.7.4 Evaporators shall be aluminium fins on copper coil construction and installed to ensure that there is effective condensate drainage for the coil without carry over.

4.7.5 Condensate trays shall be provided under the evaporator to collect condensate. The tray shall be stainless steel, polyurethane or similar non corrosive material.

4.7.6 Condensate shall be disposed of at the condensing unit by evaporating the condensate on the warm condenser coils.

4.7.7 Filters, of the washable type, shall be provided behind the return air grilles. Filters shall be easily removable. Return air grilles on console and split console units shall be positioned in the front facia to enable the units to be mounted on the floor.

4.7.8 Room temperature shall be controlled by means of a thermostat which will automatically switch the compressor or heater on and off. The temperature setting shall be adjustable within an acceptable comfort range.

4.7.9 Compressors shall be of the totally hermetic dome type to operate on 220 volt single phase power supply. Compressors shall be protected against overload.

4.7.10 Condenser coils shall be copper tubes with copper fins for all coastal applications. For inland areas aluminium fins will be accepted.

4.7.11 Condenser fans shall be either propeller or of the centrifugal type and driven by means of a two speed motor arranged to automatically control refrigerant head pressure.

4.7.12 Console units shall be provided complete with wall sleeves, weather louvres and external architraves. Wall sleeves shall be handed to the builder for building in. It is the responsibility of the Subcontractor to ensure that sleeves are installed correctly and the builder shall be provided with detailed instructions regarding installation requirements.

4.7.13 Refrigerant piping for split air conditioning units shall be installed as specified herein. Reference shall be made to the manufacturer's specification regarding pipe sizes, refrigerant lift and pipe lengths. Precaution s shall be taken to ensure efficient oil return compressors and where required, additional oil shall be introduced into the system.

4.7.14 Units shall be suitably insulated to ensure quiet operation.

4.8 AIR HANDLING UNITS

4.8.1 Air handling units may be provided as complete proprietary packages and suitably adapted to meet the specification requirements or alternatively, complete built up air handling units may be offered.

4.8.2 Casings downstream of the coil and including coil sections shall be double skin insulated, to include top, side and bottom panels. Casings upstream of the coil shall be single skin insulated panels.

4.8.3 Panels shall be manufactured from the following materials;

4.8.3.1 Two skins of minimum 1mm thick galvanised mild steel or 3 CR 12 of 304 stainless steel or 1,5mm aluminium sheet metal sandwiching 50mm of insulating materials being foam polyurethane having a density of not less than 36 kg/m.

4.8.3.2 Galvanised, Aluminium and 3 CR 12 sheet metal surfaces shall be painted internally and externally and finished with high gloss epoxy enamel after suitable corrosion protection.

4.8.3.3 Stainless steel casings shall be finished with two coats of high gloss epoxy suitably applied.

4.8.4 Panels shall be fastened together using suitable inert fasteners. The assembled casings shall be air tight with joints between panels sealed by the application of a suitable silicone sealant during construction.

4.8.5 Casings support framework shall be 304 stainless steel sheet metal sections. Stiffening of the casings shall be provided to eliminate drumming under operating conditions.

4.8.6 Condensate trays shall be provided under the complete coil sections to catch any condensate including that due to carry over. Condensate trays shall be suitably insulated with a minimum of 15mm thick isosinurate foam faced with an additional aluminium foil vapour barrier to prevent condensation.

4.8.7 Coil sections shall have heavy duty coil tracks extending the full width of the unit to provide slip-in, slip-out coils for easy service and maintenance. Where cooling coils are stacked, they are to have intermediate drain pans with drop tubes at each end to drain condensate to the main drain pan without flooding the lower coil.

4.8.8 Cooling coils are to be ripple corrugated plate fins on staggered copper tubes. Fins shall have bevelled collars and shall be bonded to the tubes by mechanical expansion. The minimum fin spaces shall not be less than 8 fins per 25mm.

4.8.9 Design of the air handling unit shall ensure an even distribution across the coil banks without leakage between or around the coils.

4.8.10 Fans incorporated within the casings shall be of the double inlet double width centrifugal type as later specified herein, refer Clause 4.22.

4.8.11 Access doors shall be provided on the units to give access to the fan, filter and coil sections. Door openings shall be not less than 600 x 600mm. Doors shall be manufactured similar to the unit panels and door frameworks and appurtenances shall be constructed of stainless steel. The doors shall be hinged and provided with cam locks which can be operated from either side of the door.

4.9 FAN COIL UNITS

4.9.1 Units shall be of the type and arranged for the mounting or as later specified herein and shall consist of the following components all housed within, or forming part of their steel cabinets:

Chilled water fed cooling coil and controls

Electric heater battery

Centrifugal supply air fans

Motor with direct drive to fans

Cleanable air filters

Internal electrical wiring

4.9.2 Casings shall be constructed of not less than 1,0mm thick mild steel panels suitably braced or 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. The casing panels shall be internally insulated with non-combustible material, such insulation being adequately secured to the internal surfaces of the cabinet with a non-combustible adhesive. The casing and framework shall be thoroughly degreased and then painted with a suitable rust proofing primer prior to the application of two finishing coats of good quality enamel in the standard colour of the manufacturer.

4.9.3 Coils shall comprise of aluminium plate fins mechanically bonded to seamless copper tubing. The coils shall be encased in heavy gauge galvanised steel casings. Units with cooling coils shall be provided with insulated condensate drip pans extended on the coil connection side so as to accommodate condensation from pipe connections and valves.

4.9.4 Fans shall be centrifugal, forward curved, double width constructed of corrosion resistant aluminium. Fan scrolls shall be of moulded reinforced plastic for maximum corrosion resistance.

4.9.5 Motors shall be wound for three speeds and of shaded pole construction with bronze sleeve type bearings with oil reservoirs.

4.9.6 Filters shall be easily accessible and shall be of the cleanable plastic foam type in a rigid frame.

4.9.7 Supply air grilles shall be multi-directional of extruded aluminium or plastic.

4.9.8 Valves and all automatic controls shall be incorporated as later specified herein.

4.10 REFRIGERATION PIPEWORK

4.10.1 Refrigeration pipework between refrigeration condensing units and direct expansion cooling coils in air handling units shall be installed in full accordance with the relevant diagrams.

4.10.2 Refrigeration piping shall be carried out in seamless, bright, clean refrigeration quality copper tubing received from its suppliers with capped or sealed ends. 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. Joints on soft copper lines shall be flared type, forged or drawn brass fittings similar or equal to 'Mueller-Brass' being used. For joints on hard drawn copper lines use sweat fittings in conjunction with a suitable flux and silver solder. All pipe cuts shall be neatly reamered and cleaned prior to making joints. When brazing any refrigeration pipework, dry nitrogen must be bled through system continuously to stop any build-up of oxidisation in the system.

4.10.3 Liquid refrigerant lines shall incorporate the following components should they not be included within the refrigeration condensing units:

Y-type full-flow strainers

Isolating valves of the diaphragm type to the filter dryers

Moisture-indicating type single part 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 expansion valves of the external equaliser type, at the air handling units

4.10.4 Vibration eliminators of 'ANACONDA' or equal make shall be installed in the positions indicated on the diagrams.

4.10.5 Suction lines shall be vapour-proof insulated with 38mm thick preformed 'ARMAFLEX' sections.

4.10.6 Refrigeration pipework shall be supported at not exceeding 2m centres. Pipes shall be securely clamped to points of support using suitable holderbats. Insulated piping shall have moulded cork inserts of 50mm thickness in place of normal insulation where supports occur, vapourproofing at such positions being carefully executed.

4.10.7 All refrigeration pipework passing through plantroom walls shall have moulded cork surrounds of 50mm thickness by width not less than that of the wall, vapourproofing at such positions being carefully executed.

4.10.8 The sensing bulb of the thermostatic expansion valves shall be securely fastened to the suction lines using copper strip and brass screws, then insulated.

4.10.9 Particular care shall be exercised to ensure that pipework is neatly run in straight lines, this applying the more so to soft copper tubing. Pipes shall pitch 25mm in 6m in the direction of flow to prevent oil traps. No pipes shall be left opened for any period of time.

4.10.10 Oil traps shall be provided on all risers and where necessary, dual risers shall be installed to ensure proper oil return.

4.10.11 All refrigerant pipework shall be colour coded to enable immediate identification at any part of the run at approximately 3 metre intervals.

4.11 REFRIGERANT CHARGE

4.11.1 Refrigerant piping systems shall be charged with refrigerant after evacuation and testing for leaks as outlined below, it being required that the Subcontractor guarantee the installation with respect to loss of refrigerant for the full guarantee period applicable to the Works.

4.11.2 Completed refrigerant circuits shall be tested by means of dry Nitrogen to a pressure of at least 50% above working pressure.

4.11.3 With the system under the pressure of the Nitrogen, brush all possible points of leakage with a solution of soap and water to which a few drops of Glycerine have been added. All soldered joints shall be tapped on with a hammer to break possible flux seals. Any leaks which may be found due to bubbling of the soapy water should be made good after the Nitrogen has first been released. "Patching-up" of a leaking joint is not permitted; the fitting shall be taken out, cleaned and resoldered into the pipework again.

4.11.4 Systems should next be charged with Refrigerant to a minimum pressure of 200 kPa and then be 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.

4.11.5 Systems found to be free of leaks should be allowed to remain under the pressure for a 24-hour period. If no pressure drop is observed after this period, due cognisance being taken of ambient air temperatures, the Nitrogen mixture may be discharged to atmosphere.

4.11.6 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, no pressure rise having occurred, may be charged with refrigerant via the charging valve.

4.11.7 The refrigerant charge shall be sufficient to ensure the correct evaporative and condensing temperatures to ensure efficient operation of the plant.

4.11.8 Make reference to manufacturer's instructions to ensure correct refrigerant charge dependent on length of pipe runs. When recommended pipe runs are exceeded, make reference to manufacturer's instructions regarding additional oil charge. The Subcontractor shall provide the recommended refrigerant and oil charge.

4.12 COOLING TOWERS

4.12.1 Cooling towers shall be of such a capacity as to match the heat rejection requirements of the Water Cooled refrigeration plant whilst being selected in accordance with the air entering wet bulb temperature given in Part V of the Specification.

4.12.2 Cooling towers shall be of the forced draft type, rectangular in shape and of sectional steel construction. Towers shall consist of three removable sections namely, the fan section, water spray and eliminators section, the third section forming the sump and air distribution plenum.

4.12.3 Forced draft fan sections shall consist of a double inlet forward bladed centrifugal fan fitted into rectangular steel-clad framework so as to form rectangular air entry plena on either side of the fan's suction eyes. The air entrances to the foregoing plena shall be protected with readily removable wire mesh guards. Fan shafts shall be extended beyond one side of the rectangular casing so as to be capable of accepting an outboard driving pulley. Fan bearings shall be located on either side of the rectangular casing accessible via the removable air inlet screens and be of the self-aligning sleeve type. The fan's air volume shall be readily controlled by means of a single aerofoil-bladed damper vane located in the fan discharge and arranged so as to accept readily a damper motor controller.

4.12.4 Driving motors serving the cooling tower fans shall be of the totally enclosed fan cooled squirrel cage three phase type and run at a speed of not exceeding 1500 rpm. The motors shall be mounted on a suitable adjustable base for belt tensioning, the base being located on top of the fan section previously specified. Belt drives shall be adequately rated and shall consist of not less than TWO vee belts and be fitted with a substantial drive guard.

4.12.5 Sump and air distribution sections shall be constructed of heavy gauge hot dip galvanised steel and be complete with the following built-in components:

Fan discharge evase, sloped to disallow water entering the fan and projecting well into the cooling tower.

Access panels, readily removable and watertight.

Pump suction screens, easily removable for cleaning.

Pump suction pipe connections and internal intake piping, all arranged to disallow water cavitation.

Ball-float make-up with suitable provision for mains water supply connections.

Eliminator and water distribution sections shall be of like construction to the sump and air distribution section, and shall each house:

A wet deck tower fill of efficient design constructed of non-corrodible modular metal sections coated with rustproof bitumenised paint, or formed plastic sections.

A spray tree consisting of a galvanised steel pipework header, similar branches and readily removable non-clog brass atomising spray nozzles.

Hot dip galvanised steel moisture eliminators, arranged in easily removable frame sections and of good efficiency.

All necessary supports for the foregoing items.

4.12.6 Cooling towers shall be heavily paint-coated with a high quality corrosionproof paint, which paintwork shall be made good as required once the tower has been installed.

4.12.7 Cooling towers shall be the product of an acknowledged and reputable manufacturer of the type to produce the heat rejection capacity specified in Part V of these Specification.

4.12.8 Bases shall be provided in accordance with the manufacturer's instructions. Cooling towers shall be mounted on suitable R.S.J.s which in turn shall be mounted on vibration insulators all to ensure that the tower does not distort or leak.

4.13 CLOSED CIRCUIT COOLING TOWERS

4.13.1 Unit construction shall be all hot dip galvanised steel and shall consist of a fan section, water spray and eliminator section, sump and plenum section, circulating pump and heat exchanger section.

4.13.2 Forced draught fan sections shall consist of double inlet forward curved centrifugal fans as later specified herein, refer Clause 4.22. Fan housings shall be arranged to prevent water from entering the fans. Fans shall be statically and dynamically balanced. Fan bearings shall be self aligning ball bearings, suitable for a 200 thousand hour average life. Fan shafts shall have exposed surfaces coated with a rust preventative.

4.13.3 Fan motors shall be suitable for outdoor operation and shall be mounted on an adjustable base for belt tensioning. Fans shall be driven through V-belt drives. The motor nameplate power shall exceed the brake power by a minimum of 15% and the motors shall be suitable for the starting method as later specified herein, refer Clause 4.23.

4.13.4 Belt drives shall be designed for a minimum of 25% overload with no less than two matched belts being used. Belts shall be selected and installed in accordance with BS 3790 1973.

4.13.5 Pulleys shall be of the taper lock type and shall be accurately keyed to the shafts and aligned before the system is put into operation.

4.13.6 Belt guards shall be provided and arranged to permit oiling, use of tachometers and other testing and maintenance operations with the guard in place. Guards shall have a front screen of expanded metal.

4.13.7 Heat exchanger sections shall consist of galvanised steel tube bundles enclosed in galvanised steel panels. The entire section shall be removable from the fan and water distribution system. Tube bundles shall have sloping tube to permit the free drainage of the fluid. A vent connection shall be provided at each tube bundle.

4.13.8 Eliminator and water distribution sections shall house wet deck tower spray trees and drift eliminators. Eliminators shall be constructed of extra heavy coated hot dip galvanised steel and shall be removable in easily handled sections. They shall have a minimum of three directional changes with a hooked leaving edge and shall direct leaving air away from the fans.

4.13.9 Pumps shall be of the close coupled centrifugal type with mechanical seals and completely piped to suction strainers and water distribution systems shall be provided and installed on the pan sections such that the suction is flooded at all times and that the pumps will drain freely when the sump is drained.

4.13.10 Sumps shall have sufficient capacity so that air will not be entertained in the outlets when operating and no water will overflow on shut down. Sumps shall be provided with an outlet connection, overflow, valved drain, quick fill and float controlled water make-up. Outlet connections shall be equipped with a suction strainer with mesh size sufficient to retain matter which could block the spray nozzles.

4.13.11 The entire unit shall be mounted on a separate steel base frame.

4.13.12 The unit shall be painted with a high quality corrosion-proof paint, which paintwork shall be made good after installation.

4.14 EVAPORATIVE CONDENSERS

4.14.1 Unit construction shall be all hot dip galvanised steel and shall consist of a fan section, water spray and eliminator section, sump and plenum section, circulating pump and heat exchanger section.

4.14.2 Forced draught fan sections shall consist of double inlet forward curved centrifugal fans as later specified herein, refer Clause 4.22. Fan housings shall be arranged to prevent water from entering the fans. Fans shall be statically and dynamically balanced. Fan bearings shall be self aligning ball bearings, suitable for a 200 thousand hour average life. Fan shafts shall have exposed surfaces coated with a rust preventative.

4.14.3 Fan motors shall be suitable for outdoor operation and shall be mounted on an adjustable base for belt tensioning. Fans shall be driven through V-belt drives. The motor nameplate power shall exceed the brake power of a minimum of 15% and the motors shall be suitable for the starting method as later specified herein, refer Clause 4.23.

4.14.4 Belt drives shall be designed for a minimum 25% overload with no less than two matched belts being used. Belts shall be selected and installed in accordance with BS 3790 1973.

4.14.5 Pulleys shall be of the taper lock type and shall be accurately keyed to the shafts and aligned before the system is put into operation.

4.14.6 Belt guards shall be provided and arranged to permit oiling, use of tachometers and other testing and maintenance operations with the guard in place. Guards shall have a front screen of expanded metal.

4.14.7 Heat exchanger sections shall consist of galvanised steel tube bundles enclosed in galvanised steel panels. The entire section shall be removable from the fan and water distribution system. Tube bundles shall have sloping tube to permit the free drainage of the liquid refrigerant. Tube bundles shall be tested to 2700 kPa air pressure while immersed in water.

4.14.8 Eliminator and water distribution sections shall house wet deck tower spray trees and drift eliminators. Eliminators shall be constructed of extra heavy coated hot dip galvanised steel and shall be removable in easily handled sections. They shall have a minimum of three directional changes with a hooked leaving edge and shall direct leaving air away from the fans.

4.14.9 Recirculating pumps shall be of the close coupled centrifugal type with mechanical seals and completely piped to suction strainers and water distribution systems shall be provided and installed on the pan sections such that the suction is flooded at all times and that the pumps will drain freely when the sump is drained.

4.14.10 Sumps shall have sufficient capacity so that air will not be entertained in the outlets when operating and no water will overflow on shut down. Sumps shall be provided with an outlet connection, overflow, valved drain, quick fill and float controlled water make up. Outlet connections shall be equipped with a suction strainer with mesh size sufficient to retain matter which could block the spray nozzles.

4.14.11 The entire shall be mounted on a separate steel base frame.

4.14.12 The unit shall be painted with a high quality corrosion-proof paint, which paintwork shall be made good after installation.

4.14.13 Evaporative condensers shall be of such a capacity as to match the heat rejection requirements of the refrigeration plant whilst being selected in accordance with the air entering wet bulb temperature given in the detailed Specification.

4.15 AIR COOLED CONDENSERS

4.15.1 Air cooled condensing units shall be suitable in all respects for the unprotected outdoor location and shall comprise essentially of the following components all factory assembled onto a rigid framework constructed of mild steel sections, and housed within, or forming part of, its steel or fibreglass cabinet:

Air-cooled condenser coil(s)

Condenser fans and motors

Refrigeration pipework

Refrigerant gas charge

Electrical switchpanel

Internal electrical wiring

4.15.2 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 serve the purpose of holding all internal equipment in position. All mild steel casing panels and framework shall be thoroughly degreased and then painted with a suitable rust proofing primer prior to the application of two finishing coats of good quality enamel or lacquer in the standard colour of the manufacturer.

4.15.3 Units shall contain either single or dual condenser coils to suit the refrigerant circuiting.

4.15.4 Condenser coil(s) shall consist of copper tubes fitted with mechanically bonded aluminium plate fins, all housed in a robust galvanised steel frame and protected with a suitable galvanised wire mesh screen and hail guard.

4.15.5 Condenser fans shall be of the slow-running propeller type direct or belt driven by squirrel cage electric motors. The unit shall be provided with a minimum of our or more propeller fans which shall be arranged for vertical discharge through suitably weatherproofed protective wire guards. The fan and motor bearings shall be of the permanently lubricated sealed type and the motors shall be resiliently mounted so as not to transmit vibrations to the unit casing. The fans shall be protected against hail.

4.15.6 Condenser air intake and discharge arrangements shall be such that no short-circuited discharged air can be drawn back into the air intake.

4.15.7 Refrigeration pipework shall be carried out in seamless refrigeration quality copper tubing, suitable provision being made that the piping is not subjected to any stresses by vibration from the compressor(s).

4.15.8 Provision shall be made for pressure relief of the high side refrigerant piping in compliance with Government regulations. Provision shall also be made for cycling the condenser fans so that the unit may be capable of operating at full load down to an ambient temperature of 0ºC db.

4.15.9 A weatherproof electrical switchpanel shall be incorporated to form part of the unit and shall house all switchgear required to operate the various components within the unit. The switchpanel shall comply with best modern practice and incorporate all necessary protection against overload or short-circuit, being fitted also with a main incoming isolator of sufficient capacity. The electrical equipment shall be fully interlocked so that the compressor cannot operate unless the condenser fans are first operational.

4.15.10 Wiring within the panel and the unit shall comply with wiring regulations as relevant and shall be neatly grouped to horizontal and vertical runs and bound with P.V.C. tape. All wiring shall also 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, connection strips etc., must be fully insulated in P.V.C. tape of the colours mentioned above. All outgoing leads shall be connected to a marked terminal strip.

4.15.11 Panels shall be fully labelled with black ivorine labels having 5mm high white lettering and riveted to the cover plates precariously referred to. Labels which are merely affixed with adhesive will **NOT** be acceptable.

4.15.12 All switch panels shall have phase failure, phase rotation and low voltage protection with automatic reset adjustable to a maximum period of 10 minutes.

4.16 FEED AND EXPANSION TANKS

4.16.1 Feed and expansion tanks shall be provided on hot water and chilled water installations to allow changes in density of this water to expand freely without damage to the piping systems.

4.16.2 Construction of the tanks shall be equal to Braithwaite sectional hot dip galvanised tanks, site assembled if necessary, with bolts and packings to their manufacturer's recommendations. Tops of the tanks shall be covered but a readily removable drop-in type inspection hatch shall be provided, the hatch complete with handles and vent.

4.16.3 Each tank shall also serve as water supply source for the system it is connected to and shall be complete with, but not necessarily limited to, the following fittings:

High pressure ball valve, with copper ball, 19mm for tanks less than 1800 litres, 25mm for tanks 1800 to 3600 litres and 38mm on larger tank capacities.

Quickfill valved connection, sized as for above ball-float valves.

Overflow and drain connections, 50mm pipe size for tanks up to 1800 litres capacity, 63mm size on 1800 to 3600 litres and 75mm pipe diameter for larger sizes.

Feed/expansion connection of 50mm pipe size for tanks up to 1800 litres capacity and 75mm on larger sizes.

4.16.4 Expansion tanks shall be sized by the air conditioning Subcontractor so that its contents between minimum level and full level are one-tenth of total water content of the system it serves. Minimum water level shall be 230mm from tank bottoms and expanded water level shall be 150mm below overflow connections.

4.16.5 Tanks mounted outside and exposed to the elements shall be insulated with 38mm thick heavy density fibreglass covered with 0,85mm galvanised sheetmetal jacketing and neatly finished, this applicable to tank sides only. The top of the tank need not be insulated but the bottom shall rest on 50mm thick hardwood planks suitably treated against rotting and insect attack.

4.16.6 Furnish sufficiently robust tank stands constructed of mild steel sections, the steelwork painted if indoor located and hot dip galvanised for exterior situations. Tank stands shall be complete with 450mm wide catladders where required to inspect water levels. Stands shall further comply with the relevant clauses on the Specification referring to Equipment Supports, refer clause 4.41.

4.17 WATER TREATMENT PLANTS

4.17.1 Evaporative cooling plants shall be provided with a chemical treatment plant which shall include chemical dosing to inhibit corrosion and scale formation and to protect the system against sludge formation and algae growth.

4.17.2 Cooling towers shall in addition, be provided with side stream sand filters with integral pump and backwash facility in order to filter the circulating water by drawing from the main distribution piping and returning the filtered water back into the system.

4.17.3 Closed circuit systems shall be treated with a chemical such as "Watergy 2753" or equal corrosion inhibitor and scale suppressant. The chemical treatment shall be applied only after the system has been flushed out and filled with clean water.

4.17.4 Subcontractors shall employ the service of a competent water treatment company regularly engaged in the water treatment to Air Conditioning Plant. The water treatment company employed shall provide all necessary service and operation training to ensure the efficient operation of the system.

4.17.5 Routine service of the water treatment plant shall be conducted at a minimum of 12 times during the guarantee period. The purpose of these service visits shall be to prevent potential problems from arising that will reduce equipment efficiency and result in equipment damage. Service reports shall be submitted to the Engineer detailing the work carried out at each service, problems encountered and what action was taken to rectify this.

4.17.6 The water treatment company employed shall have major laboratory back-up capabilities to assist in the solution of problems which may arise.

4.17.7 All water circuits shall include corrosion coupon monitoring with rates not to exceed 2,0 mls per year on mild steels.

4.17.8 Chemical dosing shall be automatic and the system shall include all necessary metering pumps, storage drums, conductivity monitor, bleed off control and all other appurtenances necessary for the efficient dosing and monitoring of the chemicals.

4.18 WATER PUMPS

4.18.1 Pumps shall be of the non-overloading, volute, centrifugal type, horizontal split, with bearing pedestals.

4.18.2 Volute casings shall be cast iron and overhung from heavy duty bearing pedestals. Casings shall have axial suction and radial discharge nozzles and shall be fitted with renewable case wear rings of spun cast iron.

4.18.3 Impellers shall be of the cast bronze radial type overhung and shall be dynamically balanced.

4.18.4 Shafts shall be chrome or stainless steel of sufficient diameter with withstand all stresses imposed and with a critical speed well above the maximum running speed. Shafts are to be supported axially and radially by two deep groove ball bearings built into the bearing pedestals.

4.18.5 Pumps are to be fitted with mechanical seals.

4.18.6 Pump casings shall be provided with an air vent cock at the highest point and a drain cock is to be provided at the lowest point.

4.18.7 Pumps shall be directly coupled to an electric motor which shall be of sufficient capacity to operate over the entire range of the pump without exceeding the motor power ratings.

4.18.8 Couplings between motors and pumps shall be by means of flexible couplings, "Fennerblex" or equal and approved. Couplings shall be provided with a removable galvanised sheet steel coupling guard, minimum 1mm thick, which shall be securely bolted to the bedplate of the pumps.

4.18.9 Characteristic curves for all pumps shall be stable over the entire operating range. Pumps shall operate at or near the point of peak efficiency, permitting operation at capacities approximately 25% beyond the design capacity without exceeding the break-off point. The subcontractor shall submit pump curves for approval with shop drawings and verify the system resistance, including pressure drops through all components, in order to establish the pump head. Pumping heads indicated under the Schedule of Equipment Capacities Required, are merely a guide for tendering purposes.

4.18.10 Pumps and motors shall be mounted on a baseplate of either cast iron or fabricated steel of ample size and strength to hold the total assembly in correct alignment. Suitable drip trays shall also be provided and the baseplate is to be filled with concrete.

4.18.11 A pipe shall be run from each drain point on each assembly and shall terminate with a suitable gap over the nearest floor drain.

4.19 WATER PIPEWORK

4.19.1 General

4.19.1.1 Water piping systems shall be run to general routes indicated on the relevant drawings. Piping shall be arranged to maintain headroom, keeping access ways unobstructed, allowing pipe routes not to interfere with maintenance and adjustment of valves and equipment. Piping should be installed at right angles, parallel to surrounding walls, plumb and of as direct routing as possible. Provide offsets where required to pass columns, beams or other structural features while maintaining headroom and proper clearance for insulation where relevant.

4.19.1.2 Where pipe sizes are not indicated on drawings, pipes shall be sized for a maximum water velocity of 2,5m/s within plantrooms and all other piping shall convey water at a velocity not exceeding 2m/s.

4.19.2 Piping Materials and Strength

4.19.2.1 Chilled water piping shall be seamless steel in accordance with specifications to the ASTM 106 or API 5L GRD B Schedule 40. Piping 50mm and smaller shall have screwed or welded joints. Piping 65mm and larger shall have welded or flanged joints.

4.19.2.2 Condenser water piping shall be galvanised to BS1387 or SABS 62 for pipes up to 150mm nominal bore, and SABS 719 for pipe larger than 150mm.

4.19.2.3 Pipes shall be galvanised in accordance with SABS 763.

4.19.2.4 Where pipework is fabricated, this shall be hot dip galvanised after fabrication. No welding of galvanised pipe shall be permitted.

4.19.2.5 All drainage piping and similar open vented systems shall be galvanised or copper.

4.19.2.6 Mains water supplies shall be hand drawn copper with capillary fittings. Suitable dielectric couplings shall be provided at junctions between copper piping and any galvanised material to prevent electrostatic action.

4.19.3 Fittings

4.19.3.1 Long radius bends shall be used wherever possible, elbows only being permissible where limited space dictates their use.

4.19.3.2 Reductions in pipe sizes shall be effected with reducing sockets, bushing reducers not being allowable for this purpose.

4.19.3.3 Threaded fittings shall be malleable iron to S.A.B.S. 509-1975 Specification or wrought steel to BSS 1740 as relevant.

4.19.3.4 Welded fittings shall be genuine butt-weld fittings to BSS 1740. No welding of threaded fittings shall be permitted.

4.19.3.5 Strainers, screwed Y-Type on pipe diameters up to and including 50mm, flanged Y-type for piping up to 200mm diameter and flanged pot type on larger sizes. Screens shall be fitted with extraction handles for easy removal.

4.19.3.6 Gate valves, screwed brass with brass trim to S.A.B.S. 776-1975 on pipe diameters up to and including 50mm and flanged on larger sizes.

4.19.3.7 Globe valves, screwed bronze with bronze trim on pipe diameters up to and including 50mm and flanged type on larger sizes.

4.19.3.8 Check valves screwed bronze swing check bronze trim on pipe diameters up to an including 50mm and for 65mm and above wafer type double door spring closing Non-slam.

4.19.3.9 All flanged valves to comply with B.S. 4504 or S.A.B.S. 1123.

4.19.4 **Vents and Drains**

4.19.4.1 At all high points of water systems fit Spirax type 05 or equal automatic air vents with integral check valves. Each air vent shall be preceded by a gate valve to allow maintenance of air vents. Automatic air vents shall ensure positive removal of all air from water piping systems. At all low points of the system fit 15mm ball valves with hose unions, these valves so located that the entire piping systems can be completely drained. Fit such drain valves also at all equipment to allow complete drainage.

4.19.5 **Flexible Connectors**

4.19.5.1 At all equipment connections to vibrating equipment, or where shown on the Drawings, fit flexible connectors equal to VIBRO-FLEX. All flexible connectors to have flanged joints and be capable of 875 kPa or 1,5 times the system working pressure, whichever is the higher value.

4.19.6 **Pipe Joints**

4.19.6.1 Pipe joints shall be neatly made, all pipe cuts properly cleaned and reamered. At all connections to equipment use flanged joints or conical face unions for smaller pipe sizes up to 38mm nominal bore. Incorporate sufficient flanged joints, or unions to be the foregoing limited sizes to allow dismantling of sections to pipework which can readily be handled by one tradesman and one unskilled assistant. Use screwed joints on galvanised pipework up to and including 100mm nominal size and black piping up to and including 50mm nominal size. Welding joints shall be made with proper welding sockets. On black piping all sizes may be welded; where galvanised piping is called for above 150mm diameter, use black piping with welded joints and hot dip galvanise after welding. Screwed joints on piping up to 50mm shall utilise P.T.F.E. jointing tape equal to 3-M manufacture; for larger screwed joints use hemp and Stag or equivalent jointing compound. Flanged joints shall include Klingerite gaskets or equivalent. Caulking of joints will under no circumstances be acceptable.

4.19.6.2 Flanges for pipe jointing to BS 4504 or S.A.B.S. 1123 - 1977

4.19.6.3 Welded joints shall be carried out by certificated welders to BS 2633.

4.19.7 **Protection during Installation**

4.19.7.1 Plug open ends of piping, drains, fittings and equipment connections in a workmanlike manner during installation of pipework to keep systems free of rubble, dirt and other foreign matter.

4.19.8 **Pipe Supports**

4.19.8.1 Pipework shall be supported as later specified herein, refer Clause 4.41, at the following maximum centres:

50mm diameter and smaller	3,0m
65 to 100mm diameter	4,5m
125 to 150mm diameter	6,0m
200mm diameter and above	8,0m

4.19.9 **Expansion and Contraction**

4.19.9.1 Pipework installation shall allow generous latitude for expansion and contraction, supports for this purpose being of the roller cradle type. No pipework shall cause any stress on any equipment due to the thermal movement, nor shall it bend or distort from such factors. Fit expansion joints of the bellow type as required to comply with the foregoing and where indicated on the Drawings.

4.19.10 **Flushing and Testing**

4.19.10.1 Piping systems shall be tested, by means of a hydraulic pump to twice the operating pressure of the systems or 700 kPa whichever is the greater. Where this is not permissible due to the relevant maximum allowable piping working pressure, piping shall be tested to the limits set by such maximum allowable working pressure to the Engineers approval.

4.19.10.2 The Engineer shall be notified at least 48 hours prior to commencement of the tests. The pressure test shall be witnessed and approved by the Engineer or his representative.

4.19.10.3 The Contractor shall be responsible for all testing required by State and local authorities or other statutory bodies as requested by the Engineer, or required by the Specification. The Contractor shall provide four sets of all test certificates, witnessed by the Contractor's Authorities, and Engineer's Representative, and detailed so as to identify the area tested.

4.19.10.4 Acceptance of a test by the Engineer will not relieve the Contractor of responsibility for proper materials and workmanship. It shall be the Contractor's responsibility to test all piping, valves, fittings and other items erected by the Contractor in accordance with the Local South African Standard.

4.19.10.5 The Contractor shall remove all safety valves, gauges, instruments and items which could be damaged by the test pressure and shall supply and install blanks, blinds or temporary fittings for testing. The Contractor shall remove blinds, blanks or temporary fittings and replace safety valves, gauges and items which could be damaged by the test pressure on satisfactory completion of the test.

4.19.10.6 The Contractor shall supply all test equipment and materials.

4.19.10.7 The Contractor shall be responsible for the removal of water used in flushing and testing from all piping systems, including attached equipment.

4.19.10.8 Where temporary lines are required for draining, these shall be supplied by Contractor and removed after use, leaving the area in its original condition.

4.19.10.9 Where removal of all moisture or special cleaning is necessary, the method may be specified as additional to any other procedure which follows.

4.19.10.10 All lines and attached equipment shall be thoroughly flushed and cleaned before testing, usually by washing with water. The Contractor shall supply and install temporary flushing screens on the upstream side of all equipment, and shall remove same on completion of flushing. The Contractor shall be responsible for the removal of all resulting debris from the premises.

4.19.10.11 During flushing, all flanged elbows etc., noted as being for flushing purposes will be removed by the Contractor until the flushing has been completed to the Engineer's satisfaction.

4.19.10.12 All such flanged elbows etc., will be re-installed after completion of flushing out and before hydrostatic testing.

4.19.10.13 The Contractor shall be responsible for any and all damage resulting from a test pressure more than ten per cent higher than specified by the Engineer. The Contractor shall supply a safety or relieve value which shall be used at the pressure source to protect systems under test. The Contractor shall be responsible for venting all sections of piping systems, vessels and equipment while flushing, testing and draining to ensure against their collapse by vacuum.

4.19.10.14 Variations of pressure and volume due to temperature changes will be taken into account by the Engineer during pressure testing and the Contractor will be responsible for measuring and recording the average ambient air temperature at the beginning and completion of any test to support any claim for pressure drop due to temperature change. Such temperatures may be checked by the Engineer by reference to an independent body.

4.19.10.15 In the event of a pipeline system failing a test, a new test shall be applied after repairs and corrections have been made. Under no circumstances may repairs and connections be made whilst the pipeline is filled with water.

4.19.10.16 After completion of repairs, the lines will be re-filled, vented, pressurised and tested, including any parts which may have passed a test but which, in the opinion of the Engineer may have been affected by the repairs.

4.19.10.17 The Contractor shall supply test pressure gauges which shall either be dual scale test type gauges, or, if single, indicating scale types, a second gauge shall be used immediately adjacent to the test gauge. Gauges shall be suitable for the maximum test pressure, with dials at least three inches in diameter. The maximum pressure capacity of the gauge shall not exceed twice the test pressure. Gauges shall be checked against a standard gauge.

4.20 PIPEWORK INSULATION

4.20.1 Chilled Water Piping

4.20.1.1 Chilled water piping shall be insulated with preformed sectional resin bonded mineral wool with a density of 160kg/m^3.

4.20.1.2 Insulation thickness shall be as follows:

Pipes up to 25mm diameter	30mm thick
Pipes 32mm to 150mm diameter	40mm thick
Pipes larger than 150mm diameter	50mm thick

4.20.1.3 Insulation shall be supplied with a factory applied canvas wrap and shall be provided with a vapour barrier by applying two coats of "FOSTER SEALFAS 30/36" or equivalent and approved and overcoated with "FOSTER VINYL VAPOUR BARRIER 30/42" or equivalent and approved.

4.20.1.4 Circumferential joints to the insulation shall receive one application of "FOSTER FOAMSEAL 30/40" or equivalent, to the full thickness of the insulation during erection to obviate lateral migration of moisture vapour along the pipe being serviced.

4.20.1.5 All points where pipe supports are used or where the vapour barrier is broken due to cut outs in the insulation, shall be sealed during erection with "FOSTER FOAMSEAL 30/45" or equivalent and approved.

4.20.1.6 All exposed piping shall be provided with 0,5mm thick aluminium sheet cladding over the insulation material. Bends shall be clad with lobster back covering of similar material. Valves and fittings shall be insulated and provided with aluminium cladding.

4.20.1.7 Black pipework shall be painted with primer and one coat undercoat paint prior to insulation.

4.21 FANS

4.21.1 **General**

4.21.1.1 Requirements under this heading apply to fans which are not integral parts of equipment designed and supplied as complete units by the manufacturers. Selection of fans shall be such that the operating point is as close as possible to the point of maximum efficiency. In addition, fans and motors shall be selected such that they are capable of supplying a minimum of 10% above the specified air volume.

4.21.1.2 System resistance shall be calculated by the Subcontractor to meet the requirements of selected equipment. The Subcontractor shall submit his selections to the Engineer for approval before ordering equipment. When selecting the fan, cognizance shall be taken of site altitude, system air temperature and air density at which the system duty shall be met.

4.21.1.3 Belt drives shall be designed for a minimum of 25% overload with no less than two matched belts being used. Belts shall be selected and installed in accordance with the BSS 790-1973.

4.21.1.4 Pulleys shall be of the adjustable speed taper-lock type and shall be accurately keyed to the shafts and shall be aligned before systems are put into operation.

4.21.1.5 Belt guards shall be provided in accordance with the Factories Machinery and Building Works Act 1941 as amended. The guards shall have a front screen of expanded metal and shall be arranged to permit oiling, use of tachometers and other testing and maintenance operations with the guard in place. All fan openings shall be provided with protective wire guards in accordance with the above Act.

4.21.1.6 Fan bearings shall be selected for a minimum of 200 000 (Two Hundred Thousand) h ours average life at the given duty.

4.21.1.7 Lubrication points for fan bearings shall be readily accessible and shall where necessary be extended to the outside of the face casing to permit lubrication of the fan without removal of the fan or appurtenances. Fan shafts and bearings shall be suitably protected from rust and corrosion.

4.21.2 **Centrifugal Fans**

4.21.2.1 Unless otherwise specified, centrifugal fans shall be of the backward curve blade type with single thickness shaped blades designed to give the fan a non-overloading characteristic.

4.21.2.2 Fan casings shall be fabricated from heavy gauge steel adequately reinforced and supported to provide a rigid structure and prevent drumming. Field joints shall be flanged and bolted with gaskets fitted between the flanges to render these airtight.

4.21.2.3 Shafts shall be steel with sufficient mass so that the critical speed of the wheel and shaft is well above the maximum permitted speed of the fan. Wheels shall be tightly fitted and keyed to the shafts.

4.21.2.4 Fan bearings shall be self aligning ball or roller type.

4.21.2.5 Fans shall be driven by an electric motor through a V-belt drive and mounted on an adjustable motor bracket which shall form part of the fan framework.

4.21.2.6 Vibration isolation shall be provided by means of spring isolators which shall be properly selected and installed in accordance with the manufacturer’s specifications.

4.21.3 **Axial Flow Fans**

4.21.3.1 Unless otherwise specified axial flow fans shall be inline direct driven type with motor mounted inside the fan housing.

4.21.3.2 Fan casings shall be constructed from galvanised mild steel having a thickness not less than 3mm and having galvanised mild steel flanges at each end, drilled for connections to mating flanges on ducting.

4.21.3.3 Fans shall be multi-bladed aerofoil type all of non-ferrous metal or polyester construction. A varying number of blades to suit the application shall be provided. The fans shall be provided with adjustable pitch blades indexed to permit field adjustment.

4.21.4 **Propeller Fans**

4.21.4.1 Propeller fans shall be direct driven, ring or diaphragm mounted as specified or indicated on the Drawings.

4.21.4.2 The impeller shall be constructed from roll formed galvanised steel or aluminium sheet and shall be statically and dynamically balanced.

4.21.4.3 Vibration eliminators, consisting or rubber in shear mounted between the fan assembly and ring or diaphragm, shall be provided.

4.21.4.4 Exposed fans shall be provided with a suitable wire guard mesh to meet the requirements of the Factories Machinery and Building Works Act 1941 as amended.

4.21.5 **Fan Volume Controls**

4.21.5.1 Volume control of axial and centrifugal fans shall be by means of proprietary vortex dampers.

4.21.5.2 Fans shall be capable of stable operation while varying the supply air quantities from maximum design rating down to 20%.

4.22 ELECTRIC MOTORS

4.22.1 All electric motors on the installation shall be of one make unless integral with the equipment served and shall not operate in excess of 1500 R.P.M. unless previously approved by the Engineers for specific applications. Motors, unless otherwise specified, shall be 380 volt, three phase, 50 Hertz for all sizes from and including 0,4kW upwards; smaller motors may be 220 volts, single phase, 50 Hertz.

4.23 All motors shall be of the totally enclosed, fan cooled type and have metric frame dimensions. Motors shall be quiet in operation to the full acceptance of the Engineers.

4.23.1 Three Phase Motors shall all be squirrel cage induction type, special high torque motors being used on high inertia loads such as large centrifugal fans, where otherwise excessively large motors, necessary to overcome driven equipment inertia, cause operation B.kW to be less than 70% of motor nameplate kW. Starting methods for three phase motors shall be as follows:

Motors up to 4kW	direct-on-line
Above 4kW	Star-delta started, provided that the starting current does not exceed three times the full load amperes.

4.23.2 Single phase motors shall be capacitor start, induction run type with built-in manual reset overload protection.

4.23.3 Nameplate rating of electric motors shall be at least 15% greater than required driven equipment brake drive losses duly accounted for, on motors below 15kW nameplate. On larger motors 10% margin shall suffice.

4.23.4 All switch panels shall have phase failure, phase rotation and low voltage protection with automatic reset adjustable to a maximum period of 10 minutes.

4.24 MACHINERY DRIVES

4.24.1 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 coupling 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.

4.24.2 Vee 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 machined 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., Vee-belts shall be fitted in matched sets only.

4.24.3 All drives shall be fitted with adequate drive guards complying with the relevant Government regulations, which guards shall totally enclose all moving parts. Drive guards shall be readily removable for access to the drives. Guards fitted to belt drives shall have an expanded metal fact to enable visual inspection of the drive without the need to remove the guard.

4.25 AIR FILTERS

4.25.1 General

4.25.1.1 Provide and install air filters in the positions as indicated on the Drawings and on all air handling plant providing conditioned air.

4.25.1.2 Filters shall be a standard product of a reputable manufacturer regularly engaged in the manufacture of the particular filter. The manufacturer shall submit evidence to the satisfaction of the Engineer, that the filters have been tested, by an independent South African Authority and that they meet the minimum arrestance efficiency and dust holding capacity specified.

4.25.1.3 Filters shall be tested in accordance with the A.S.H.R.A.E. Standard 52-76 Gravimetric on primary and Opacimetric on secondary and tertiary filters.

4.25.1.4 The systems resistance for selection of fans shall make allowance for resistance of the filters at 80% of the recommended final filter resistance.

4.25.1.5 Manometers shall be provided across each filter bank and shall indicate filter resistance. The clean and change out resistance of the filter shall be clearly marked on the manometer.

4.25.2 Primary Air Filters

4.25.2.1 Primary air filters shall, unless otherwise specified, be washable non woven polyester material, pleated to provide an extended surface with an efficiency of 88%, Gravimetric.

4.25.2.2 Media shall be firmly held in place by rust proofed wire screens to maintain pleat strength and spacing.

4.25.2.3 Media and support screens shall be continuously bonded into aluminium support frames folded to form a robust media support frame. The bonding between media and frame shall be continuous to prevent leakage.

4.25.3 Secondary Filters

4.25.3.1 Secondary filters shall, unless otherwise specified, be of the pocket type manufacture using fine filament, non-woven, polyester media constructed in such a manner so as to withstand vacuum cleaning.

4.25.3.2 Media shall be supported to expose the greatest effective area to air flow and to promote uniform dust loading. The filter shall maintain its rigidity under all flow conditions from maximum air flow to no air flow. This being particularly important on Variable Air Volume systems.

4.25.3.3 Secondary filters shall have an efficiency of 65%, Opacimetric

4.25.4 **Tertiary Filters**

4.25.4.1 Tertiary filters shall be of the high efficiency HEPA type contained in a solid frame with seals which ensure the integrity of the filter without bypass.

4.25.4.2 Media shall be supported to expose the greatest effective area to air flow and to promote uniform dust loading. The filter shall maintain its rigidity under all flow conditions from maximum air flow to no air flow. This being particularly important on Variable Air Volume systems.

4.25.4.3 The supply air fan on all systems with tertiary filters shall be capable of providing the specified air volume with all filters dirty. The fan shall be provided with a speed controller to automatically maintain the specified air volume at all times. The control shall be achieved through a velocity sensor in the supply airstream.

4.25.4.4 Tertiary filters shall have an efficiency of at least 99.999% at 5µ.

4.25.4.5 After installation of the filters, the system shall be validated by an approved testing authority using equipment with a valid calibration certificate.

4.25.4.6 Tertiary filters shall always be installed downstream of the fan and any other system equipment and as close as possible to the supply terminals.

4.25.5 **Filter Handling Frames**

4.25.5.1 Each filter cell shall be provided with a factory made holding frame, constructed of not less than 1,00mm thick stainless steel grade 304 or powder epoxy coated galvanised steel. On primary and secondary filters, a quick release spring type clip shall securely hold the filter cell in place without permitting leakage of air. The holding frames of multiple cell filter banks shall be suitably joined and sealed so as to prevent the leakage of air between the frames.

4.25.5.2 The frames shall ensure that the filters can be accessed for removal and replacement, either side access or rear access

4.26 COOLING AND HEATING COILS

4.26.1 Heating and Cooling water fed coils shall be of the serpentine form, extended surface type with cast iron, brass or copper supply and return headers with inlet, outlet, vent and drain connections on the same end of each coil.

4.26.2 Tubes shall be fabricated from not less than 16mm diameter copper or brass tubing having a wall thickness of not less than 0,5mm and shall be soldered or brazed into the pipe headers unless the headers are thick enough or provided with bosses heavy enough to withstand, without distortion, the stresses imposed due to rolling or expanded the tubes into the headers. Pressure parts of the coils shall be constructed and tested for a working pressure of not less than 1350 kPa.

4.26.3 Fins shall be of the helical or plate type spaced at not less than 12 fins per 25mm (2,12mm centres or 470 fins per meter) for aluminium fins and at not less than 8 fins per 22mm (3mm centres or 333 fins per meter) for copper fins. Helical fins may be crimped or tapered. Crimped fins shall have a nominal thickness of not less than 0,18mm and shall be soldered to the tubes. Tapered copper fins shall have a thickness of not less than 0,2mm at the base and shall be soldered to the tubes or wound with sufficient tension to ensure a permanent bond. Plate type fins may be flat or formed and shall have a nominal thickness of not less than 0,13mm for copper and 0,2mm for aluminium. Plate fins shall be soldered to

the tubes or shall be provided with integral spacing collars at least 3mm wide, or full width of fin spacing if this is less than 3mm, into which the tubes shall be tightly and permanently expanded.

4.26.4 Casings shall be constructed of not less than 2,0mm thick galvanised steel and shall be provided with drilled flanges for bolting to other coil sections or to unit casings. Coil sections having a tube length in excess of two meters shall be fitted with centre braces for tube support and casing rigidity. Multi-coil assemblies shall be supported on hot dipped galvanised steel channel frames. Such supports shall not pierce the drip pans and shall be arranged so that condensate cannot run down them past the drip pans. Flanged sections between coils shall be sealed and covered with 1,0mm thick galvanised sheet metal flashing to prevent air bypassing between the sections and each complete coil assembly shall be installed so that no air bypasses around the edges of the casings.

4.26.5 Condensate drain pans shall be fabricated from 1,6mm thick galvanised sheet steel riveted and soldered and sloped to drain all condensate. A pan shall be installed below each coil and the drain pans of multi-coil assemblies shall be provided with galvanised pipe connections through each drain pan to the lowest drain pan, from whence the condensate shall be piped to the drain point to be provided by others. Drain pans shall be extended 50mm beyond the coil casings on the leaving air side. All condensate drain pans shall be insulated and vapour sealed on the underside to prevent the formation of condensation. The insulation material and adhesive shall be non-combustible.

4.26.6 Eliminators shall be provided on the fan side of cooling coils if there is any possibility of water droplets being carried over into the fan chambers. Such eliminators shall then be designed to eliminate all condensate from the air stream and shall be fabricated from extruded sheet plastic and shall be sectionalised to facilitate maintenance. Should it be necessary to install eliminators then the drip pans shall be extended to drain condensate removed by the eliminators. If eliminators are not provided for by the Tenderer, then the Subcontractor shall provide the Engineer with a written guarantee that no moisture will be carried beyond the drip pans under the operating conditions for which the coils are to be selected.

4.26.7 Sumps for sprayed coils shall be as later specified herein.

4.26.8 Coils shall be suitably protected during shipment and installation so that fins and casings are not damaged. Coils having loose or damaged fins at the time of the final inspection shall be replaced if considered necessary by the Engineer.

4.27 SPRAYED COIL ASSEMBLIES

4.27.1 Sprayed coil assemblies shall be factory manufactured and assembled units of a specialist equipment manufacturer and shall each comprise of the following components contained within or forming part of the casing of the self-contained Sprayed Cooling Coil units which shall be installed in the positions indicated on the Drawings and shall be supplied with treated water from the water treatment plant located in the Sub-Basement Plant Room.

Chilled water fed cooling coil, as previously specified herein,

Recirculated water sump,

Inlet air baffles,

Spray nozzles with associated piping,

Air outlet drift eliminators.

4.27.2 The cooling coil shall be as previously specified in Clause 4.26 of these Specifications and shall be installed within the sprayed coil unit casing assembly so as to prevent air and water bypassing around the perimeter of the coil casing.

4.27.3 The water sump shall be constructed of hot dip galvanised steel of 3mm minimum thickness, reinforced as necessary to carry the weight of the cooling coils, eliminators, etc., and further rust proofed with a

suitable and approved epoxy resin based sealer. The sump shall be suitably insulated with 12mm minimum thickness of factory-applied polyurethane foam. The sump shall be 75mm minimum deeper than the working water level.

4.27.4 Sump fittings shall include the following items, all connections to the sump being made by the use of pipe sockets welded into it before the sump is galvanised.

A suitable anti-cavitation pump suction connection,

A removable copper mesh pump suction screen,

A 20mm NB ball-float valve of the high pressure type, complete with 200mm diameter copper ball and 20mm NB drain and overflow connections.

4.27.5 On the air inlet side of the sprayed coil unit shall be fitted 0,6mm thick galvanised sheet steel suitable rustproof coated, or extruded sheet plastic, air inlet baffles spaced at not exceeding 75mm centres. The baffles shall be suitably stiffened and bent at both the leading and the trailing edges and shall be horizontally arranged in sections and be readily removable for replacement. NO spray water shall pass through the baffles when the spray washer is tested with no air flow through it.

4.27.6 Between the air intake baffles and the cooling coil battery, provided the spray washer system of the unit. The spray washer shall be of the single bank type utilising one set of nozzles spraying in the direction of the air flow.

4.27.7 The spray header to the nozzles shall consist of one horizontal inlet pipe with its inlet water connection welded into one side of the sump. Vertical standpipes shall be fitted to this header with a suitable number of small bore pipe branches being fitted to the former for attachment of the spray nozzles. All pipework within the spray chamber shall be galvanised, as also shall be any pipe supports required.

4.27.8 The spray nozzles shall operate at a pressure of 50 kPa and handle the correct water quantity as called for in the detailed Specifications. The spray nozzles shall provide coverage of the entire coil face area. All nozzles shall be 10mm NB diameter inlet and of the brass "non-clog" type with removable orifice caps.

4.27.9 On the air leaving side of the cooling coil battery a set of vertical drift eliminators are to be installed, these eliminators to have a minimum of three bends and to be of identical construction and finish to the air inlet baffles, a minimum of 300mm in overall length in the direction of air flow and spaced at 75mm maximum centres. The eliminators shall be supported between notched hot dip galvanised or extruded plastic angles on leading and trailing edges and so arranged that no spray water shall be allowed to pass them into the air stream under a test air velocity of 3 meters per second. The eliminators shall be readily removable for access to the cooling coil or for purposes of replacement.

4.27.10 The casing shall be suitably stiffened at the air entering and leaving ends and be constructed of not less than 1,6mm thick galvanised steel sheet rustproof paint-coated and braced and framed with hot dip galvanised steel angles. The casing shall be fixed to the sump below it by means of flanges, cadmium plated bolts and a suitable water-resistant gasket. All seams in the casing shall be adequately sealed with mastic or similar non-hardening substance. Suitable access provisions shall be allowed in the casing for sufficient access to the spray nozzles for servicing purposes, unless the air inlet baffle assembly already affords such access.

4.27.11 The complete unit shall be installed on a reinforced concrete base provided by others. Between the sump of the unit and the concrete base, lay a 50mm thick layer of good quality steam-baked cork insulation and properly vapour proof same with bitumen applied hot. The base shall be pitched towards the drain connections on the unit, to facilitate drainage and cleaning and the drain connection shall be piped to the drain point to be provided by others in the Plant Rooms, in the positions indicated on the Drawings.

4.28 ELECTRIC HEATER BATTERIES

4.28.1 Electric heater elements shall be factory-bent type so arranged that all connections are on the same side. They shall be black heat, 5W/cm rated for still air operation by their manufacturers but operated at a minimum air velocity of 5 meters per second on this project. Elements shall be rated for 250 volt site electricity supply, with consequent lower wattage heat output and lower sheath temperature. Arrangement of 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 arrange in staggered rows to ensure best distribution of air flow over individual elements.

4.28.2 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.

4.28.3 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 cover shall however be secured with clip type fasteners. All wiring within the heater terminal box shall be carried out with silicone insulated stove 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.

4.28.4 Ductwork attached to heater batteries shall be insulated internally with 6mm asbestos millboard for 500mm on air inlet side and 1000mm on air leaving side, if space permits. Such asbestos shall be fitted over any other internal duct insulation that may be required and the rough edges shall be fitted with galvanised sheet metal covers, riveted to the ductwork, to prevent entrainment of loose fibres into the air stream.

4.28.5 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 air 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 switchpanel.

4.28.6 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. Under alarm signal control conditions for shutting down the plants, the fans shall be isolated immediately.

4.28.7 All heaters shall be installed from the top of the ducting where at all possible.

4.29 HUMIDIFIERS

4.29.1 Humidifiers shall have the capacities as called for in the detailed specification.

4.29.2 Humidifiers shall be of the packaged type consisting of submerged resistance heating elements contained in a stainless steel vessel. The container shall be cleanable by means of a removable lime collecting bag. The unit shall be completely automatic in operation and shall include an automatic self flushing system which shall be adjustable to suit the different water conditions. All switching sequences shall be by means of solid state switching.

4.29.3 Steam output shall be adjustable in response to an external automatic control signal. This proportional response must be instantaneous and is to be achieved without boildown or dumping of hot water. Proportional control must be from 0 to 100% variable.

4.29.4 Humidifiers shall be installed in full accordance with their manufacturer's instructions and have their steam injection nozzles fitted in the positions indicated on the Drawings.

4.29.5 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 from the manufacturers 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, preformed fibreglass sectional lagging covered with P.V.C. plastic sheeting overlapped over each section and fixed with approved adhesive, as previously specified herein for the insulation of all hot water piping.

4.29.5.1 Each humidifier shall be supplied with two sets of spare replaceable lime collecting bags.

4.29.6 Water connections to and drain connections from the humidifiers shall be carried out in water quality copper 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.

4.30 DUCTWORK

4.30.1 Ductwork shall be carried out in accordance with the details shown on the relevant Drawings and be fabricated from prime quality galvanised sheetmetal, except where otherwise called for. Where duct sizes are shown on the Drawings, such dimensions are metal sizes and to include the necessary allowances for any internal insulation which may be specified.

4.30.2 Ductwork shall be fabricated and installed in accordance with the duct construction and installation standards as detailed in the HVAC DUCT CONSTRUCTION STANDARDS - METAL AND FLEXIBLE - latest edition as issued by SMACNA (Sheet Metal and Air Conditioning Contractors National Association, Inc. of America) or SANS 1238.

4.30.3 Unless otherwise specified or allowed, main ducts shall be constructed to a minimum of 100mm wg. and branch ducting to a minimum of 50mm wg.

4.30.4 Fittings such as elbows, parallel flow branches, branch connections, off-sets and transitions shall be manufactured and installed in accordance with the SMACNA standards.

4.30.5 All ducting shall be sufficiently airtight to ensure economical and quiet performance of the system and joints shall be suitably sealed in accordance with the relevant SMACNA standards with suitable non-combustible filler compound or adhesive tape applied in accordance with the manufacturer's instructions and to the Engineer's approval.

4.30.6 Access doors shall be provided where indicated or required for inspection, maintenance, and replacement of all instruments, controls and other equipment. In particular, access doors shall be provided at all Fire Dampers, Automatic Dampers, Main Balancing Dampers, Filter Banks, and at the inlet and outlet sides of Axial type fans.

4.30.7 Access doors, where possible, shall be a minimum of 500mm x 500mm square. Where access doors are provided to items of plant these shall be as large as possible to permit access to the plant for maintenance and removal of equipment.

4.30.8 Access doors shall be constructed in accordance with the SMACNA standards and shall be installed in a reinforced frame to ensure that the door is airtight. Access doors shall be hinged and held in position by means of a minimum of two Sashlocks or Camlocks. Where access doors are intended for main access, the locking mechanism shall be capable of operation from both sides of the access door.

4.30.9 Duct connections to vibrating equipment shall consist of a flanged joint, followed by a flexible connector consisting of a fire retardant PVC covered cloth affixed on either side of the joint and a double lock seem 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 duct and no stress is imposed upon the flexible joint.

4.30.10 Test holes, where provided in ductwalls for admission of testing apparatus, shall consist of a suitable opening having a self-sealing Neoprene rubber grommet.

4.30.11 Flexible ducting shall be coated fibreglass fabric mechanically locked to a galvanised flat steel helix, "Kopes" or equal. The material shall be non-flammable and shall meet the requirement of the fire authorities having jurisdiction.

4.30.12 Flexible ducting shall be suitable for the operating temperature and pressure and shall be secured to spigots by means of circular "Jubilee" securing bonds making air tight connections.

4.30.13 Flexible ducting shall be installed with "easy" bends of not less than one duct diameter centreline and shall be supported to SMACNA specifications to ensure that ducting does not kink. The length of flexible ducting shall be kept to a minimum and shall not exceed lengths of 1200mm.

4.31 DUCTWORK AND PLENUM INSULATION

4.31.1 Ductwork shall be insulated according to the requirements as indicated on the Drawings and in accordance with the following specification.

4.31.2 Internal duct lining shall, unless otherwise specified, comprise 25mm thick 24gk/m^3 density, 8% resin content bonded fibreglass cloth, SONIC LINER, or equal, glued to the inside surface of the ductwork with a fire retardant adhesive equal to EUROPAIR'S EUROBOND self-extinguishing adhesive, the butting edges of the insulation first heavily caulked with FOSTER'S 60-30 mastic, or equal, to seal them. Additionally, the insulation shall be mechanically secured with GRIP NAILS or WELDPINS at 400mm centres and not more than 75mm from the edges of each panel. Insulation ends shall be covered with 0,85 thick galvanised sheet metal strip riveted to the duct panels to prevent the erosion of particles of insulation into the air stream.

4.31.3 Any insulation of which the facing has been damaged shall be properly patched with FOSTER'S 60-30 mastic and fibreglass cloth.

4.31.4 Externally insulated concealed ductwork shall be insulated with 50mm thick, minimum 18kg/m^3 8% resin content bonded fibreglass blanket faced with a fibreglass scrim reinforced aluminium foil kraft facing. The insulation material shall be wrapped around the ductwork and sealed at the joints which shall overlap and be covered with a 50mm wide aluminium foil tape, to ensure vapour proofing.

4.31.5 The insulation shall be applied to the ductwork with EUROPAIR'S EUROBOND or equal, self-extinguishing adhesive and be mechanically secured with 20mm wide aluminium bands strapped around ducting at regular intervals of not more than one meter centres.

4.31.6 Externally insulated exposed ducting shall be insulated with 25mm thick minimum 64kg/m^3 density, 8% resin content, bonded fibreglass batts evenly secured to the ductwork, with EUROBOND adhesive and WELDPINS at 400mm centres, and covered with wire mesh securely attached and plastered to a smooth finish with not less than 12mm thick hard setting compound. All corners shall be neatly rounded off and the finished surface shall be painted as later specified herein for exposed ductwork in Plant Rooms.

4.31.7 Flexible ducting shall be insulated with 25mm thick 12kg/m^3 resin bonded insulation wrapped with a P.V.C. sheath.

4.31.8 External insulation to ductwork and plenum insulation as specified herein shall be undertaken by a firm of specialist insulation contractors employed by the air conditioning Subcontractor, costs for their work being duly allowed for by the air conditioning Subcontractor in his Tender Price. The air conditioning Subcontractor will be held fully responsible for the work of his insulation Subcontractor in all respects.

4.31.9 Exhaust and outside air intake ducting shall not be insulated.

4.32 DAMPERS

4.32.1 Provide dampers where shown on the Drawings, where necessary for shut-off, bypass or volume control purposes, and where required to comply with local fire codes, as relevant.

4.32.2 Volume control dampers shall consist of multiple extruded aluminium aerofoil blades acting in opposed blade fashion with aluminium gears. The blades shall be fitted with rubber sealing strips on their edges and shall be robustly linked together to operate in complete unison. Permanently set dampers shall be provided with suitable devices to facilitate locking them in position such device to consist of a quadrant with "Open" and "Shut" position indication.

4.32.3 Motorised dampers shall include suitable fastenings and supports for motor actuators. The damper blade axle shall be mounted in the damper frame on suitable roller bearings to provide free movement of the blades.

4.32.4 Damper hardware shall be the product of an accredited manufacturer of such items, equal to EUROPAIR. Entire damper sections shall be housed in flanged sheet metal casings of 1,6mm thick galvanised steel. No damper blade shall exceed 200mm in width. Dampers over 900mm blade length shall be sectionalised into separate cells each with its own shafts and bearings to ensure that blade length of each section does not exceed 900mm.

4.32.5 Splitter dampers shall be equal to Titus type AG-45 Air Volume Extractors with No. 2 duct regulator to enable adjustment without access into the duct. Entire installation of splitter dampers shall be such that they do not vibrate or rattle due to air movement over them.

4.32.6 Non return dampers shall be provided as specified or indicated on the Drawings and in all installations where fans are mounted in parallel. The dampers shall be constructed of rigid aluminium blades of not less than 2mm thickness and shall be constructed in accordance with the SMACNA specifications. The non return dampers shall open by means of air flow and close by back draught and shall be free from vibration and rattling.

4.32.7 Fire dampers shall be manufactured to a recognised fire code for a two-hour fire rating. Damper casings shall have flanged ends and single blade units applicable to rectangular ducts, and shall not exceed 300mm blade width. The fire dampers shall further be specialist manufactured by an accredited firm in this field and shall additionally comply in all respects with the requirements of the local municipal fire authorities, in the area where they are to be installed and S.A.B.S. 193-1972.

4.32.8 Damper blades shall be closed by the operation of approved fusible links located where they would be immediately affected by an abnormal rise of temperature of the air stream. When specified in Part Five of the Specifications the blades shall also be actuated by 24 volt D.C. solenoid operators which shall be provided by the damper manufacturers. When closed the blades shall be held by a catch arrangement so as to provide a positive seal against the air stream.

4.32.9 All dampers installed in ducts shall be provided with an inspection opening so that the dampers may be checked and maintained. Inspection openings shall be covered with suitably sealed access panels.

4.32.10 Smoke dampers shall be the product of a specialist manufacturer in this field, built to an acknowledged standard such as Underwriters Laboratories and be smoke tight against an air pressure of 50mm wg. They shall be actuated by 24 volt D.C. Solenoid operators which shall be provided by the damper manufacturers. When closed the blades shall be held by a catch arrangement so as to provide a positive seal against the air stream. Adequate access provisions shall be incorporated in adjoining ductwork to allow resetting of dampers which have tripped.

4.33 SOUND ATTENUATORS

4.33.1 Sound attenuators shall be provided and installed in the positions indicated on the Drawings and shall be selected to provide the Noise Criteria levels as further specified herein. All sound attenuators shall be the

factory fabricated product of an accredited manufacturer of such equipment, such as I.A.C. (International Acoustics Company), DONKIN or TROX, who publish selection data on their products, which data shall be submitted to the Engineers for approval of each sound attenuator offered.

4.33.2 Metalwork on sound attenuators shall be galvanised steel or aluminium and acoustic insulation shall be non-combustible material, properly bonded and covered so as not to permit insulation particles being eroded by air movement over them.

4.33.3 Sound absorbing lining material of sound attenuators in low velocity ductwork shall have a density of not less than 24kg/m^3 and a thickness of not less than 25mm and in medium pressure ductwork the thickness shall not be less than 50mm with a minimum density of 48kg/m_3. Material for cell type sound absorbers shall be of the rigid type. The sound absorbing efficiency at each frequency shall not be less than;

Frequency-cycles per second	250	500	1000	2000	
Percentage Absorption		45	65	70	80

4.33.4 All lining which is damaged in shipment or due to exposure or any other cause shall not be installed and any material which may be damaged prior to the final acceptance shall be replaced as directed by the Engineer.

4.33.5 Casings shall be manufactured of galvanised sheet steel not lighter than the thicknesses previously specified herein for ductwork of the same dimensions, for the various pressure systems.

4.33.6 Kitchen extract ducting sound attenuators shall be either PACKLESS as manufactured by the International Acoustics Company, or equal and shall be suitably treated to the unaffected by the build up of grease which will occur on the attenuator.

4.34 AIR TERMINALS

4.34.1 Air distribution shall be effected by means of grilles or diffusers of the sizes, types and having the discharge patterns as indicated on the Drawings.

4.34.2 Tenderers must reselect grille and diffuser sizes if, for the makes offered, the dimensions called for on the Drawings do not provide for sound power levels later specified herein in Section Seven hereof, when handling the required air volumes.

4.34.3 The Subcontractor shall liaise and co-operate with the firm appointed for the installation of the ceiling, who shall undertake the final lining-up and levelling of the diffusers which shall be installed in conjunction with the ceiling to form an integrated, compatible and acceptable unit.

4.34.4 The finish of all grilles, diffusers and louvres shall be epoxy powder coated, baked enamel or colour anodised, the colour being to the Owner's or Architect's choice of colour, to be advised and approved by the Engineers.

4.34.5 Grilles and diffusers shall be fixed to spigots extended 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.

4.34.6 Supply air grilles shall, unless otherwise specified or indicated on the Drawings, be of the double deflection type consisting of two rows of individually adjustable aerofoil section vanes, front vanes being horizontal, rear vanes vertical, all vanes housed in a surrounding fixing flange with neat mitred joints at the corners. The entire grille assembly shall be of extruded aluminium construction.

4.34.7 All supply air grilles shall be complete with factory fitted opposed blade dampers as later specified herein.

4.34.8 Supply air diffusers shall be of steel or aluminium construction and shall consist of an inner section which is readily removable from the outer core to facilitate access to the control dampers to be located behind the diffusers as later specified. The inner section of the diffusers shall consist of concentric rectangular or circular collars, the outer section consisting of a single rectangular or circular bevel collar provided with concealed fixing devices for attaching it to the supply air ductwork.

4.34.9 Supply air grilles and diffusers shall be provided with multivane opposed blade dampers finished in matt black lacquer. The dampers shall be attached to the rear of the grilles and fitted into the spigot connections to the diffusers and shall be adjustable, by means of a key or lever, from the front of the installed grilles and diffusers.

4.34.10 Return air grilles shall, unless otherwise specified or indicated on the Drawings, consist of aluminium grid core housed in an extruded aluminium fixing flange with neat mitred corners and finished in anodised aluminium to match colour sample to be supplied by the Engineer.

4.34.11 Return air grilles shall be equal to TITUS model 50 F with a 12mm grid core.

4.34.12 Transfer grilles shall be of extruded aluminium construction equal to TITUS model T-700-B grilles fitted to timber frames, to be provided by others, on both sides of openings through walls or partitions thicker than 50mm, alternative standard door grilles may be used with the grille installed on the "public" side and the auxiliary frame installed from the other side.

4.34.13 Door grilles shall be of extruded aluminium construction equal to TITUS model CT-700-BF suitable for fitting into doors of varying thickness and shall be finished in anodised aluminium.

4.34.14 Outside air intake weather louvres shall be of the extruded aluminium fixed vane type fitted with a vermin proof screen on the rear side as well as an opposed acting damper.

4.34.15 Dampers shall be provided with a locking device so that once they have been set for the correct air flow quantity they can be permanently locked in position. Louvres shall be finished in anodised aluminium.

4.34.16 Where indicated on the Drawings the outside air intake weather louvre assembly shall be fitted with filter holding frames with firmly fixed foam rubber gaskets and spring type clips for the attachment of the fresh air filters, as later specified herein. The frames shall be fixed to the weather louvre so as to prevent any air bypassing the filters.

4.34.17 Volume control opposed blade dampers shall be installed where noted on the Drawings. The dampers shall be as previously specified herein in Clause 4.32.

4.34.18 Rubber gaskets shall be glued to the rear of the fixing flanges of all air grilles, diffusers and louvres to ensure airtight seals and prevent smudging.

4.35 CANOPIES AND GREASE ELIMINATORS

4.35.1 Canopies and grease eliminators shall be the make of specialist in this field and shall not be manufactured by the Subcontractor. Canopies shall be equal to CYCLO-Wash or CYCLO-VENT with CYCLO-CLEAN grease filters and shall, unless otherwise specified, be constructed from 1,2mm thick grade 304 stainless steel with a number 3 finish.

4.35.2 Joints and seams shall be of welded construction and be watertight and all exposed welds shall be ground and polished to the original finish of the material.

4.35.3 Grease filters shall contain a series of vertical baffles to change the direction of the air flow and efficiently divert grease particles out of the air stream by centrifugal action. Each filter bank shall contain a condensate trough and removable grease storage container.

4.35.4 Fire Dampers, operated by fusible links, shall be provided in each air outlet connection and shall form an integral part of the canopy construction.

4.35.5 Lights shall be fitted into the canopy construction by the manufacturer.

4.35.6 Canopies having a length of less than 1300mm shall be provided with one, flush mounted, incandescent 100 watt, light fitting opposite each air intake. The fittings shall be square and recessed and shall consist of a steel housing with baked reflective white enamel finish, stainless steel exposed trim and diffuser of tempered glass with prismatic interior. Access for bulb replacement shall be through the face of the fitting without the use of tools.

4.35.7 Canopies having a length of more than 1300mm shall be provided with one flush mounted two lamp fluorescent light fitting opposite each air intake for every 2000mm of canopy length. The fittings shall have a steel housing with baked reflective white enamel finish, stainless steel exposed trim and diffuser of tempered glass with prismatic interior. Access for tube replacement shall be through the face of the fitting without the use of tools.

4.35.8 Canopies installed in the public view shall in addition be fitted with a 12,5mm square aluminium grid core shall be supported on a 25mm return on the inside edge of the canopy and shall be fitted in 600mm wide sections and be easily removable for cleaning.

4.35.9 Wet type canopies, equal to CYCLO-WASH shall be provided complete with control panel to provide automatic operation of the exhaust and make-up air blowers in addition to the wash and run cycles of the ventilator.

4.35.10 Control panels shall be constructed of 1,4mm thick galvanised steel and the front frames, doors and exposed trim shall be fabricated of 1,2mm grade 304 stainless steel having a number 3 finish.

4.35.11 Operation of the control sequence shall be initiated by front panel push button switches with individual wash and run indicator lights. An additional front panel indicator light and buzzer shall provide a warning in the event of a low detergent condition. Each control panel shall contain a hand shut-off valve, line strainer, solenoid valve and union connections for the hot water line. The detergent pump shall be capable of being adjusted to inject the proper amount of detergent into the hot water line.

4.35.12 Hot and cold water connections shall be provided adjacent to each wet type canopy by others, each connection shall be terminated within two meters of the canopy in an isolating valve. The Subcontractor shall allow for all necessary pressure reducing valves, filters and appurtenances necessary for the efficient operation of the system. Drain connections shall be provided by others within two meters of each canopy.

4.36 AUTOMATIC CONTROLS

4.36.1 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 Subcontractor 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.

4.36.2 Automatic control valves shall have bodies, discs, stems and sealing gland designed for not less than 1600 kPa operating pressure. Valves 40mm and smaller shall be gunmetal with union ends and machined seat. Valves 50mm and above, shall be cast steel with flanged connections. The sealing gland shall be of the double O-ring type permitting replacement without removing the valve. Spindle and plug shall be stainless steel.

4.36.3 Automatic valve and actuators shall be supplied separately, the assembly of which shall be done without the need for special tool or adjustment. Valves shall be opened by the actuator and closed by means of a return spring. A visible position indicator shall be provided. The actuator shall permit manual operation at the valve.

4.36.4 Automatic damper actuators shall be electro-thermal or electro-hydraulic, to suit the load requirements, linear stroke actuators with overload protection and spring return. The stroke of the push rod shall be controlled such that the stroke corresponds proportionally to the control signal.

4.36.5 Automatic valve and damper actuators shall be controlled by means of an electronic controller.

4.36.6 Electronic controllers shall be suitable for the application intended and shall provide P, PI or PID control as selected. The controller shall incorporate a manual/automatic switch. In addition, the P band and dead zone shall be adjustable. A plug-in service testing point shall be provided to facilitate commissioning of the installation. The mode of operation shall be adjustable.

4.36.7 Step control function shall be achieved by means of an electronic on/off controller. The controller shall provide for either switching of stages with decreasing valve or switching of stages with increasing valve or sequencing of stages with different modes of operation. The unit shall incorporate an adjustable switching time delay and shall provide for adjustable switching interval and differential on all stages. A plug-in service tester point shall be provided to facilitate commissioning of the installation.

4.36.8 Temperature and Humidity control shall be as indicated on the wiring Diagrams and/or specified in Part 5 of the Specifications.

4.36.9 All plants shall be controlled by means of a remote sensor mounted in the location indicated on the Drawings. When not shown, the sensor shall be located where it will respond to arrange temperature on humidity in the room.

4.36.10 All air conditioning and central ventilation plants as well as plants indicated on the Drawing as being controlled shall be switched on and off automatically by means of a programmable time switch.

Unless otherwise specified, the time switch shall have the following functions;

Day of week display

Time display

Auto/Off switch

Keyswitch to prevent programme alteration by unauthorised persons

Key pad for programming

Plus one hour override

Battery reserve of 24 hours minimum to maintain memory

4.36.11 The time switch shall generally be installed remote from the central plant and as such will act as a manual override switch. A manual override switch shall also be provided at the plant.

4.36.12 Thermostats 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 between offices if other locations are possible. Thermostats mounted on outside walls shall be provided with insulating bases.

4.36.13 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.

4.36.14 Electric temperature control systems operating at less than the normal, lighting circuit voltage shall be provided with transformers to supply power for equipment.

4.36.15 Transformers and line voltage controllers serving individual ventilating or air conditioning units may be fed from the fan motor leads, and other transformers and controls fed from the nearest distribution panelboard or motor control centre, utilising circuits provided for the purpose and not spare circuits or circuit provided for other purposes. Individual room controls and zone controls may be connected to any convenient outlet circuit providing power consumption does not exceed 3000 watts.

4.36.16 Transformers other than transformers in bridge circuits shall have primaries wound for the current available and secondaries wound for the correct control circuit voltage. Each transformer shall have capacity to operate simultaneously all apparatus connected to it and shall be capable of carrying a 25 per cent overload for one hour. No control transformers shall be rated less than 200 VA. 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.

4.36.17 All three phase equipment shall have phase failure, phase rotation and low voltage protection with automatic reset adjustable to a maximum period of 10 minutes.

4.36.18 Duct thermostats used for temperature control shall be remote sensing element type with controller mounted on a panel. Sensing elements (remote bulb averaging type or rigid stem) shall be located where they will respond to a representative temperature within the duct or casing. Operating and adjusting thermostatic mechanisms shall be enclosed in metal or phenolic resin cases and shall be installed outside of ducts and casings. Where ducts or casings are insulated, thermostats shall be mounted flush outside of insulation in such a manner that moisture will not condense on thermostat or on supports.

4.36.19 Where the distance from a bulb to a sensing element panel exceeds manufacturer's maximum recommended capillary length, a remote transmitter, mounted on the outside of the duct, shall be used between the elements and the operating and adjusting mechanism on the panel. Capillary tubes or wires other than stainless steel elements and operating mechanisms shall be protected by conduit moulding or flexible armour. Excess capillary lengths shall be neatly coiled and fastened out of the way. Capillaries and wiring shall pierce thermal insulation at the smallest practicable number of points and shall be properly sealed wherever they pierce an insulation vapour seal.

4.36.20 Pipe and Tank Thermostats shall be of the immersion type with liquid filled separable sockets. Where the socket is located more than 1,5 metres above the floor or where the operating and adjusting mechanism is specified to be panel mounted, the thermostat shall be of the remote sensing element type with liquid filled separable socket and the mechanism shall be mounted on a wall or column 1,5 metres above the floor or panel mounted. Where the distance from the bulb to a panel exceeds the manufacturer's recommended capillary length, a remote transmitter shall be used as specified for duct thermostats. Separable sockets shall be of brass or stainless steel heavy enough to withstand pulsations and turbulence in the fluid controlled. Protection of capillary tubing and wires shall be as specified for duct thermostats.

4.36.21 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 as indicated on the Drawings, to sense the return air temperature and shut down the entire system should the return air temperature exceed 40ºC. These thermostats shall be of the manual reset type.

4.36.22 Plants shall be started in sequence by means of time delay relays. The timing between switching stages shall be set at not less than 15 seconds.

4.36.23 Where applicable, the temperature control circuit of each water-cooled unit shall be interlocked with a water flow switch in the condenser water line so that the compressors will not operate unless the flow switch contacts are closed.

4.36.24 Heaters shall be interlocked with an air pressure differential switch mounted on the discharge duct of the respective unit to sense the air flow within the supply air duct in which the heaters are installed. Sail-switches will not be acceptable.

4.36.25 Heater circuits shall also be interconnected through a fire safety thermostat, with manual reset feature, to break the circuit should the temperature of the air in the duct exceed 55ºC. These safety thermostats shall also be of the rigid tailstock type and shall be mounted on the side of the ducts downstream of the heater batteries between 300mm and 600mm from the heating elements.

4.36.26 Where applicable for water-cooled systems, condenser water temperature shall be automatically controlled at the cooling tower as refrigeration will be required to operate on a year-round basis.

4.36.27 A remote sensor type proportional temperature controller with its sensing element suitably located to measure the temperature of condenser water flow shall be provided. This instrument shall control a damper actuator fitted to a damper in the cooling tower fan discharge, and shall cause variation of the air volume handled by the tower fan in response to condenser water temperature. A limit switch attached to the damper motor shall shut down the fan when the damper reaches the fully closed position and start when the damper reaches the fully open position.

4.36.28 Each refrigerant circuit within 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.

4.36.29 Ventilation and exhaust fans shall be interlocked with the air conditioning plant or as called for on the relative Wiring Diagram or indicated on the Drawings.

4.36.30 Fresh air intake fans shall be interlocked to operate only when the plant is switched on.

4.36.31 Static pressure controller shall be electronic remote sensing differential pressure detector mounted in the position indicated on the Drawings and arranged to sent a remote signal to a universal proportional controller which shall operate a motorised damper. The controller shall give a digital reading of the static pressure within the duct.

4.36.32 Pressure controller on chilled water shall be electronic remote sensing pressure detector mounted in the position indicated on the Drawings and arranged to transmit a signal to a universal proportional controller which shall operate a control device as required and indicated on the Drawings. The controller shall give a digital reading of the pressure within the system.

4.36.33 Sump pumps shall operate automatically under the control of their float switches. A single pole double throw selector switch contained in the relevant switchpanel shall allow manual selection of which pump can operate and which would be on standby. A high level alarm float switch shall initiate a warning light and bell at the switchpanel and bring the standby pump into operation.

4.36.34 **Building Automation System (BACS) Specification**

4.36.34.1 General

The Building Automation System (BACS) supplier shall furnish and install a fully integrated building automation system, incorporating direct digital control (DDC) for energy management, equipment monitoring and control, suitable for the building usage.

The control strategies shall be developed to ensure that the specified environmental conditions are maintained, whilst giving due regard to minimising of energy consumption in accordance with Building Regulations Part L2, and any subsequent revisions.

Materials and equipment installed shall be the catalogued products of the approved supplier and shall be the manufacturer's latest standard design that complies with the specification requirements.

The installer of the building automation system shall provide documentation supporting the

manufacturer's compliance with ISO-9002 (Model for Quality Assurance in Production, Installation and Servicing). The intent of this specification requirement is to ensure that the products from the manufacturer are delivered through a Quality System and Framework that will assure consistency in the products delivered for this project.

All peripheral equipment e.g. sensors, pressure switches, control valves and actuators, shall be of the same manufacture as the direct digital control modules and outstations.

The design of the BACS network shall be such that additional outstations may be added to the network in the future or the network expanded with minimal disruption to the normal operation of the system. Each local area network LAN shall have a minimum of 20% spare capacity to install additional devices.

The system design shall utilise the latest technology in "open" network architecture, distributive intelligence and processing, and direct digital control.

The automation level main plant DDC controls to be freely programmable based on DMAP programming language.

The products used in constructing the BACS management and automation level shall conform to the BACnet protocol on a LONtalk data communications network, for building automation and control networks. All products types shall have attained a BACnet Testing Laboratories (BTL) listing and display the BTL logo

Room units shall utilize a two-wire communication link at each controller with the capability for acquisition of room temperature, local set point, integral temperature indication and digital set point display, as specified by the control application.

The overall system-operating concept must be structured such that the data can be accessed at any point in the network(s) commensurate on the operator's access authority (security key/passwords).

It shall be possible, with additional hardware if necessary, to interrogate the system remotely via the following possible methods

- Telephone connection
- Building IT network
- Web browser technology with password access via IT networks
- Alarm reporting to mobile pagers/phones/e-mail etc
- Energy usage monitoring and control via Desigo Insight Building Management Systems.

4.36.34.2 Drawings and Records

Submit drawings for all equipment to be provided, including but not limited to:

.1 Software packages
.2 Management station central equipment
.3 Schematic diagrams showing system configuration and interconnection of management stations and all field panels.
.4 Descriptive data of all operating, user and application software including complete operators manuals, and programme manuals.

Final as-built documentation including the above items shall be included in the operation and

maintenance manuals.

Provide final documentation to serve the diverse needs of personnel concerned with instruction, operation, procurement, installation and maintenance.

Drawings and final documentation will be reviewed to ensure that such documents are in keeping with the intent of this specification and fully meet the requirements in terms of content and format.

Delivery of the final approved documentation, in hardcover 2-ring or 4-ring binders with index page and index tabs, is required before the Certificate of Substantial Completion will be issued.

Maintain a complete and current copy of all reviewed drawings at the job site.

All Licence rights to the control systems manufacturer's software packages shall be transferred to the client at the time of hand over. User Registration must be made on behalf of the client, direct to the control system manufacturer by the specialist System House Partner.

Three copies of all of the control system manufacturers Monitoring or BACS software shall be provided on CD-ROM, or other mass storage device, together with copies of any graphics and databases that may be required to re-install the system after a fatal computer failure.

4.36.34.3 Reference Standards

Provide electrical material and installation in accordance with the appropriate requirements, and in accordance with applicable sections of the current edition of the applicable local codes for electrical work and signalling systems. Install wiring in conduit or approved totally enclosed raceways. Do not use cable raceways or troughs. Approved ceiling plenum cable is acceptable where permitted by the local Authorities.

Provide electrical and electronic equipment which meets the CE conformity requirements as defined in CE directive 89/336/EEC Low voltage directive 73/23/EEC.

Provide BACS system which supports ANSI/ASHRAE BACnet Standard 135.

Automation level freely programmable DDC controllers shall have attained BACnet Laboratories (BTL) listing and shall display BTL logo.

The configuration of the Building Management System shall provide an "open" network architecture conforming to the ASHRAE's BACnet/IP protocol standard CEN ISO 16484-5.

The field level terminal unit controls shall conform to the ANSI/EIA Standard 709.1, employing the LonTalk protocol, and the product interoperability standards defined by the LonMark® Association.

Modem interfacing provisions shall meet EIA RS232C. Modems shall comply with the local required communication protocol with minimum transmission rate of 28,800 baud.

All equipment and systems installed under this Contract shall meet following specifications on electromagnetic compatibility:

Interference immunity according to EN50082-2
Emitted interference according to EN50081-1

Provide equipment which functions and meets all detailed performance criteria when operating in the following minimum ambient condition ranges:

Operating Temperature - 0 to 50 deg C [32 to 122 deg F] (Class 3K5 to IEC 721)
Relative Humidity 10% to 85% non –condensing (Class 3K5 to IEC 721)

The limits above, are minimums and shall not take precedence over ranges detailed in this or the

manufacturers specification.

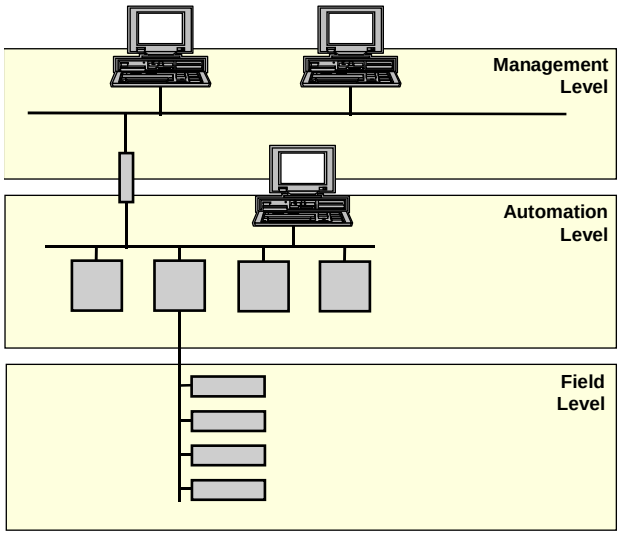
4.36.34.4 General System Architecture

The system shall be logically structured into distinctive levels based on the functions, performance, modularity and autonomy required at each level. Based on these requirements the most appropriate technology will be used. A physically flat architecture may only be appropriate to small systems.

Functionality shall be realised always on the most appropriate system level as defined below to ensure maximum resilience of the system

Each level shall be autonomous from the other. Applying three levels ensures the best performance, easier fault finding, better fault tolerance and expandability.

The levels are defined as Management Level, Automation Level and Field Level.



Peer to peer communication shall be possible on all system levels.

The system design shall be modular in structure to allow straight forward extensions.

4.36.34.5 Management level Functionality

Personal computer based operator management stations shall be provided for plant supervision and operation, alarm management, information and database management function. All real-time control functions shall be resident in the DDC controllers to facilitate greater fault tolerance and reliability.

The operator management station should be capable of multi-tasking 32-bit programs by utilising a Microsoft Windows 2000 or XP operating system.

The management station shall be capable of the following:

1 Display of graphical representations of the plant overlaid with live data
2 Monitor and operate / influence process devices
3 Receiving of alarm messages from the process level and directing them to the appropriate reporting device e.g. printer, pager, fax, e-mail
4 Monitor process devices for communication problems and other device faults.
5 Adjusting time strategies in the process level.
6 Long term storage of logged data from the process devices

7 Archiving / retrieve data to/from long term data storage
8 Display graphically the logged data
9 Custom application programming

The management station shall allow supplier independent integration of further subsystems.

The management station can either be stand alone or connected together via an IT network.

When management stations are connected together they must be capable of sharing data. Either one management station should become a network server or a dedicated server should be used.

For maximum fault tolerance, the management stations connect to the process level via point to point communications. This shall be via RS232, Ethernet/TCP/IP LAN / WAN or via AutoDial links.

The user interface shall be based on a basic taskbar, which is always visible, and which provides at all times a summary of the most important system information and essential system functions which are:

.1 Alarm summary which indicates for at least 3 priority groups the number of active alarms and system message status, site connection status and time and date .
.2 Control of access privileges and security mechanisms for access to program modules and third-party software at log-in and log-out.
3 User- and password-dependent access to systems and sub-systems.
.4 Automatic user-specific start sequences
.5 Facility to establish and terminate connection to various sites
.6 Simultaneous connection of at least of 4 sites via serial connections / 50 sites via LAN/WAN connections for a comprehensive overview on geographically distributed projects

Provide functionality such that any of the following may be performed simultaneously on-line, and in any combination, via user-sized windows. Operator shall be able to send information between applications reducing the number of operation steps.

System access control for individual access to sites, applications, functions and objects

Dynamic colour graphics and graphic control

Plant operation with explorer – all objects shall be displayed in a graphical tree structure in order to access points which are not included / defined in the graphics

Alarm handling – all the alarms shall be displayed in a graphical tree structure in order located alarms quick and easily.

Alarm routing to printers, pager, cellular phones/SMS, fax, e-mail on designated locations

Trend data module, including dynamic trend data definition and graphical presentation

History logging for alarms, user actions, system events and messages

Scheduling for operation and programming of the time programmes

Remote communications software, supporting remote access from/to process devices on automation via:
.1 AutoDial links (both dial-up and dial-down)
.2 ISDN facilities
.3 Ethernet / TCP/IP Local Area Networks
.4 TCP/IP Wide Area Networks

4.36.34.6 Management level network

The management level network shall use the standard BACnet protocol and shall be able to deal with the high data traffic with complex data structures between management stations and between the management station and the process level.

The network technology must be based the IT standards Ethernet and TCP/IP, and be compatible with the latest LAN, WAN technology.

When connected to an IT network this can be either a dedicated IT network for the building management stations or own the clients IT network.

When connected to a clients IT network, the management stations and process devices connected to that network have to co-exist with the other network devices.

Where the system works over more than one building over a large area (WAN - Wide Area Network), the client will be responsible for Data management devices ensuring the BACS can send information over routers, fire walls etc.

4.36.34.7 Automation level

Functionality

The Process devices control and monitor main plant equipment within a building. Each DDC controller shall have the ability to perform all the following routines.

.1 Process control & interlock functions.
.2 Generate alarms/events based on comparing measured values against know parameters.
.3 Time control strategies
.4 Runtime totalisation
.5 Trend logging of specific data-points with transmission of the logged values to the management level
.6 Energy calculations
.7 Backup of the data/program

The process devices shall be able to operate autonomously and independently from the management level.

The DDC control modules to be selected from either modular or compact type of device to suit the most economic inclusion of all data points specified.

The input/output connection to Modular controllers shall be via individual plug-in modules suitable for the particular peripheral device. The digital modules shall have visual indication of the status of the input/output. Digital input modules shall be capable of accepting control voltages up to 230vac and will have integral status indication.

Software application tool to utilize freely programmable DMAP software programming language.

In the event of a sensor failure an alarm shall be raised and the software application default to a safe value.

DDC Control Module Specification

Based on ANSI/ASHRAE standard 135-2001 (BACNet), ENV13321-1
Operation standalone or as part of LonTalk (clause 11) system network TP/FT-10, 78kBits with Built in BACnet/Lontalk interface
Optional connection to operator terminal, management station and via Web browser with Web server device.

Freely Programmable
Flash ROM, real time processing and multi tasking
32 bit dual processor system, 1.5 MB program memory
Supply voltage AC 24V +/-20% 50/60 Hz
Event driven data transmission
Automatic mains recovery
PPS2 connection for up to five two wire QAX room units
Digital output to be 250V 2A rated changeover contacts
Historical data memory storage
Software application stored in non volatile memory
Battery back up
Automation level network

All controllers and other devices shall communicate using the standard BACnet protocol.

The communications shall be able to transfer control parameters between devices at high speed and transmit logged data to management stations. The communications shall use change of state based communications to allow high event transmission speed on all transport media including AutoDial links.

This network shall be independent of the management network because IT networks require shutdown due to maintenance and because the network traffic could affect the performance of the IT network and vice versa.

The communications must be able to deal at least with following basic BACS functions:

.1 Change parameter
.2 Read parameter
.3 Share value with another process device
.4 Transmit alarm/event
.5 Transmit current logged data
.6 Time strategies, including optimum start and stop

Local Operator Terminals

A local operator terminal shall allow full operation of all DDC control modules connected to the LonTalk BACnet network. Functions to include

.1 Alarm monitoring with acknowledgement and visual and audible alarm indication.
.2 Pop up window with detailed message for alarms and events
.3 Alarm and event history
.4 Data point display and operation of all measured values, setpoints, plant states, operating states and parameters
.5 Graphic based display and operation of all time schedules, exception calendar, online trending and heating curve.
.6 User specific configurable overview of main values in plant
7 Multi user level access protection

The operator terminal shall have a high resolution 6 line illuminated display for graphics and text, keys for operation and a visual and audible common alarm indication. The textual information displayed must reflect the layout of building and plant with clear English descriptions of up to 40 characters.

The operators terminal shall be capable of being located either at any outstation or remote, powered by a local transformer. It shall be capable of being mounted in control panel door, backplate mounted, wall mounted or portable.

Each MCC enclosure shall be provided with local operators terminal mounted on the control panel facia.

Additional local operator terminals shall be able to be added to each control system, if required by the client, all of which shall be able to address any function on any control module. The additional operator terminal shall automatically read data from the network without the need for any pre configuration of the device.

Access all DDC Controllers on the network

Embedded Web Server

The system shall have the facility for a Web server to be added to allow full operation of all automation station control modules connected to the LonTalk BACnet network via a standard thin client/web browser. Functions to include

.1 Display of graphical representations of the plant overlaid with live data
.2 Data point display and operation of all measured values, setpoints, plant states, operating states and parameters
.3 Alarm monitoring with acknowledgement and visual and audible alarm indication.
.4 Alarm and event history
.5 Alarm transmission via SMS and e-mail
.6 Operation of all time schedules, exception calendar and heating curves.
.7 Reading of trend data with facility to export data to Microsoft Excel.
.8 Multi user level access protection
.9 Ethernet or Modem connection

All information accessed via the web browser shall be stored in web server device connected to the LonTalk BACnet network to allow access from any PC workstation with suitable Ethernet/IP network or modem connection. No installation of any custom software shall be required on the operators PC workstation.

BACS Web Server software shall support browsers used by Personal Digital Assistants like Siemens, 3Com, Palm Pilots and other Internet appliances.

Field level
Terminal Unit Controllers
All the terminal unit controllers shall fullfil following general requirements:
LONMARK communication
AC230 V power supply
mountable with screws or DIN rail
optional terminal cover for local installation without cabinet
Downloadable application software /adjustable parameter set, The type of use shall be defined by downloadable pre-tested application software.

The Terminal Unit controls on field level shall be capable of:

.1 Process control & interlock functions.
.2 Autonomous operation.
.3 local operating units

Common functions like grouping, scheduling, etc., shall be realised within a master controller on automation level. Each master controller shall have the ability to perform any of all the following routines:

.1 Process control & interlock functions
.2 Generate alarms/events based
.3 Time control strategies
.4 Runtime totalisation

.5 Trend logging of specific data-points with transmission of the logged values to the management level
.6 Energy calculations
.7 Backup of the data/program
.8 Energy calculations
.9 Backup of data/program

Room Units (for local operation)

All the room units shall fulfil the following general requirements:

Ergonomically designed plastic housing
Suitable for wall mounting or mounting flush over standard wall box, cable entry surface or flush;
Include mounting plate and accessories
Two-wire connection to the controller
Standard RJ45 socket for connection of a commissioning and room temperature;
Selection of automatic or manual fan speed control

All terminal unit controllers supplied on the project shall have the facility for local setpoint adjustment via a room unit.

It shall be possible to group the controllers as required (according to building zone or user), these groups being capable of communication over the LON bus.

For each 2-wire bus cable, all controllers connected to the LonTalk data bus must be capable of being operated remotely via service terminals at each controller or room operation unit.

Upward-compatibility with other hierarchical levels, such as operating, management and remote management systems (with the BACnet protocol in addition to manufacturer-specific protocols) is an essential and compulsory requirement.

Terminal Unit Controllers Basic functionality

The controllers shall fulfil the following real-time functions as a minimum:

Control and interlock for specific comfort conditions in rooms and self-contained zones

Provision of optimum comfort for the user while consuming the minimum of energy

The operation of all room functions in accordance with individual requirements, also via LONMARK protocol on the LON bus

Local operation using room operating units with individual adjustment facilities using 2 wire bus.

Remote operation and/or display via LONMARK on the LON bus

Room occupancy determined manually via the room unit or automatically via occupancy sensor

Detection of influencing variables, e.g. via window switches (energy hold-off)

Control of the room temperature in heating and/or cooling mode, and of the air volume (comfort mode)

Room temperature increased or reduced in unoccupied rooms (Stand-by mode)
Individual setpoint resets

Individual allocation of time programmes

Ability to communicate with other controllers, and with higher-level systems for programming and operation, including management stations for purposes such as the use of energy management functions

Integration of all room functions where required, including the facility to combine HVAC control with the control of lighting and blinds

4.36.34.8 Engineering

The possible uses of the controllers shall be defined in the form of pre-programmed standard HVAC applications which can be downloaded from an application library with a software tool. Following pre-tested standard applications shall be at least available:

Fan coil systems:

Electric heating coil
2-pipe system with change-over
2-pipe system with change-over and electric reheater
4-pipe system
4-pipe system with supply air temperature limitation
2-pipe system with change-over and outside air damper
4-pipe system with outside air damper
2-pipe system (cooling) and radiator
4-pipe system with air-side control

Common functions of above fan coil applications:
Window contact, occupancy detector, 3 operating modes
Manual fan control with room unit
Automatic fan control (single-speed or three-speed)
Options with 2-pipe systems: heating only, cooling only or change-over, via LON bus

VAV systems:

Single duct supply or extract air system
Single-duct supply air system with reheater/cooler
Single-duct supply air system with electric reheater
Dual duct supply and extract air system
Dual duct supply and extract air system with reheater/cooler
Dual duct supply and extract air system, with electric reheater

Common functions of above VAV applications:
Window contact, occupancy detector, 3 operating modes
Built-in pressure sensor
DC 0 ... 10 V inputs for external pressure sensors
Control of compact volume controllers
Direct control of damper actuators

Integrated room management applications:

The combined applications shall consist of a HVAC application:
Fan coil
Heated / chilled ceilings and radiators
VAV systems
With one ore more of following electrical functions:
Groups of lights on/off
Groups of lights dimmed
Blinds up/down (with or without slat adjustment as required)

4.36.34.9 Field Level Network

All controllers and other devices shall communicate using the standard LonMark protocol on the LON bus. Network variables, data structures and mechanisms involved shall correspond to the >Integrated Room Management< template supplied by LNO in LonMark.The individual room management system must ensure demand-based control of individual thermal comfort, while at the same timekeeping energy demand to a minimum.

Integration into a common communications network must be achieved peer-to-peer and with the next higher hierarchical level via the LON bus interface and LonMark protocol.

Use of communication standards

Only the following standards are appropriate to be used at the three levels.

.1 Management level- BACnet, Ethernet TCP/IP
.2 Automation level- BACnet on Lon
.3 Field level- LonTalk with LonMark profiles

Where a configuration software tool is used to set-up the network and devices from a number of manufactures to be connected to the same network, only one tool from one manufacturer shall be used to configure the whole project to ensure consistence and interoperability.

If the standard creates a project specific database in order to configure network, the client shall have ownership of that database.

Integration of secondary systems

Integration's shall be carried out at the most appropriate level within a system, depending on the functions and interaction required. The following integrations must be possible.

LonWorks
LonMark
BACNet /LonWorks
BACNet/IP
OPC

Integration of standard proprietary buses :Modbus, M Bus, KNX

As part of the requirements for an open system devices with a Native BACnet protocol shall be connected onto a common field bus backbone network directly without any Gateway/Protocol converter device.

If interaction is required between different sub-systems, the integration shall be carried out at either the automation or field level. The integration must not occur at the management level.

Link to a third party software package such as a Planned Preventive Maintenance package or a Energy Monitoring package shall be carried out at the management level.

When sharing alarm and historical information with Maintenance Management and Energy Management packages, the management system shall provide the information in a standard commercially available format e.g. MS Access and using standard mechanisms e.g. ODBC .

Real-time "live" information shall be transferred form the management system to a third party package e.g. MS Excel, either by a standard inter-application mechanism e.g. DDE or OPC or by developing a connection by using a documented API for the management system.

Where a physical connection is required between a 3rd party device and the management system, the sub-system supplier shall provide the necessary line drivers and cables, documentation and support to make the connection into the device that will provide the protocol conversion.

4.37 SWITCHPANELS AND CONTROL BOARDS

4.37.1 Provide and install, in the positions indicated on the Drawings, switchpanel and control boards complying in operating principals with the automatic control sequences as described before and the relevant control and wiring Diagrams.

4.37.2 The Schematic Control Diagrams serve to illustrate the mode and sequence of operation and the required protection interlocking, and circuits may be modified to accept individual suppliers electrical components selected by in so doing no inherent protection or mode of working shall be adversely affected.

4.37.3 The Subcontractor shall be responsible for the checking and modifying if necessary, of all wiring Diagrams prepared by the Engineer for the guidance of the Subcontractor and any errors shall be brought to the attention of the Engineer before work is started on the equipment or installation.

4.37.4 Before commencing with the manufacture and wiring of the switchpanel and control boards the Subcontractor 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.

4.37.5 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.

4.37.6 The complete electrical installation and all electrical equipment and materials covered under this Subcontract shall comply with the latest edition of the S.A.B.S. Specification. The workmanship and installation shall comply with the "Standard Regulations for the Wiring of Premises".

4.37.7 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.

4.37.8 System Fault Levels for which the switchpanel components shall be designed and selected shall be at least as specified in Section 5 or indicated on the Drawings. It shall be the responsibility of the Subcontractor to ascertain the correct fault level from the Engineer which shall n not less than 5 kA.

4.37.9 All equipment in the switchpanel such as fused switches and moulded case circuit breakers, controlling outgoing circuits, shall be rated accordingly. Where moulded case circuit breakers are not capable of dealing with this fault level, they shall be backed up by HRC fuses which must be capable of being replaced without any other circuit being switched off to do so, and must be capable of being made "dead" for replacement.

4.37.10 Switchpanel and control boards shall be of the floor mounted type for panels having a total face area in excess of 1,2m², and wall mounted if less than 1,2m². Where switchpanel exceed 1,2 metres in length they shall be divided into multi-sections.

4.37.11 All switchpanel, unless otherwise specified, shall be arranged for front access only and top cable entry with the main incoming isolators positioned on the extreme left hand side of each switchpanel. The switchpanel shall be arranged for top exit via cable ducts.

4.37.12 All switchpanel shall be adequately ventilated either by natural or forced ventilation.

4.37.13 When starting equipment creates higher than normal ambient temperatures the switchpanel shall be adequately ventilated by means of splash-proof top ventilating openings provided with vermin proof screens.

4.37.14 The switchpanel and control centres shall be the products of specialist manufacturers 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.

4.37.15 Switchpanel and control centre 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.

4.37.16 Wall mounting panels shall be of the surface type with removable inner mounting chassis.

4.37.17 Floor standing switchpanel and control centres shall be mounted on channel section mild steel bases.

4.37.18 Door widths shall not exceed 900mm for all switchpanel and 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.

4.37.18.1 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 acceptable.

4.37.19 The switchpanel shall be so designed that, with the doors open, no switchgear is exposed, this being concealed behind removable recessed 1,6mm thick cover plates neatly slotted to allow protrusion of circuit breaker toggles only. 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 switchpanel, this equipment being flush mounted on suitable panelled sections of the switchpanel on one side of or above the access doors.

4.37.20 Adequate barriers shall be provided in the switchpanel and control boards to segregate each load circuit compartment from all others, and from the busbar chamber, in such a way that transmission of flame from one compartment to another is minimized.

4.37.21 Each cubicle shall be self-contained and hold only the equipment for one circuit. It shall be capable of being isolated and the equipment worked on without interfering with other equipment. Ample access and space shall be allowed for inspection, repair and replacement of equipment and component parts.

4.37.22 The electrical equipment within the panels shall be mounted on steel chassis located behind the coverplates previously referred to. Such chassis shall also be used for the mounting of the relevant busbars.

4.37.23 The finish of the panels shall be epoxy powder coated or baked enamel. The boards shall be given three coats of paint after an initial coating of zinc-rich primer to give a high-class gloss finish.

4.37.24 Busbars shall be provided in hard drawn annealed copper loaded to not more than 1,55 Amps/mm^2 of copper on a 50^{o}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 40 000 Amps 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.

4.37.25 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 up after all connections are made

4.37.26 Neutral bars are to be not less than half the cross-sectional area of 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.

4.37.27 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.

4.37.28 Earthing strips of not less than 25mm x 6mm copper shall run 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.

4.37.29 Wall mounted switchpanel shall be provided with an earthing brass bolt of not less than 10mm diameter, securely fixed to the panel chassis.

4.37.30 All wiring within the panels shall be neatly grouped in horizontal and vertically run approved fire resistant P.V.C. trunking with clip-on removable covers. All wiring shall also be colour-coded in the colours red, yellow and blue for the relevant phases and black for neutral, the busbars being similarly marked.

4.37.31 Power wiring shall be of 2,5mm² minimum section P.V.C. covered stranded wire rated for 600 volts.

4.37.32 Control wiring shall be minimum 1,5mm² P.V.C. covered, stranded, 250 volt grade wire with bared ends soldered.

4.37.33 All switchpanel shall be carefully designed and sized to ensure ample space for wiring and making-off incoming cables.

4.37.34 Fused switches shall be of the fault making, load breaking type selected for the continuous rating of not less than the full load rating of the equipment which they control.

4.37.35 All fused switches shall be of the 500 volt metal clad type with self-aligning switch contacts of the quick make and break type having two breaks in series per pole. Switch covers are to be hinged and mechanically interlocked so that the cover can be only opened with the switch in the "off" position. Cartridge fuse links shall be fitted on each live pole. The sizes of the fuses shall be determined by the load or starting characteristics of motors and the system fault level.

4.37.36 All fuses shall be of the HRC type with a 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.

4.37.37 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.

4.37.38 Isolators installed within the switchpanel 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 disconnecting switch while the enclosing door is open unless a manual bypass 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 be longer than 100mm. Provision shall be made available for padlocking the disconnect switch in the open position only with up to three 10mm shackle padlocks regardless of whether door is open or closed.

4.37.39 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.

4.37.40 Moulded case air circuit breakers shall be rated to comply with the fault level and current rating specified to suit the load and shall be fitted with thermal overloads and instantaneous magnetic over-current releases.

4.37.41 The breaking capacity, in kilo-amps, shall be suitable for the prospective fault current expected in the circuit. Under-voltage shunt trips shall not be incorporated unless specifically called for.

4.37.42 Miniature circuit breakers shall be to S.A.B.S. 156/1963. All parts of the mechanism shall be of corrosion resisting material or suitable protected by plating or other approved means to prevent corrosion from normal atmospheric conditions. All circuit breakers shall, as far as possible, be of the same type and manufacture throughout the installation.

4.37.43 Current transformers shall be air insulated and shall have an accuracy within 2% of the 0-100% scale output.

4.37.44 Magnetic contractor 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 contacts, either normally open or normally closed. Contacts and coils shall be replaceable without removing the entire contactor from the cubicle.

4.37.45 Motor Starters shall comply with BS775 and NEMA specifications and shall have two 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 non-teasable snap action contacts cannot be held closed against continued overload. The ultimate trip current of overload devices shall be a nominal 115% of the motor full load current. With special hard starting, e.g. axial flow 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.

4.37.46 Control relays shall be either of the heavy duty industrial type, 600 volt with minimum 10 ampere replaceable contacts and shall be equipped with 220 volt, 50 Hz holding coils for continuous operation within a voltage range of 200 to 260 volts. Holding coils shall be replaceable without removing the entire relay from the cubicle or;

4.37.47 Alternatively the control relays may be of the plug-in type, hermetically sealed in plastic containers.

4.37.48 Phase Reversal Relays shall contain contacts so that on failure or phase reversing the plants will stop. The relays shall be equal to Cutler-Hammer Igranic and shall be installed as indicated on the Wiring Diagrams.

4.37.49 Timers shall be of the synchronous drive type equal to SIEMENS or TESCH.

4.37.50 Rotary switches shall be gauged type, minimum rating 6 amperes at 220 volts single phase, have engraved plastic faceplates for usage designation and equal to Telux or Kraus & Naimer. Where called for they shall be key operated type, supplied with three sets of keys.

4.37.51 Sequence controllers to start plant with minimum of 15 seconds time delay between each start-up of motors of 5kW and over shall be provided to avoid heavy current inrush on plant start-up. Sequence controllers shall be synchronous motor driven type and shall automatically recycle to zero position after power interruption and on normal plant shutdown.

4.37.52 Pilot lights shall be of the low voltage incandescent, multi-lamp, push to test type, equal to SWISSTAC SERIES 2, with 18 x 24mm rectangular "plexiglass" face engraved to indicate the function as noted on the Wiring Diagrams. The colours of the face plates shall be as noted on the Wiring Diagrams to generally indicate the following:

Indication	- Amber
Operation	- Green
Failure or Alarm	- Red

4.37.53 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.

4.37.54 Reset Pushbuttons shall be similar in appearance and size to the pilot lights, equal to SWISSTAC SERIES 2, and shall be mounted adjacent to the Red Failure or Alarm pilot lamps on the switchpanel.

4.37.55 The main incoming switch of each switchpanel shall be fitted with three Ammeters and one Volt meter with selector switch.

4.37.56 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.

4.37.57 Ammeters shall be fitted where specified or shown on the Drawings. Ammeters over 50 Amps shall be operated by current transformers of the ring type. Ammeter shall have an accuracy of 2% of the scale range or better. For non-inductive loads the scale of the 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 expanded scale in the region of the operating current.

4.37.58 Volt Meters shall be of the moving iron or moving coil type.

4.37.59 All indicating instruments shall be of the flush mounted square faced pattern with 96mm dials.

4.37.60 Pressure and temperature reference instruments shall be anti-vibration mounted where they may be subject to vibration.

4.37.61 Compensating cables to be run separate from all other cabling.

4.37.62 Each power circuit shall be contained in its own, individually isolatable compartment, and shall be furnished with its own circuit breaker as shown on the Drawings.

4.37.63 Each control circuit shall be protected with a single pole miniature circuit breaker. Controls shall be suitable for 220 volt operation.

4.37.64 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 free and be 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 and field wiring shall be marked accordingly by means of numbered ferrules. Not more than one incoming and one outgoing wire shall be fixed to any one terminal.

4.37.65 Labels showing the unit designations shall be provided adjacent to each of the terminals.

4.37.66 The Switchpanel shall be fully labelled with engraved black ivorine labels having 6mm high white lettering. The labels shall be riveted to switchpanel cover or chassis plates to identify all switchgear, relays, instruments and controls, etc., on the face of or inside the switchpanel.

4.37.67 Equipment operating above 250 volts shall be fitted also with a red danger label.

4.37.68 Embossed Tape or Labels fixed with adhesive will not be acceptable.

4.37.69 The Subcontractor shall be responsible for marking all switchgear and other equipment on the wiring diagrams with the working of the labels to be used.

4.37.70 All cable terminals shall be clearly identified by permanent labels.

4.37.71 Every wire inside and outside the switchboard shall be fitted with ferrules and labelled with identical numbers at both ends.

4.37.72 All terminal numbers and wire identification numbers shall correspond with identical numbers which must be shown on the wiring and control diagrams.

4.37.73 Works tests may be witnessed at the discretion of the Engineer, who shall be given one month'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 14 days before testing can be commenced.

4.37.74 Testing shall be carried out on all complete equipment, including;

4.37.75 High voltage insulation and insulation resistance tests to earth and between phases.

4.37.76 Satisfactory operation of relays shall be proved.

4.37.77 Closing and opening operation of all starters and contactors shall be satisfactorily demonstrated.

4.37.78 All mechanical interlocks shall be satisfactorily demonstrated.

4.37.79 Satisfactory operation of pilot lights.

4.37.80 Satisfactory operation of current and voltage instruments.

4.37.81 Operation of all control circuits shall be proved by simulating operation of switching devices in the external circuit.

4.37.82 In addition, all components parts shall comply with the type tests specified in the S.A.B.S. or B.S. Standards.

4.37.83 The pre-delivery test is not a final acceptance test, and does not absolve the Subcontractor from his responsibility for the switchpanel.

4.37.84 All protective devices throughout shall be correctly set by the Subcontractor to the approval of the Engineer. Before any circuit is energised, the Subcontractor is required to obtain all the necessary data for correct settings to be established.

4.37.85 The Subcontractor shall be responsible for the complete electrical installation. Selection of equipment of appropriate rating and capacity, including the rupture capacity of fuses and circuit breakers, covered under this Subcontract.

4.37.85.1 Provide for each item of equipment located out of sight of the electrical switchpanel serving same, a remote lock-up stop housed in a dustproof case. Where located in positions exposed to the weather, they shall be waterproof type fitted with suitable watertight cable entry glands.

4.38 ELECTRICAL CABLING AND WIRING

4.38.1 General

4.38.1.1 Mains electricity supplies as relevant, will be provided by others, including making-off of cables within the electrical switchpanel provided by the air conditioning Subcontractor who shall attend upon and liaise with whoever brings power cabling to his switchpanel.

4.38.2 Cabling

4.38.2.1 Termination of P.V.C. insulated armoured cables

4.38.2.1.1 All cables shall be terminated with approved glands ensuring a watertight connection between the sheath, gland and equipment. In cases where copper earth conductors are joined to the armouring, special glands adhering to S.A.B.S. 150-1970, shall be used.

4.38.2.1.2 The glands to be used shall be constructed so that the armouring of the cable is clamped between two bevelled cores with a screw-clamp.

4.38.2.1.3 Glands shall be suitable for PVC SWA and PVC sheathed general purpose 600/1 000 volt cable.

4.38.2.1.4 The non-watertight glands shall be easily converted to watertight glands by means of sealing rings and waterproofing shroud. The glands shall be Pratley, Captive Cone or other approved type. The glands shall be fitted with an earth terminal.

4.38.2.1.5 On the cable entry side of the barrel, a groove shall be provided, to accommodate a rim of the waterproof shroud.

4.38.2.1.6 The shrouds shall be made of non-deteriorating neoprene or synthetic rubber, and shall be resistant to water, oil and sunlight. The shrouds shall fit tightly around the glands and cable.

4.38.2.1.7 Epoxy-resin jointing materials shall be "Scotch-Cast" Splicing Kits or approved alternative and shall be used strictly in accordance with the supplier's recommendations.

4.38.2.1.8 Copper cables shall be terminated either by crimped or soldered lugs. Termination of aluminium cables are to be made by a method approved by the Engineer.

4.38.2.1.9 The cable gland shall be screwed to the gland plate or equipment and fixed with a locknut.

4.38.2.1.10 A Neoprene or P.V.C. shroud shall be used to seal the gland and sheath watertight.

4.38.2.1.11 Cable cores shall be connected to equipment with suitable lugs.

4.38.2.1.12 Exposed armouring shall be covered with bitumen-base paint.

4.38.2.1.13 Cable ends shall be supplied with the necessary earth connection.

4.38.2.1.14 A P4000 "SANKEYSTRUT" channel or other approved means of support shall be provided to remove mechanical stress from the cable glands.

4.38.2.2 Connection of cable cores

4.38.2.2.1 Ferrules shall be used as far as possible where cable cores are connected directly to equipment with screws against the conductor strands. Alternatively cable ends shall be soldered.

4.38.2.2.2 Contact surfaces shall be cleaned properly where cable cores are bolted onto terminals. Suitable lugs shall be used.

4.38.2.2.3 Lugs may be crimped or soldered. For larger size cables purpose designed mechanical or pneumatic crimping tools shall be used.

4.38.2.2.4 Care shall be taken to leave no strands exposed when cutting away insulation from cable cores to fit into lugs.

4.38.2.2.5 The correct size of lugs shall be used for each size of conductor.

4.38.2.3 **Fixing of cables**

4.38.2.3.1 Cables may be installed in one of the following ways:

On horizontal cable trays,
Against vertical cable trays with suitable clamps,
Against horizontal or vertical metal supports or brackets with suitable clamps, or
On clamps which are fixed to the structure.

4.38.2.4 Clamps

4.38.2.4.1 Suitable clamps (cleats) which will secure cables without damage shall be used. Clamps shall consist of adjustable metal wings which clamp to a metal support, or consist of two halves that are bolted together. Wooden blocks shall only be used in exceptional circumstances with the approval of the Engineer. The correct clamps size to fit the cable shall be used. Cables of different sizes may only be fixed by a common clamp when the clamp is specially made to accommodate the various cables.

4.38.2.5 Distance between fixings.

4.38.2.5.1 The maximum spacing between cleats (clamps) to which the cables are fixed in horizontal and vertical cable routes shall be determined from the table below. Additional cleats shall be installed at each bend or offset in the cable run. The maximum distance between supports or cleats for multi-core cables shall be 20 times the outside diameter of the cable with a maximum spacing of 550mm for unarmoured cables and 30 times the outside diameter of the cable with a maximum spacing of 900mm for armoured cables.

4.38.2.6 Maximum spacing of support cleats (mm)

Cross-Sectional	Armoured Cables		Unarmoured Cables		Mineral Insulated Cables	
Area of Cable	Cable Routes		Cable Routes			
Conductors mm²	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical
1,5	450	750	300	400	600	
2,5	450	750	300	400	600	
6,0	600	750	300	400	600	
10,0			750	900	400	450	900
16,0			750	1000	450	550	900
25,0			900	1000	450	550	1200
35,0			900	1000	450	550	1200
Larger than 35,0			900	1000	450	550	1200

4.38.3 **Wiring and Conduits**

4.38.3.1 **E**xcept in cases where cables are specified, all wiring shall be P.V.C. insulated, single core stranded copper conductors and bare stranded or green P.V.C. insulated copper conductors for earth continuity in compliance with S.A.B.S. 150 and the installation shall comply with S.A.B.S. code of practice for the wiring of premises S.A.B.S. 0142-1981 as amended.

4.38.3.2 The colour of the conductors for all 220V circuits shall correspond to the colour of the supply phase for that circuit. Neutral conductors shall be black. All other conductors in the board, supplying control circuits, etc. shall be coded in colours other that those specified above. A colour code shall be devised for each board and the colour code shall be shown on the wiring Diagrams. All conductors that terminate at terminal strips and all conductors used for the internal wiring of the switchboard, shall further be identified at both ends by means of durable cable marking ferrules. P.V.C. or other tape is not acceptable. The numbers of the markers shall also be shown on the wiring Diagrams.

4.38.3.3 Conduits shall be heavy gauge, welded or solid drawn to S.A.B.S. specifications. All joints shall be screwed. No conduit less than 200mm shall be used. Conduit fittings and boxes shall be of enamelled malleable iron.

4.38.3.4 Galvanised conduits and conduits fittings shall be installed in positions exposed to weather, or in moist surroundings. Where galvanising has been removed by threading, cutting, etc., the exposed parts shall be suitably treated or painted to render weatherproof, and rust resistant.

4.38.3.5 Conduit shall either by screwed and locknutted to, or 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.

4.38.3.6 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.

4.38.3.7 No conduit is to cross an expansion joint in the structure without an approved arrangement for crossover. Where details of crossover are not given, the Subcontractor shall refer to the Engineer for instructions.

4.38.3.8 The Subcontractor 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.

4.38.3.9 Conduit for future requirements shall be terminated with boxes and overlapping coverplates, 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.

4.38.3.10 Inspection facilities shall be provided at every third change of direction in a run of conduit and at maximum intervals of 10 meters on straight runs. The use of tees and elbows will only be allowed in exceptional cases and shall be inspection type.

4.38.3.11 Exposed conduits shall be fixed with steel saddles of same finish as conduit on centres not exceeding 2 meters.

4.38.3.12 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.

4.38.3.13 Drawboxes and blank boxes in R.C. slabs, beams, 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.

4.38.3.14 Drawboxes in roof spaces which are only accessible above ceiling, shall not be installed in positions where clearance from ceiling to roof is less than 1 meter.

4.38.3.15 Blank switch and plug boxes shall be fitted with blank coverplates and screws to match those specified for switches and switch sockets.

4.38.3.16 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.

4.38.4 **Earthing**

4.38.4.1 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.

4.38.4.2 Each run of P.V.C./S.W.A. multi-core cable or mineral sheathed cable shall carry an additional conductor to be used for earth continuity and properly made-off for this purpose. On P.I.L.C.S.W.A. cable use a separate bare stranded copper earth continuity conductor with minimum section 1/2 of size of conductor inside cable.

4.38.5 **Cable Trays**

4.38.5.1 The Subcontractor shall supply and install all cable trays or ladders as specified or as required by the cable routes including the necessary supports, clamps, hangers, fixing materials, bends, angles, junctions, reducers, T-pieces etc.

4.38.5.2 For coastal areas CABRAC CABLE TRAYS or equal and approved shall be provided as supplied by B.R.C. Weldmesh (Pty) Limited, Telephone No. (011) 894-3246/9.

4.38.5.3 The cabrac shall be the medium duty type pre-galvanised epoxy coated.

4.38.6 **Cable Ladders**

4.38.6.1 **General**

4.38.6.1.1 Metal cable ladders shall consist of 76mm high side rail of 2mm minimum thickness. Cross pieces consisting of P3300 "SANKEYSTRUT" channel sections shall be spaced at maximum intervals of 250mm. Where cables of 10mm² or smaller are installed on cable ladders, the spacing of the cross pieces shall be 125mm. Cables shall be clamped in position by means of purposes made cable clamps that fit into the cross pieces. Cross pieces consisting of slotted metal rails which accommodate plastic or metal cable binding bands, may be used in vertical cable runs against walls etc. where the prior approval of the Engineer has been obtained. These cross pieces are not acceptable in horizontal cable runs.

4.38.6.2 Finishes

4.38.6.2.1 Metal cable ladders shall be finished as follows:

In coastal areas	hot-dipped galvanised to S.A.B.S. 763 or epoxy powder coating
False ceiling voids	electro-galvanised or epoxy powder coating
Vertical building ducts	hot-dipped galvanised to S.A.B.S. 763 or epoxy powder coating
Plant rooms, substations, service tunnels, basements	electro-galvanised or epoxy powder coating
Damp areas, exposed	hot-dipped galvanised to S.A.B.S. 763 or epoxy powder coating
Undercover industrial applications	hot-dipped galvanised to S.A.B.S. 763 or epoxy powder coating

4.38.6.2.2 The abovementioned finishes shall apply unless specified to the contrary in the Detailed Technical Specifications. Hot-dipped galvanised or electro-galvanised trays and ladders shall be cold galvanised at all joints, sections that have been cut and at places where the galvanising has been damaged. Powder coated trays and ladders shall likewise be touched up at joints, cuts and damaged portions using spray canisters recommended by the manufacturer of the trays and ladders.

4.38.6.3 Supports

4.38.6.3.1 Trays shall be supported at the following maximum intervals:

1,6mm thick metal trays	- 1m maximum spacing
Metal trays with folded over return and 50mm upstand	- 1,22mm spacing
2,4mm thick metal trays, and 75mm return	- 1,5m spacing
Metal cable ladders	- 1,5m spacing
3,0mm thick P.V.C. trays with 40mm return	- 1,0 maximum spacing
4,0mm thick P.V.C. trays with 60mm return	- 1,5m maximum spacing

4.38.6.3.2 In addition trays and ladders shall be supported at each bend, off-set and T-junction.

4.38.6.4 Joints

4.38.6.4.1 Joints shall be smooth without projections or rough edges that may damage the cables. The Subcontractor will be required to cover joints with rubber cement or other hardening rubberised or plastic compounds if in the opinion of the Engineer joints may damage cables. Joints shall as far as possible be arranged to fall on supports. Where joints do not coincide with supports, joints shall in the case of trays with single returns (items (a) and (c) of 4.15.8) be made by means of wrap-around splices of the same thickness as the tray and at least 450mm long.

4.38.6.4.2 The two cable tray ends shall butt tightly at the centre of the splice and the splice shall be bolted to each cable tray by means of at least 8 round head bolts, nuts and washers. Splices shall have the same finish as the rest of the tray. Where joints which do not coincide with supports occur in trays with folded over returns, tight fitting metal guide pieces, at least 450mm long, shall be inserted in the folded returns to provide the necessary support to the two cable tray ends. Splices as described above shall be provided if trays sag.

4.38.6.5 Fixing

4.38.6.5.1 Trays shall be bolted to supports by at least two hexagon headed bolts and nuts per support. Bolts shall be securely tightened to avoid cables being damaged during installation. The use of square nuts may not be permitted.

4.38.6.6 Fixing to the structure

4.38.6.6.1 The supports for cable trays and ladders shall in all cases by securely fixed to the structure by means of heavy duty, expansion type anchor bolts. It is the responsibility of the Subcontractor to ensure that adequate fixing is provided since cable trays and ladders that work loose shall be rectified at his expense.

4.38.6.7 Accessories

4.38.6.7.1 Horizontal and vertical bends, T-junctions and cross connections shall be supplied by the Subcontractor. The dimensions of these connections shall correspond to the dimensions of the linear sections to which they are connected. The radius of all bends shall be 1000mm minimum. The inside

dimensions of horizontal angles or connections shall be large enough to ensure that the allowable bending radius of the cables is not exceeded. Sharp angles shall have a 45º cornice.

4.38.6.8 Installation of cables

4.38.6.8.1 Cables shall be installed adjacent and parallel to each other on the trays with spacings as determined by the current ratings. Horizontal trays and ladders shall in general be installed 450mm below slabs, ceilings etc. to facilitate access during installation.

4.38.6.9 Earthing

4.38.6.9.1 Metal trays and ladders shall be bonded to the earth bar of the switchboard to which the cables are connected. Additional bar copper stranded conductors or copper tape shall be bolted to the tray or ladder where the electrical continuity cannot be guaranteed.

4.38.7 **Cable Trunking**

4.38.7.1 **Construction**

4.38.7.1.1 Cable trunking shall consist of butting sections constructed from high grade sheet steel having a minimum thickness of 1,6mm.

4.38.7.1.2 It shall be rust proofed by an approved metalising process, finished with one coat of rust resisting paint and one coat of high grade stove enamel.

4.38.7.1.3 The lids of the trunking shall be made from the same material, shall be removable over the whole length of the trunking and secured at centres not greater than 450mm.

4.38.7.1.4 Adjoining lengths of trunking shall be correctly aligned and the two sides at right angles to the cover shall each be joined to the corresponding sides of the adjacent trunking by means of internal fishplate connectors.

4.38.7.2 Installation

4.38.7.2.1 Support of cable trunking shall be at least as follows:

Trunking Size	Maximum spacing of Hangers and Fixings
Up to 76 x 76mm	600mm centres
Up to 150 x 76mm	1 000mm centres
Up to 380 x 200mm	1 200mm centres

4.38.7.2.2 The trunking shall be mechanically continuous throughout. At each joint in the trunking continuity shall be maintained by the installation of copper or brass links secured by brass nuts, locking washers or bolts. Self-tapping screws will not be acceptable.

4.38.7.2.3 All tees, reducers, angles and other accessories for trunking shall have folded and welded corners.

4.38.7.2.4 All trunking bends shall be of easy sweep design with fillet corners, and where branch or cross-over connections are made the edges of the apparatus shall be rendered smooth with approved edging strips.

4.38.7.2.5 Where trunking is not directly fixed to surfaces it shall be hung from straps or rod hangers arranged to support the trunking rigidly in both directions.

4.38.7.2.6 Where inverted trunking is used the cables shall be retained in their individual compartments by clips at not less than 1m intervals. Groups of cable shall be secured within the trunking with plastic tape.

4.38.7.2.7 The Electrical Subcontractor shall arrange his layout of trunking in conjunction with other trades and no work shall commence until the Electrical Subcontractor has verified that his trunking will not clash with the services of other trades by means of co-ordination Drawings to the Engineer's approval.

4.38.7.2.8 Adequate allowance shall be made for expansion and contraction on all runs and where the trunking passes over expansion joints in the building structure, expansion couplers shall be provided.

4.38.7.2.9 Care shall be taken to ensure that water, concrete and other foreign matter are not allowed to enter trunking particularly where trunking is cast into or through structural concrete or floor screeds.

4.38.7.3 **Coverplates**

4.38.7.3.1 All channels up to 125mm wide shall have snap-in cover plates of metal or P.V.C. Cover plates for wider channels shall be of metal and shall be fixed by means of screws which shall permanently be tapped into the cover plates spaces at suitable intervals to prevent warping. The finish of the covers shall comply with paragraph 4.10.9.

4.38.7.4 Connections

4.38.7.4.1 Adjoining lengths shall be correctly aligned and securely joined by means of fishplates and mushroom bolts, washers and nuts or connection pieces that are pop-rivetted to both adjoining sections. All adjoining sections shall be rectangular and shall butt tightly. Covers shall fit tightly across the joint.

4.38.7.5 Vermin proofing

4.38.7.5.1 All cable channels shall be vermin proof after installation. Holes shall be covered by means of screwed metal plugs or by means of metal strips that are bolted or pop-rivetted to the channel. Wooden or other plugs which are driven into holes or other temporary plugs or covers are not acceptable.

4.38.7.5.2 When installing trunking the Subcontractor shall ensure that:-

4.38.7.5.3 When cut, filled or drilled, the connections shall be given one coat of approved anti- corrosive paint subsequent to the removal of all burrs.

4.38.7.5.4 When conduits enter trunking, the connection shall be made with two locknuts and a female brass bush.

4.38.7.5.5 All burrs caused by drilling or machines shall be removed prior to the installation of cables and the fixing of lids.

4.38.7.6 **Internal finishes**

4.38.7.6.1 All bends shall be of easy sweep design with 45º cornices. Burrs and sharp edges shall be removed and the inside edges of all joints shall be lined with rubber cement or other suitable rubberised or plastic compound to prevent conductor insulation laceration.

4.38.7.7 Services

4.38.7.7.1 Multiple duct runs or internal metal partitions shall be used where conductors for power, control and other services are present.

4.38.7.8 **Materials and finishes**

4.38.7.8.1 Cable ducts shall be of the "SANKEYSTRUT" type or similar. The ducts shall be rolled from 1,2mm minimum sheet steel and shall be finished as follows:

In coastal areas (under all installation circumstances)		hot-dipped galvanised to S.A.B.S. 763 or epoxy powder coating
Cast in concrete	- pre-galvanised	hot-dipped galvanised to S.A.B.S. 763 or epoxy powder coating
False ceiling voids	-	hot-dipped galvanised to S.A.B.S. 763 or epoxy powder coating
Surface mounted in plant rooms, substations, service tunnels, basements -		epoxy powder coating or electro-galvanised
Damp areas, exposed to weather, underground runs in contact with earth		hot-dipped galvanised to S.A.B.S. 763 or epoxy powder coating
Undercover industrial applications		hot-dipped galvanised to S.A.B.S. 763 or epoxy powder coating

4.38.7.8.2 Hot-dipped galvanised or electro-galvanised ducts shall be cold galvanised at all joints, sections that have been cut and at places where the galvanising has been damaged. Powder coated ducts shall likewise be touched up at joints, cuts and damaged portions using spray canisters recommended by the manufacturers of the channels.

4.39 INSTRUMENTS

4.39.1 Provide and install instruments where shown on the applicable Drawings or mentioned herein as follows, the instruments to be fully metricated to local standards. 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.

4.39.2 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 plated. All panel mounted instruments shall be suitable for flush mounting and fixing from within the panels without screws projecting through the panels.

4.39.3 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 any minimum and/or maximum limits.

4.39.4 Air and water temperatures shall be measured with stem or remote bulb 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.

4.39.5 Stems or bulbs sensing temperatures in pipes shall be fitted into oil filled brass wells and bulbs in ducts or plena shall be neatly fitted on insulated brackets to the satisfaction of the Engineer.

4.39.6 Bulbs sensing wet bulb temperatures shall be provided with suitable cotton socks and copper/brass wet bulb tank with ball float make-up piped to raw mains water supply, overflow and drain connection, the latter piped to drain. Wet bulb tanks shall preferably be the product of a control instrument manufacturer. Two spare cotton wicks per wet bulb sensor shall be provided.

4.39.7 Water pressure gauges shall be glycerine filled Bourdon tube type, scaled from 0 to 150% of operating pressure and of steam quality and first grade accuracy. Each pressure gauge shall be preceded by a siphon tube and high quality gauge cock.

4.39.8 Orifice plates complete with cocks shall be provided and installed at all positions necessary to enable readings to be taken of water flow quantity. The orifice plates shall fit between flanges in the water piping and be provided with permanently affixed brass engraved plates indicating orifice diameter. Orifice plates shall be as supplied by NEGRETTI & ZAMBRA and sized to use standard water flowmeters as procurable from the firm from which orifice plates are purchased. The Subcontractor shall note that he shall be responsible to set water quantities by use of the orifice plates and shall therefore be in possession of a portable flowmeter suitable for the orifice plates he installs.

4.39.9 Air pressure gauges shall be 50mm dial scaled from 0 to 150% of normal operating pressure, equal to JOHNSON CONTROLS manufacture.

4.39.10 Static pressure indicators shall be of the diaphragm actuated, dial and pointer 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.

4.39.11 Kilowatt-hour meters shall be of the house service type, approximately 162 x 112 x 100mm deep, of robust construction, housed in a dust proof sealed metal or plastic case, shall utilise a magnetic suspension for the disc and shall comply with BSS 37.

4.39.12 The meter element shall be suitable for operation on single phase, or three phase as specified, 50 Hertz AC system and shall be of the indicator type, capable of continuously carrying the rated current. Accuracy shall be "Commercial Grade" as defined in S.A.B.S. 01.

4.39.13 The registering mechanism shall be of the cyclometer type giving a reading of six figures, the lowest indicating tenths of a unit.

4.39.14 The meters shall be suitable for the supply voltage specified and the rated current shall be as directed.

4.39.15 Voltmeters shall be of the moving iron flush mounting type, rectangular or circular and size as specified. They shall be suitable for vertical switchboard mounting and studs shall be provided for back connection. The voltmeters shall be suitable for operation on a 50 Hertz system, and be calibrated as required. The voltmeters shall be manufactured in accordance with BSS 89 to industrial grade accuracy as specified therein.

4.39.16 The voltmeters shall be protected by high rupturing capacity cartridge fuses to S.A.B.S. 172 : housed in suitable insulated fuse carriers with a panel-mounted base. Voltmeter selector switches shall be incorporated.

4.39.17 Ammeters shall be and of the moving iron flush mounting type and of the pattern, size and scale range as specified. Ammeters for use in motor circuits shall have a suitably compressed overload range.

4.39.18 Ammeters selector switches shall be installed if specified. Selected switches having spring loaded contacts running over copper segments are not acceptable.

4.39.19 Combined maximum demand and indicating ammeters shall be flush panel mounting, rectangular in shape, the dial size being approximately 125 x 125mm or 80 x 80mm as specified. The ammeters shall comply with BSS 89.

4.39.20 The instrument shall comprise a moving iron ammeter showing the instantaneous current value, combined with a maximum ammeter employing a bimetallic spiral device which will indicate the mean current value on the basis of a 15 or 30 minute period as noted, and which is fitted with a residual pointer to indicate the maximum mean current reached during any period between manual resetting.

4.39.21 All three indications shall be registered on concentric scales, and instruments having small moving iron ammeters with window cut-outs scales are not acceptable. The bimetallic system shall incorporate ambient temperature compensation.

4.39.22 The instrument shall be used with a current transformer having a 5 ampere secondary winding. 6 Ampere or 8 ampere instruments may be offered, scaled to the full load primary current of the current transformers, with an additional overload scale in the case of 6 amp instruments.

4.39.23 Power factor indicators shall be housed in pressed steel cases. Shadowless scale plates shall be fitted. Instruments shall comply with BS 89. Indicators shall be suitable for flush mounting in switchboards. Current rating shall be 0,5 to 5 A continuous at the rated voltage. Power factor range shall be from 0,5 PF lead to 0,5 PF lag, and size shall be as specified.

4.39.24 Elapsed time meters shall be of the flush mounting type, square phenolic frame, suitable for switchboard mounting. Registers shall be calibrated in hours and tenths of hours. Cyclometer details to be noted. Voltage range shall be 200 - 250 V 50 Hz unless otherwise noted. Motors shall be self-starting, synchronous, non-reversing and shall be energised from the same supply as the apparatus being metered.

4.39.25 Transducers shall be suitable for use in remote indication systems for alternating current and voltage using lightweight telephone type pilot wires. Outputs shall be suitable for operating moving coil instruments and recorders.

4.40 EQUIPMENT BASES

4.40.1 Provide, as called for in the detailed specification or as indicated on the Drawings, equipment bases of the applicable type as specified below:

4.40.2 Inertia bases shall comprise a reinforced concrete pad of mass one and a 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 Subcontractor. 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 it. 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 a 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 provision in the design and construction of the steel tray being made for the attachment of the necessary vibration isolating mountings.

4.40.3 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 plastered 80mm high "housekeeping" plinth on which to mount the aforementioned steel base, the plinth to be 100mm minimum larger than the base all round.

4.40.4 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.

4.40.5 The Subcontractor shall provide and position, where required, a channel iron frame, with mitred welded corner joints, and sheet-metal bottom tray for the Principal Contractor to fill with concrete. The finish of the plinths shall be tinted granolithic.

4.40.6 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.

4.40.7 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., although other approved makes would also be acceptable.

Equipment	Minimum Static Deflection	Type of Mounting	Model
Centrifugal chillers and Reciprocating Compressors/Chillers	50mm	Helical spring with levelling adjustment	SLF
Cooling Towers over or non-occupied areas		Neoprene Vibration Pads	NK WMW
Over occupied areas with levelling adjustment	To suit fan speed	Restrained Helical spring	SLR
Centrifugal Pumps or over non-occupied areas		Neoprene Vibration Pads	NK WMW
Over occupied areas	25mm	Helical Spring with levelling adjustment	SLF

Equipment	Minimum Static Deflection	Type of Mounting	Model
Fans			
Up to 500 rpm 500 to 1200 rpm Above 1200 rpm	65mm	Helical Spring with levelling adjustment	SLF
Axial Flow Fans	6mm	Neoprene in sheer and compression	3ON
Air Conditioning units Air Handling units and Condensing units on concrete floors or bases	To suit fan speed	Neoprene Vibration Pads	NK or WMW
Air handling units and Air Conditioning units over occupied areas	To suit fan speed	Helical spring with levelling adjustment	SLF
Minor rotating and equipment in non-critical areas	6mm	Neoprene in sheer compression	N

4.40.8 Full details of all floating steel bases and all anti-vibration mountings selections shall be approved by the Engineer prior to the mountings being ordered and the bases fabricated.

4.40.9 Where applicable, the Subcontractor shall exercise particular care to prevent damage to the roof slab waterproofing when hoisting, positioning and connecting plant and equipment and shall note that he will be held responsible to repair any damage caused as a result of this installation.

4.40.10 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.

4.41 EQUIPMENT SUPPORTS

4.41.1 Where equipment supports, stands, platforms and suspension brackets are indicated, specified or necessary for ductwork, pipework, tanks, air handling units, cooling towers, etc., the Subcontractor 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.

4.41.2 Supporting of any rotating equipment shall incorporate vibration mountings of the type and selection specified in the applicable clauses referring to equipment bases herein.

4.41.3 All methods of suspension or supports shall be submitted to the Engineer for approval and for reference to the Structural Engineers where necessary, prior to manufacture or installation.

4.41.4 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 riveted 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 be of minimum diameter 12mm. For longer suspensions use mild steel angles. Angle iron supports shall be of 38mm x 5mm minimum. All supporting structures for equipment located in unprotected areas shall be hot dip galvanised.

4.41.5 Fastening methods shall employ REDHEAD or RAWBOLT anchor bolts or their equivalent, for fixing supports to the building structure, it not being permissible to utilise gunpowder shotdriven bolts for this purpose unless prior approval be obtained.

4.41.6 Pipework supporting holderbats shall be the product of a recognised manufacturer of such equipment, shop-fabricated saddles or similar devices being unacceptable unless limited space available necessitates their use. On insulated pipework, hardwood inserts consisting of two half-round machine cut pieces of timber shall be clamped around the pipe, insulation being cut away at any such points, to allow proper support fitting. 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 or vapour sealing to them.

4.41.7 Flexible pipes shall be supported on Unistrut or equivalent perforated galvanised cable tray, manufactured by specialists, shop-fabricated trays or racks not being acceptable. The cable tray shall be suspended or bracketted using suitable mild steel angles.

4.41.8 Reference shall be made to manufacturer's requirements regarding equipment supports and these requirements shall be fully complied with.

4.42 NOISE AND VIBRATION

4.42.1 Particular care shall be taken in the selection, application and installation of all equipment used to ensure that if operates below the maximum allowed noise levels, as specified in Part Five hereof, and with the least vibration possible, all to the full satisfaction of the Engineer.

4.42.2 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.

4.42.3 Rectangular ductwork in the vicinity of critical areas shall be provided with internal acoustic insulation.

4.42.4 Anti-vibration cuff connections or flexible joints shall be used on ductwork where it joins vibrating equipment such as fans and air conditioning units.

4.42.5 Pipework connecting rotating or vibrating machinery shall be provided with anti-vibration flexible joints, all as previously specified.

4.42.6 Equipment shall be mounted on vibration isolators of the correct type and selection, dependent upon deflection requirements versus vibrating frequency.

4.42.7 Pipework and ductwork shall be suspended or mounted using suitable supports with vibration isolators to prevent transmission of vibration from them to the structure to which they are attached, where necessary only.

4.42.8 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 Five hereof.

4.42.9 The Subcontractor shall provide sound level data to the Engineers on the completion of the installation detailing the noise levels in octave bands for each separate air conditioned and ventilated areas.

4.42.10 Noise measurements for the sound level data shall be taken during full or nearly full cooling load conditions by an approved organisation. No measurement shall be taken closer than 1 meter from any outlet, ceiling, wall or floor surface.

4.42.11 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.

4.43 PAINTING AND CLEANING

4.43.1 No untreated metal surfaces shall be permitted on the project. Items which are not galvanised or similarly protected against rust and 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 prime coat before despatch from their place of manufacture.

4.43.2 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 one coat of universal undercoat, finish with two coats of quality high-gloss enamel of an acceptable make. Final finish shall be to the full approval of the Engineer.

4.43.3 With the exception of certain air conditioning 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. Where galvanised finish is painted, it shall be primed with a Calcium Plumbate Primer.

4.43.4 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.

4.43.5 Whereas it would not be necessary to paint any ductwork, conduits or pipework 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 rust-proofing paint if not galvanised or not metal subject otherwise to rust.

4.43.6 Where the inside of ducting is visible through grilles and diffusers or any other openings the visible section of the interior of the duct shall be painted matt black after degreasing and priming as specified above.

4.43.7 All plant and equipment on the project shall be painted and colour-coded in accordance with standards recognised in the Republic of South Africa and, where possible, to comply with relevant South African Bureau of Standards Colour Codes, or as later specified herein.

4.43.8 All plant and equipment shall be painted in accordance with a colour code given and where factory painted items such as the Air Conditioning Units, Cooling Towers and Pumps are not painted a colour similar to that specified they shall be repainted by the Subcontractor.

4.43.9 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.

4.43.10 On completion of the installation the Subcontractor 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 as finalised, after completion of the "Preliminary Tests".

4.44 LABELLING AND IDENTIFICATION

4.44.1 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 riveted or secured using epoxy based glue, no other type of adhesive being acceptable.

4.44.2 Prepare a complete piping diagram for the complete installation also showing drains, vents, etc., and give every valve on the project a designation. Fit every valve with an identification tag of engraved plastic or aluminium 3mm thick, 40mm diameter, such tag affixed to the valve with key tag type ball chain of chromium plated finish. The aforementioned piping diagram shall form part of plant operating instructions later referred to in this Specification.

4.44.3 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 labels glued on with epoxy-based adhesive. 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.

4.44.4 Identify pipes, ducts, equipment, by colour coding as previously mentioned herein. In addition to this label pipes and ducts with directional arrows neatly stencilled onto finished paintwork 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.

4.44.5 Belt guards and items of plant containing belt driven equipment shall be fitted with a label stating the number of and sizes of the belts for each vee belt drive. The labels shall be of the same type and dimensions and shall be fixed as specified for all equipment.

4.44.6 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 labels glued on with epoxy-based adhesive. 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.

4.44.7 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.

4.44.8 Provide and install all necessary notices required in terms of Governmental and Local Authorities' laws, such as "No Entry to Unauthorised Person", at all Plant room entrance doors, etc. Such notices to be silk-screened onto 3mm minimum thickness P.V.C. sheet, as obtainable from Messrs. Mine Safety Appliances.

4.44.9 On multiple split systems pipework identification shall be installed at approximately 3 metre intervals.

4.45 COMMISSIONING AND TESTING - PRELIMINARY TESTS ON COMPLETION

4.45.1 Following completion of the Works, or any portion of the Works as specified or directed by the Engineer, the Subcontractor 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.

4.45.2 All balancing, settling and testing shall be done by the Subcontractor entirely at his own expense. The Subcontractor 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.

4.45.3 The Subcontractor 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 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.

4.45.4 All test instruments shall be checked for accuracy by the manufacturers, suppliers 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.

4.45.5 Gauges, thermometers, ammeters and other instruments specified as part of the permanent Plant may be used for test purposes providing that the Subcontractor ensures that all such instruments are accurately calibrated. The Subcontractor shall check the accuracy and calibrate all such instruments against laboratory tested instruments.

4.45.6 The Subcontractor 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.

4.45.7 The Subcontractor 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.

4.45.8 The Engineer reserves the right to inspect any item of equipment during manufacture or before delivery to Site. The Subcontractor shall make available any item for such inspection.

4.45.9 Electrical switchpanel shall be inspected by the Engineer at their place of manufacture, prior to delivery to Site. At such inspection and testing, the Subcontractor shall demonstrate the functioning of the switchpanel to the Engineer. Any defects in materials, finishes and operations of the switchpanel shall be corrected at their place of manufacture prior to delivery to Site.

4.45.10 The Subcontractor 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.

4.45.11 The Subcontractor 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 to its inspectors entirely at the Subcontractor's expense, making good included.

4.45.12 Prior to the "Final Tests", to be attended by the Engineer, the Subcontractor 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 Subcontractor who shall provide the Engineer with three typed copies of all test

recordings which shall set out the 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.

4.45.13 On receipt of an acceptable preliminary latest report and draft copy of the Preliminary Operating and Maintenance Instructions the Engineer shall advise the Subcontractor in writing that he may arrange for the final acceptance tests.

4.45.14 The "Preliminary Tests" shall include the following:

Completed sections of water pipework shall be tested with water pressure of not less than 700kPa or 50% above the maximum working pressure, whichever is greater, at the lowest point in the system. Care shall be taken to avoid putting excessive pressures on mechanical seals, safety devices etc., which are not designed to withstand pressures used in tests. The system shall be filled and all air vented before the actual test pressure is applied. Test pressure shall be applied when water and average ambient temperatures are approximately equal and constant. Test pressure shall be maintained for not less than 30 minutes without appreciable drop after the force pump has been disconnected. Leaks in screwed fittings shall be corrected by remaking the joints. Leaks in welded joints shall be cut out and rewelded and not caulked. All testing must be performed and systems approved prior to covering or concealing piping.

On completion of the entire installations, all water circulating systems shall be flushed and balanced to provide the water quantities circulated through all heat transfer equipment as specified or required to provide the capacity specified. All temperature control valves shall be fully open during balancing and all regulating valves shall be permanently marked at the final settings. All balancing valves shall have their handwheels removed and stored, with the Spare Parts on completion of the tests.

Drains shall be tested for proper functioning by pouring water down them at a rate of at least four times normal drainage quantity.

Compressed air piping, except low pressure control piping, shall be tested at not less than 1000kPa. This pressure shall be maintained for one hour without pumping. A correction of the final pressure of not more than 13kPa for each 3ºC change in average ambient temperature during the test will be permitted. Leaks shall be corrected as specified for water piping.

Low pressure temperature control air piping shall be tested with 200kPa air pressure. This pressure shall be maintained for one hour without pumping during which time the pressure shall not drop more than 8kPa. A correction of the final pressure of not more than 3,5kPa for each 3ºC change in average ambient temperature during the test will be permitted. Leaks shall be corrected by remaking the joints and not by caulking.

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 be4 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.

Capacities of Refrigeration Machines, Cooling Towers, Pumps, Air Conditioning Units, Air Handling Units, Condensers, Heaters, 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 and water quantities measured during such tests.

Water quantities shall be measured with calibrated orifice or venturi type flow meters. Water quantities read from pump curves shall not be used for determining capacities.

Temperature differences required for determining capacities shall be measured by thermometers having graduations that permit interpolations having an accuracy of plus or minus 0,5 degrees 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.

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 1,55 m/s, above which velocities shall be measured with Pitot tubes. Properly capped openings shall be provided in ducting as required. Final settings of all volume adjusting devices shall be permanently marked.

Air duct systems shall be adjusted and balanced so that air quantities at outlets are as specified, further, the distribution from supply outlets is free from drafts, and uniform over the face of each outlet.

The entire air distribution system shall be adjusted and balanced in accordance with the "Manual for Balanced Adjustment of Air Distribution System" as compiled by SMACNA.

Air quantities specified for fans include for duct leakage. The sum of the air quantities of all outlets would normally be accepted at a tolerance of plus or minus 5% of that specified for the fans.

The air quantities at the terminals would normally be accepted at a tolerance of plus or minus 10% provided the total air supplied to the particular space is within a tolerance of plus or minus 5%.

Airflow quantities shall not be reduced by artificially increasing the system resistance by more than plus or minus 5% of the total system resistance.

4.45.15 Airflow quantities shall be determined by a combination of the following:

- o Airflow by means of anemometer over filter bank or coil.
- o Main duct airflow by means of a pitot tube traverse.
- o Pressure differential across and power consumption of fan.
- o Supply air quantity at terminals using a calibrated hood.

4.45.16 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, then such re-balancing shall be carried out as an extra to the Subcontract and shall be authorised, by the issue of a "Variation Order", by the Engineer.

4.45.17 Sound tests to demonstrate compliance with sound guarantees shall be made at locations selected by the Engineer.

4.45.18 Sound levels shall be measured with sound meter complying with the latest American Standards Association. The "A" scale shall be used for overall sound level readings. Where sound levels are specified in octave bands, the above sound level meter shall be supplemented by an Octave Band Analyser complying with the latest American Standards Specifications for an Octave Band Filter Set No.

Z24.10, published by the American Standards Association. The sound level meter shall be set on the "C" scale of all octave band readings.

4.45.19 "Equipment components" of room noise levels (those portions of total room noise levels attributed solely to air conditioning equipment) shall be determined at any point within a room not less than 1,8 meters from air terminals.

4.45.20 Sound level readings shall be taken on a Sunday morning when the building is unoccupied and when activity in surrounding areas, and background noise levels in areas tested, are at a minimum and relatively free from sudden changes in noise levels. Readings shall be taken with no equipment operating and with all air conditioning equipment, capable of transmitting sound to the space tested, in operation.

4.45.21 All automatic controls and safety devices shall be checked for correct performance and satisfactory operation and set to the respective settings required, such settings to be recorded.

4.45.22 All electrical switchpanel shall be checked for the correct functioning of all components and electrical interlocks and all time clocks, time delay relays and automatic control devices shall be set for their correct function.

4.45.23 The 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.

4.45.24 The Subcontractor shall ensure that the plants operate satisfactorily and uninterruptedly for a period of 7 days prior to final acceptance by the Engineer. Evidence of this, for air conditioning systems, shall be given in the form of 24 hour long continuous recordings of temperature and humidity, which recordings 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 installations.

4.45.25 The original recorder graphs shall be supplied to the Engineer and the Subcontractor 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.

4.46 OPERATING AND MAINTENANCE INSTRUCTIONS

4.46.1 The Subcontractor 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 alter and adjust all parts of the Works.

4.46.2 The Works shall not be considered to be completed for the purposes of taking over until the required Instructions and Drawings have been supplied to the Engineer.

4.46.3 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.

4.46.4 After approval of the draft manual, the sub-contractor shall submit three copies of the document in hard copy, bound in a hard cover with the details of the project clearly indicated on the spine. In addition, an electronic copy of the complete document on a CD and in pdf format shall be supplied together with electronic copies of all the as built drawings in dwg or dxf format. The CD shall be labelled and indexed.

4.46.5 The "Operating Instructions" shall include the following:

4.46.5.1 INDEX (in detail)

4.46.5.2 DESCRIPTION OF PLANT (as installed)

4.46.5.3 OPERATION OF PLANT (as installed) to include:

Automatic and manual start-up and shut-down procedure

Operation and Sequences 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 button and alarms, and instructions for adjusting and re-setting all controls and cut-out switches.

4.46.5.4 PLANT AND EQUIPMENT

Scheduled list of all major plant and equipment to include

- Description
- Make
- Model Number
- Supplier's name and address.

4.46.5.5 TEST REPORT

Copy of "Final Test" report as accepted by Engineer. (Draft copy of "Operating Instructions" for Engineer's approval may contain a copy of the "Preliminary Test" report).

4.46.5.6 MAINTENANCE INSTRUCTIONS

In schedule form setting out each item of plant, the description and frequency of the required maintenance operations as necessary for preventive maintenance of the Plant as installed.

4.46.5.7 SPARE PARTS

List of spare parts supplied (in accordance with these Specifications) and recommended with detailed description of each part, make, model or part number and supplier's name and address.

4.46.5.8 DESCRIPTIVE LITERATURE

To include manufacturer's operating and maintenance instructions, performance curves or charts and spare parts lists where applicable and when available.

4.46.5.9 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 and 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 delays and the overload settings and actual rated amperages of all electrical components, and any other relevant variable and adjustable items, to permit checking and adjustment of all instruments, controls and motor functions.

4.46.5.10 COPIES OF INSTRUCTIONS IN PLANT ROOMS

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.

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.

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.

4.46.6 A plant log book shall be provided and handed over to the Owner. The log book shall be a hard covered book containing details of each item of machinery together with provision for making service notes.

4.46.7 The Subcontractor shall instruct the Owners in the correct operation and use of the Plants. For this purpose the Subcontractor shall allow for the time of a competent instructor for a total of 5 days and four return trips to the Site for the purpose of providing such instructions.

4.46.8 During this period the Subcontractor shall fully explain the layout, operation and maintenance of the plant to the Owners or the Owners' representatives.

4.46.9 At the conclusion of this period of instruction the Subcontractor shall obtain from each of the Owners, 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.

4.47 MAINTENANCE

4.47.1 The Subcontractor shall maintain and service the Plant, in accordance with the following requirements for a period of twelve months calculated from the date of Taking Over or, in the event of more than one certificate having been issued by the Engineer, from the respective dates so certified.

4.47.2 During the "Maintenance Period" the Subcontractor shall service the Plant regularly at monthly intervals and make good any Defects in accordance with the provisions of the conditions of contract of these Specifications.

4.47.3 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.

4.47.4 Report to an official nominated by the Employers on arriving and again on leaving the Works. Such person shall sign a monthly "Service Report" giving details of any Defects reported and made good, temperature readings taken, etc. A copy of each such "Service Report" shall be submitted to the Engineer by the Subcontractor within fourteen (14) days of each service.

4.47.5 Check the function of each item of the Plant including all automatic controls and safety devices for correct operation and lubricate, adjust, clean and/or replace components and ancillaries as necessary.

4.47.6 Clean all washable air filters and check all disposable media type air filters serving the air conditioning plants check for pressure drops, fitting additional filter material if required.

4.47.7 Drain cooling towers, air washers, etc., as relevant, clean their sumps thoroughly, clean all pump suction filters and thereafter refill with water.

4.47.8 Remove, clean and replace all strainers contained in all water pipework and pneumatic control systems.

4.47.9 Check all refrigeration systems for leaks, refrigerant dryness, sufficient oil in the compressors, sufficient refrigerant gas or any other defects and correct as required.

4.47.10 Check the electrical switchpanel replacing any burnt contacts or pilot lamp bulbs which have failed.

4.47.11 Take and record Wet and Dry Bulb temperatures in each of the conditioned areas and outside. Temperature readings shall be taken with a reliable calibrated psychrometer and all readings shall be recorded on the "Service Report".

4.47.12 Attend to any complaints made, with respect to the Plant, by the official nominated by the Employer, being the only other person authorised to instruct the Subcontractor or make any complaint, (other than the Engineer). No other person shall have any right to instruct or make any complaint to the Subcontractor.

4.47.13 While attending to any Defects and the Servicing of the Plant the Subcontractor shall not unduly disturb the functions of the occupants in the areas concerned.

4.48 ELECTRICAL SUPPLY

4.48.1 The Employers shall provide suitable 3 phase and/or single phase electricity supplies, in the positions indicated on the Drawings.

4.48.2 The 3 phase, 4 wire and earth electricity supplies shall be connected to the incoming terminals of the main isolator in the air conditioning plant switchpanel or in the air-cooled packaged air conditioners, as applicable.

4.49 MAINS WATER SUPPLY

4.49.1 Mains water supply connections, where applicable, will be provided at the position indicated on the Drawings, and the Subcontractor shall allow for the connection from the point indicated to the equipment supplied in accordance with these Specifications. Where not indicated, it shall be allowed that water will be provided within 3 meters of the point of connection to the equipment and terminated with a valve.

4.49.2 The mains water supply pipe shall have a nominal bore of not less than 25mm and shall be provided with a shut-off valve.

4.50 DRAINS

4.50.1 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. . Where not indicated, it shall be allowed that the drain shall be run 5 meters from the point of connection to the equipment and terminated over a tundish supplied by the plumber.

4.50.2 Drainage pipework from air handling plant and in plantrooms shall be adequately sized, not less than 32mm and carried out generally in medium grade galvanised piping, all connections to equipment being effected with conical-faced unions or flanged.

4.50.3 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.

4.50.4 Drainage pipework of longer than 4,5mm run shall be provided with cleaning eyes on all bends to facilitate maintenance.

4.50.5 Drainage pipework from split units and fan coil units shall be uPVC class 6 with solvent welded joints. The drains shall be not less than 25mm and shall be run individually. Where two or more drains connect, the minimum pipes size shall be 50mm.

4.50.6 Drains shall be run to a fall of at least 1:40 and shall be adequately supported to ensure tat the condensate drains completely and no traps are formed.

4.50.7 Under no circumstances shall drains be run into storm water drains.

4.51 EXCLUSIONS

4.51.1 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 Sub-contractor, as relevant.

4.51.2 The provision of all Plant rooms and equipment spaces shown on the Drawings, complete with level floors, lighting, suitable airtight access doors and any other builder's work, as relevant or as indicated on the Drawings.

4.51.3 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. The sub-contractor shall clearly indicate the positions of the openings and liaise with the building contractor for the cutting and making good of the openings.

4.51.4 All concrete work associated with the provision of equipment bases as detailed herein.

4.51.5 Any item, comprised of timber, bricks, mortar or concrete which can reasonably be construed as builder's work, together with the building-in of any item required.

4.51.6 The architectural concealment of any equipment to be installed by the successful Tenderer. This would apply particularly to piping and ducting.

4.51.7 The provision of masonry shafts and ducts as shown on the Drawings, complete with smooth internal plastered finish.

4.51.8 All openings in glazing in windows for the installation of fans.

4.51.9 The provision of mains water supply points, each terminating in a gate type isolating valve within three meters of the equipment it serves.

4.51.10 Drainage points provided in the positions and of the sizes indicated on the Drawings, such drains for general equipment drainage and condensate disposal.

4.51.11 The bringing up and connecting to the incoming terminals of the main isolators in each switchpanel suitably rated 380 volt, 3 phase, four wire electricity supplies. 220 volts, single phase outlets for plugged equipment or terminating with a switched isolator for directly coupled equipment

4.51.12 Any other item mentioned in these Specifications or on the accompanying Drawings as being expressly for the provision of others.

PART IV

STANDARD TECHNICAL SPECIFICATION

for

PLUMBING, DRAINAGE & FIRE PROTECTION INSTALLATIONS

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1. GENERAL

The standard specifications included define the standard of equipment and materials as well as the quality of the services required for the various sections of the installation. Not all the clauses in this section of the standard specification shall necessarily be applicable on the contract. Refer to the detailed or material specification for materials and equipment to be used.

1.1 The contractor shall at all times adhere to this specification unless otherwise specified on the drawings and/or in the detailed specifications.

1.2 The engineers' drawings show broad principles of design, general layouts, schematic arrangements and when read together with the specifications and the drawings of other disciplines and other contractors, they carry sufficient information to enable the contractor to determine how the installation is to be installed, operated, services and maintained.

1.3 Pipe sizes and possible positions are shown on the engineers' drawings. Fittings, valves, strainers etc must adapt to these pipe sizes.

1.4 The contractor shall submit workshop drawings, samples, catalogues, performance characteristics etc., on all equipment, except when specifically included by the engineer.

1.5 The contractor shall take in situ measurements for installation of the equipment of the system and produce complete workshop drawings for fabrication and installation. These drawings shall be co-ordinated by the contractor with all other relevant equipment and services. Dimensions given on the engineers' drawings are only a guide and should be adapted to suit the relevant measurements of the specific fittings and/or equipment.

2. DEFINITIONS AND ABBREVIATIONS

2.1 Definitions of terms used herein:

"Provide" : to supply, install and connect up, complete and ready for safe and regular operation particular work referred to unless specifically indicated or specified otherwise.

"Install" : to erect, mount and connect complete with all related accessories.

"Supply" : to purchase, procure, acquire and deliver complete with all related accessories.

"Work" : all labour, materials, equipment, apparatus, controls, accessories and other items required for proper and complete installation.

"Concealed" : embedded in masonry or other construction, installed in furred spaces within double partitions or hung ceiling, in trenches, in crawl spaces or in enclosures.

"Exposed" : not installed underground or "concealed" as defined above.

"Indicated", "Shown" or "Noted" : as indicated, shown or noted on drawings and/or specifications.

"Similar" or "Equal" : of approved manufacture, equal in materials, weight, size, design and efficiency of specified product.

"Approved", "Satisfactory", "Accepted" or "Directed" : as approved, satisfactory, accepted or directed by the Engineer.

2.2 Abbreviations:

"SABS" : The South African Bureau of Standards and the number following shall refer to the latest amendment of the relevant specification or Code of Practice as the case may be.

"BSS" : British Standard Specifications

"NB" : Nominal Bore

"WWP" : ; Water Working Pressure

"WOG" : ; Water, Oil, Gas

"PB" : Polished Brass

"CP" : Chromium Plated

"AASHTO" : American Association of State Highway and Transportation Officials.

"AISI" : American Institute of Steel Industries

"CKS" : Co-ordinating Specifications issued by the Central Co-ordinating Committee under the auspices of the South African Bureau of Standards.

"CSIR" : Council for Scientific and Industrial Research

2.3 **Diameters of Pipes**

All diameters of pipes given are the nominal bore or external diameters in accordance with the normal conventions of the materials being used.

3. CODES OF PRACTICE, LAWS AND STANDARDS

All workmanship and materials used in the execution of the works shall be of the highest class and, where not fully covered by the Specification, shall be carried out in conformity with best modern practice, as determined by the Engineer.

It shall be the contractor's responsibility to ensure that the entire installation fully complying with all relevant requirements of governmental and Local Authorities whose jurisdiction embraces the location of the Site of the Works and the equipment provided for those installations which shall comply in every respect with the National Building Regulations and Building Standards Act, Act 103 of 1975 and the Occupational Safety Act, Act Nº6 of 1983, both as amended to date, excepting only where exemption from any such regulations has first been obtained in writing from the said authorities, provided that the approval of the Engineer has been given prior to application for any exemption.

All materials and equipment supplied and installed shall carry the SABS or BS mark of approval unless otherwise specified or agreed to in writing by the engineer. Where alternatives are offered, the submission is to include full details of the item together with tests and compliances with any other standards.

All electrical wiring shall comply fully with the latest edition of the Standard Regulations for the wiring of Premises, SABS 0142 and the additional requirements of any local authority who has jurisdiction over the Site of Works, as well as being in accordance with best modern practice.

Wherever relevant, this Specification shall be understood to be amplified to embrace Codes of Practice and Standards promulgated by recognised authorities in the field of Plumbing and Drainage Technology and all other branches of engineering science applicable to this project.

It shall be assumed that the contractor is conversant with the abovementioned requirements. Should any requirement, bye-law, or regulation, which contradicts the requirements of this document, apply or become applicable during the erection of the installation, such requirement, bye-law, or regulation shall overrule this document and the contractor shall immediately inform the Engineer of such a contradiction. Under no circumstances shall the contractor carry out any variations to the installation in terms of such contradictions without obtaining written permission to do so from the Engineer.

It shall be the responsibility of the contractor to make the necessary arrangements at this own expense with the local supply authority and to supply the labour, equipment and means to inspect, test, commission and to hand over the installation.

The Subcontractor shall supply and install all Notices and Warning signs that are required by the appropriate laws, regulations and/or by this document.

4. ORGANISATION AND STAFF CONTRACT

In addition to the site supervisor and/or foreman, the contractor shall employ as many competent and experienced persons as may be necessary for the purpose of the contract and shall be bound to remove from the contract works any person to whom the employer or his agent or the principal contractor may reasonably object by reason of any failure, neglect, incompetence or substandard work execution by or under the supervision of such person.

The duties and responsibilities of the contractor's management staff shall include but not be limited to the following:

Selection of equipment and components into working assemblies in conformance with the design concept in the subcontract specification.

Submission of equipment and installation drawings for approval in accordance with the required procedure.

Programming and planning of the work to fit in with the overall principal contractor's programme.

Attendance at routine site progress meetings and programme monitoring meetings organised by the principal contractor.

Conducting of all tests required.

Expediting of the work.

Directing his employees to ensure efficient, timely and safe execution of the work, and co-operation with the principal contractor and other trades to ensure such execution.

Attendance at meetings from time to time with the engineer in order to discuss any technical matters that need clarification.

5. CO-ORDINATION WITH OTHER TRADES

The contractor shall acquaint himself with the general arrangement of all other services

and ensure that in fixing the work it will not obstruct the fixing or future maintenance of the contract works or other services.

He shall also fully co-operate with other trades and take all reasonable precautions to ensure that he does not impede the progress of, or damage their work.

6. TEST AND INSPECTION PRIOR TO COMPLETION

Except where otherwise provided in the contract, the contractor shall provide all labour, materials, power, fuel, accessories and properly calibrated and certified instruments necessary to carry out such tests. Arrangements for such tests shall be made by the contractor and he shall give at least 72 hours notice to the engineer, in writing, of the test prior to commencement.

In the event of the plant or installation not passing the test, the employer shall be at liberty to deduct from the contract price all reasonable expenses incurred by himself or his agents attending the repeated tests.

Whenever any installation or equipment is operated for testing or adjusting as provided for above, the contractor shall operate the entire system for as long a period as may be required to prove satisfactory performance at all times in the occupied space served by that system for up to twenty-four hours a day continuously until the system is handed over.

The contractor shall provide all labour and supervision required for such operation and the employer may assign operating personnel as observers but such observation time shall not be counted as instruction time.

After complete installation of the system all equipment shall be tested, adjusted and readjusted until it operates to the satisfaction and approval of the engineer and the client.

The contractor shall submit certificates of tests carried out to prove all equipment and also certificates to be obtained from all relevant authorities and statutory bodies etc.

7. SHOP DRAWINGS

7.1.1 The subcontractor shall prepare at his own expense and shall submit copies of shop drawings for all fabricated work, working or setting out drawings, shop details and schedules to the Owner's representative for approval as stated below, and related work shall not be performed by the subcontractor until such approval has been given.

7.1.2 As soon as approval has been given, the subcontractor shall furnish the Owner's representative two prints of the approved shop drawings, setting out drawings and schedules. The subcontractor shall also furnish to the Works as many prints of the approved shop drawings and schedules as are required. No work shall be performed from shop drawings and/or catalogues not stamped with the Owner's representative's approval, and such stamped drawings and/or catalogues shall be kept available at the job site as evidence of such approval.

7.1.3 The subcontractor shall be responsible for dimensions, design of adequate connections, details for the satisfactory construction of all work and the furnishing of materials for work required by the subcontract even if not indicated on the submissions that have been approved by the Owner's representative.

7.1.4 The Owner's representative will check drawings for design only and approval of the drawings, schedules and catalogues by the Owner's representative shall not be construed as a complete check and shall not relieve the subcontractor of his responsibility as above stated. If the submissions differ from the requirements of the subcontract, the

subcontractor shall make specific mention of each difference in his letter of transmission, with a request for substitution, together with his reasons for same, in order that, if acceptable, suitable action may be taken by the Owner's representative. Otherwise, the subcontractor will not be relieved of the responsibility for executing the work in accordance with the requirements of this subcontract.

7.1.5 Corrections of shop drawings by the Owner's representative are not intended to change the scope of work. Should any such corrections constitute a change of scope of work, the subcontractor shall notify the Owner's representative in writing within not more than seven calendar days of such change and shall not proceed with the fabrication until so authorised by the Owner's representative. Claims for change of scope, made after performance of the work constituting the claimed change of scope, will not be considered.

8. "AS-BUILT'" DRAWINGS AND MANUFACTURERS INFORMATION

The Subcontractor shall provide the Engineer with a complete signed transparent set of "as-built" drawings together with stored drawings in DXF electronic format as a pre-requisite to final payment; and the Engineer shall hand the set over to the Owner after having established their correctness. The "as-built" set shall include all mechanical and electrical work.

Where possible, a transparent copy of Architects or Engineers drawings shall be used and the Subcontractor may purchase copies of the necessary transparencies from the relevant party. If "as-built" variations cannot be clearly shown thereon, then the Subcontractor shall prepare supplementary transparent drawings that will properly impart the necessary information. Manufacturer's and Subcontractor's shop drawings shall be corrected to correspond with the "as-built" drawings and copies of each shall also be furnished to the Engineer.

"As-built" drawings shall be maintained on a current basis as work progresses, and all deviations in work as actually installed accurately entered, at least once a week, on paper prints of design drawings affected, with such prints kept available at the site for the inspection of the Engineer. At the end of each month, the record for the month, properly identified by notes, shall be transferred to the original drawings by competent draughtsmen. Within seven days after the end of each monthly period, submit to the Engineer one paper print of each drawing affected showing the latest corrections.

The contractor shall submit 3 (three) sets of comprehensive operating and maintenance manuals, to the engineer, after first obtaining his approval thereof.

The operating and maintenance manuals shall at least contain the following:

(i) A description of the system together with details and specifications of all equipment and items used in the works.

(ii) Detailed instruction in the operation of the system.

(iii) Details and schedules of how and when to maintain the plant and equipment.

(iv) List of spares to be carried, complete with part numbers and supplier(s) of equipment.

(v) Names and addresses of staff of the contractor or supplier(s) or subcontractor(s) to be contacted in case of an emergency etc.

(vi) Guarantees for all equipment and fittings etc.

9. QUALITY ASSURANCE SYSTEM

The contractor shall institute an approved Quality Assurance system (QA) which shall be submitted to the engineer for his approval. The records of this QA system shall be kept throughout the duration of the contract and shall be submitted to the engineer at regular intervals as required by the engineer.

10. OPERATING AND COMMISSIONING OF PLANT AND INSTALLATION

The completed system shall be put into operation after all tests and adjustments have been carried out to the satisfaction of the engineer. The contractor shall run and operate the system for a period of time as specified by the engineer and train the staff of the client to operate and maintain the system for a period as required by the engineer, which will not exceed one month.

Logging of the operation of the installations shall commence immediately upon start-up.

The contractor shall submit a full commissioning report.

11. GUARANTEE OF INSTALLATION AND EQUIPMENT

The contractor shall obtain guarantees from the manufacturer(s) and/or supplier(s) to the effect that each piece of equipment shall comply with the required performance and also that it will function as part of the complete system.

All equipment including the complete installation and the system as a whole shall be guaranteed for a period of 12 (twelve) months after the written acceptance o\by the engineer of the completed and operational system.

12. MAINTENANCE OF THE INSTALLATION DURING THE PERFORMANCE GUARANTEE PERIOD

The contractor shall furnish, free of charge, all maintenance on the entire equipment supplied by him for the guarantee period. Maintenance shall include systematic examination and adjustment of all this equipment at least every 3 months. The contractor shall, in the course of such maintenance or on call during the maintenance period, repair or replace defective parts as required and shall use only genuine standard parts produced by the manufacturer of the original part, Renewals or repairs resulting from misuse of air wear and tear, however, shall not be made at the expense of the contractor where certified as such by the engineer. Specified spares shall not be used during this period. If any spaces are used due to operational necessity and with the engineer's permission, such spares shall be replaced by the contractor.

The maintenance period shall only begin with completion of the Main Contract and when the engineer has certified the contract works as completed, unless otherwise specified.

13. COMPLETION OF CONTRACT WORKS

Completion of the contract works will only occur after the following procedure has been certified by the engineer as having been carried out in accordance with the specification.

a) Physical completion of all systems has been reported to the principal contractor by the contractor, and all defects made good. The principal contractor to satisfy himself that all work has been completed satisfactorily before reporting to the engineer.

b) Acceptance tests have successfully taken place as specified and test results have been witnessed (where required), recorded and approved by the engineer.

c) "As-built" drawings, commissioning reports and maintenance and operations manuals have been submitted to and approved by the engineer.

d) The employer's nominated operator(s) has received instruction in the operation of the contract works by the contractor.

e) The installation or part of the installation shall only be deemed handed over when completed, tested and fully commissioned and then signed off by the Engineer.

14. WORKMANSHIP AND INSTALLATION

14.1 Piping General

Materials and workmanship shall be the best of their respective kinds. Only new and undamaged materials shall be used in the Works. Materials to be permanently installed into the works shall not be used for any temporary purposes on site. Work shall be to the approval of the engineer and shall be executed in accordance with the relevant manufacturer's written recommendations and instructions.

Drawings are generally diagrammatic and indicative of work to be installed. Run and arrangements of piping shall be approximately as indicated, subject to modifications a required to suit conditions at building, to avoid interference with work of other trades, or for proper, convenience and accessible location of all parts of piping systems. Due to small scale of drawings all required offsets, fittings, valves, traps, drains etc., may not be indicated. Refer to and carefully check architectural, structural, electrical and mechanical drawings and details, noting locations where walls, partitions, ceilings, beams, columns and other surfaces are furred, location of beam cuts, location of pipe shafts and conflicts with work of other trades and arrange work accordingly, providing all offsets, fittings, valves, traps, drains etc., required to meet such conditions.

Run piping in wall chases, recesses, pipe shafts and hung ceilings where same are provided. No piping shall run in floor fill unless indicated or specifically approved. Exterior utilities are diagrammatic and exact location and invert elevations shall be as indicated or required to meet existing conditions. Install piping under buildings as high as possible. Do not permanently close up, fur in or cover piping before examination and test.

Run piping as straight and direct as possible, in general forming right angles with or parallel to walls or other piping and neatly spaced with risers erected plumb and true. Install piping so that there is clearance of at least 25mm between finished coverings (fitting hubs on uncovered piping) of piping and also between finished coverings or fitting hubs and adjoining work, Hang piping at or in ceiling from construction above, as close as possible to bottom of slabs, beams etc., maintaining maximum headroom at all times. Obtain from Engineer approved ceiling heights and install work above this height.

No piping shall be run in elevator machine rooms (except where special ducts are provided), telephone rooms containing telephone equipment, relays and terminal strips, and electric rooms and closets containing exclusively equipment such as transformers, switchgear, motor control centres, panelboards, or similar items of equipment, and in emergency generator room. Elsewhere, no piping shall be run within 1,75m laterally of such electrical apparatus as motor control panels, switchboards and electric motors, except for branch piping connecting to equipment.

All pipes are to be carefully examined for defects and flaws before installation and to be neatly fitted. They shall be run in such manner as to prevent the formation of air-locks. Automatic air vents shall be installed on all high points of the installation.

The ends of all pipes are to be cleaned, free from burrs, and rough edges, and joined together tightly. An approved pipe joint compound may be sparingly used with best quality hemp. All surplus or exposed hemp is to be thoroughly cleaned off joints before the painting of pipes.

Exposed CP piping about fixtures and equipment shall not show tool marks or more than one thread at fittings. Fittings, valves and hangers on CP piping shall have CP finish.

Use reducing fittings for changes in pipe sizes. Use no bushings except with special permission.

Use extra heavy pipe for nipples where unthreaded portion is less than 40mm. Use no close nipples, except with special permission; use only shoulder nipples.

Provide unions or flanges in connections to risers, by-passes and equipment.

All vertical pipes must be securely fixed with brackets and supports of an approved type securely fixed into the wall, not more than 40mm from the wall. These fixings must be strictly adhered to.

Pipes installed in service ducts and ceiling voids are to be perfectly plumbed and to be secured by approved brackets securely fixed at distances not exceeding the specified distances and to be not more than 40mm away from the face of the walls or soffits. Pipes inside buildings and where specified shall be chased into walls, wrapped with approved materials and properly secured and covered. Pipes must be free to move in the brackets.

During construction all pipe ends shall be kept plugged to prevent any ingress of dirt, rubble etc.

14.2 Expansion Swings

Make adequate provision for proper expansion and contraction of piping and for piping passing through building expansion joints. At connections of branches to water mains and risers and at connections to heaters, tanks, pumps, coolers and other equipment, provide sufficient number of elbow swings to allow for proper expansion and contraction of piping. Provide adequate elbow swings, or expansion loops, or approved type expansion joints, wherever indicated or required to allow for proper expansion and contraction of mains and risers.

Where flanged "Bellows" type expansion compensators are specified they are to be installed as detailed and in accordance with the manufacturer's recommendations.

Should these compensators be specified for installation in wood truss roof structures the Contractor is to report to the engineer, who will provide details of the location and installation requirements.

14.3 Sleeves

Provide sleeves large enough to accommodate pipe and its covering passing entirely through floors, ceiling, walls, or partitions. Pack sleeves through firewalls or slabs in accordance with engineer's requirements.

Provide cast iron or steel pipe sleeves for pipes passing through exterior walls, footings or beams or through floors (interior) or machinery rooms containing Plumbing, Heating, Ventilation, or Air Conditioning equipment, and here extending 50mm above finished floor. Provide sleeves through exterior walls below grade and floors specified above with continuously welded centre flange buried in construction. At exterior walls, make pipe watertight in sleeve with oakum packing and caulked lead joints on both sides of wall.

Except as otherwise noted, provide 0,710mm galvanised iron sleeves for all pipes passing through roof slabs, interior floors, ceilings, walls or partitions, unless framed opening is provided in general construction.

Copper pipes shall have PVC sleeves or be covered with "Thermoflex" or equal protection strip where they pass through walls.

Sleeves shall extend 10mm beyond finished surface.

14.4 Escutcheons

Unless otherwise noted, provide exposed pipes, both bare and covered with approved type cast brass or cast iron escutcheons where they pass through walls, partitions, floors, or ceilings; held in place by set screws or on covered pipes by internal spring tension. In toilet rooms, at tile walls and in connections with chromium plated piping, escutcheons shall have chromium plated finish.

Where sleeves, hubs or fittings project slightly from wall, partition, floor or ceiling, provide special deep type escutcheons to cover each case.

14.5 Offsets

Pipes passing through the ceilings or floors shall be offset from the wall to the front of the cornice with sufficient clearance to allow for the clear fixing of a ceiling plate. Pipes installed directly through the cornice will not be allowed. In multi-storey buildings where wall thicknesses vary, the same shall apply.

15. MATERIALS

15.1 General

All materials, etc. specified herein under a trade name, catalogue number or reference shall be either exactly as described or, in the opinion of the Engineer, of equal quality, specification and mass in all respects to those described. Written approval shall be obtained for the use of any alternative to the specification before the submission of tenders, otherwise it will be assumed that the specified materials, etc. have been allowed for in the tender.

Materials shall be new, unused, best of their respective kinds and free from defects.

Galvanising shall be by hot process on both inside and outside of pipe with zinc coating averaging at least 600g/m² and free from defects.

For Chromium Plating, materials shall be cleaned and polished before plating and plated heavily, thoroughly and evenly and guaranteed not to strip or peel. Steel or cast iron shall be firstly copper plated. Brass, copper and copper plating shall be nickel plated before

chromium plating. Finish shall be polished or satin as further specified.

15.2 **Copper Pipe Installations**

The installation of copper piping systems shall be done in accordance with the manufacturer's Code of Practice and all relevant codes, standards and regulations.

Copper pipes shall only be installed downstream of galvanised mild steel pipes when applicable.

Where dissimilar metals are joined, di-electric or isolating couplings shall be used. This is not required where copper and brass dezincified alloys join.

Copper pipes shall be of the hard drawn type Class "O" according to SABS 460 and shall be joined by means of capillary soldered type fittings. Compression fittings should not be used unless specifically authorised by the engineer and only on Class 2 or 3 piping.

The soldering flux to be used shall be water based and easily flushed out, withstand temperatures above 240^{o}C and shall contain no ammonia. The flux shall be non-toxic when dissolved in water.

The solder to be used shall be in accordance with SABS and shall consist of a material containing 97% tin and 3% copper. Solders containing lead, resin core and acid core shall not be used.

The heat source to be used shall be propane gas with induction air, at a temperature not higher than 240^{o}C. The pipe ends and fittings shall be cleaned and wiped with an approved solder flux, before soldering. The pipe and fittings shall then be fitted together and heated to the correct temperature before the solder is applied. Care must be taken not to add too much or too little solder to the joint. Immediately after setting of the solder the joint shall be wiped clean with a wet cloth. Pipes shall be washed out as soon as possible after jointing and all traces of flux shall be removed.

All bronze or brass equipment and fittings shall be of the dezincified type.

Pipes chased or built into walls or floors shall be wrapped with 2 layers of building paper or similar approved material. Hot and cold water pipes running next to each other shall have a minimum clearance of 50mm.

Equipment fixed to copper pipe outlets, where the pipes are mounted surface or built into walls, shall be done by means of copper wall plate fittings on the copper pipe, properly secured to the structure to prevent structural damage to soldered joints.

Pipe hangers and brackets shall be of copper, copper alloy or non conductive materials. No piece of copper pipe shall touch any other conductive surface. Brackets shall be designed to structurally support and fix the pipe system, and shall allow enough clearance from walls, soffits etc. to insulate hot water pipes and maintain equipment.

Pipe hangers and brackets shall be installed according to the manufacturer's specification on the following maximum spacings. Vertical pipes shall be supported at least at every floor.

PIPE DIAMETER (mm)	HORIZONTAL (metre)	VERTICAL (metre)
15	1.3	1.9
22 & 28	1.9	2.5
35 & 42	2.5	2.8
54	2.5	3.9
67 – 108	2.8	3.9

All copper pipes open to structural damage shall be protected by steel sleeves or a structurally designed cover.

Where flanged fittings are used cadmium plated bolts, nuts and spring washer shall be used to join these flanges.

Pipes shall be installed in such a manner as to prevent air locks. A minimum rise of 1:250 shall be maintained to high points which shall be fitted with suitable air release valves.

Shut-off valves shall be installed on all branch pipes, connections to equipment, sanitaryware and other fittings as indicated by the engineer.

All pipes shall be marked in accordance with SABS 0140 or as specified by the engineer.

15.3 **Galvanised Steel Pipe Installations**

All galvanised steel pipes shall, unless otherwise specified, be medium gauge mild steel screwed and socketed pipes to SABS 62 and shall be normalised and marked as such by the manufactuer. Pipes shall be hot dipped galvanised to SABS 763.

All fittings shall be malleable cast iron fittings to SABS 509 and galvanised to SABS 763.

All 100 diameter and larger pipes shall be joined with Class 16 flanged couplings to SABS 1123/1600. The bolts, nuts and washers to be used on these joints shall be cadmium plated.

In pipe ducts and elsewhere pipes shall be fixed onto walls, soffits etc. with approved type of supports, holderbats, clamps etc. Brackets shall be designed to structurally support and fix the pipe system and shall have enough clearance from walls, soffits etc. to insulate hot water pipes and maintain equipment.

Pipes shall be supported according to the manufacturer's specifications at the following maximum intervals:

NORMAL SIZE (mm)	HORIZONTAL (mm)	VERTICAL (mm)
15 Ø to 20 Ø	1.2m	1.8m
32 Ø to 40 Ø	1.8m	2.5m
50 Ø to 150 Ø	2.5m	3.0m

Pipes shall be installed in such a manner as to prevent airlocks. A minimum rise of 1:250 shall be maintained to high points which shall be fitted with suitable air release valves.

All pipes shall be marked according to SABS 0140 or as specified by the Engineer. All exposed pipes shall be painted to the required colour as specified by the architect.

Make joints in screwed piping with hemp and "Stag" jointing compound approved by the engineer and sparingly used with good quality hemp. For pipes larger than 80mm Ø a jointing compound such as Eperdermix 32 shall be used. Hemp and jointing compound

shall be used sparingly and applied to the male thread only.

Any pipe buried shall have at least 900mm cover and be coated and wrapped to SABS 1117 and tested in the presence of the engineer.

All pipework and fittings shall be pressure tested and sterilised to the engineer's specifications.

Valves shall be installed on all branch pipes and ball-o-stop valves on al connectors to basin pillar cocks, sink mixers, cistern type WCs and other fittings, as indicated by the engineer.

Approved type expansion bellows shall be installed where required for expansion and contraction to prevent excessive stain on fittings and pipe joints.

15.4 <u>uPVC Underground Pipe Installations</u>

Unless otherwise specified all underground pipework >50mm Ø shall be Class 12 uPVC to SABS 966 with rubber ring type joints.

All bends shall be uPVC Class 12 type fittings with rubber ring joints.

All other fittings such as T-pieces, reducers, flanges etc shall be bitumen dipped cast iron rubber ring jointed fittings to SABS 546.

No solvent weld type fittings will be allowed.

All cast iron fittings shall be coated and wrapped to SABS 1117.

All pipes shall be laid on a 100mm sand bedding cradle and covered with 300mm and before backfilling.

All backfilling shall be to the engineer's specification and approval.

Pipe trenching and bedding:

AREA	MINIMUM COVER	BEDDING TYPE	MAIN FILL
Vehicle Traffic	1100	Flexible pipe bedding as per SABS 1200 LB	Soilcrete
Under surface bed	600		Soilcrete
Other areas	900		90% MOD AASHTO

All thrust blocks shall be cast between the pipe and the undisturbed trench material.

No concrete shall come into direct contact with the uPVC pipe. At the thrust blocks the end shall be wrapped with a "Densopol 80 HT Tape" or similar approved.

All pipes shall be laid with at least 900mm cover to the top of the pipe.

Marker blocks shall be installed at all tees or changes of directions.

HDPE pipe connections to uPVC pipes up to 50mm Ø can be done by means of SG Iron manufactured saddles with the appropriate gaskets and cadmium plated bolts and nuts.

All pipe crossings under traffic areas shall be backfilled with soilcrete and compacted as specified.

All pipework shall be pressure tested with all joints uncovered, to the satisfaction of the Engineer.

Suitably sized air release valves built into valve chambers shall be installed at all high points of the pipe line.

15.5 HDPe Pipe Installations

15.5.1 Underground Pipework

Unless otherwise specified all underground pipework <50mm Ø shall be Class 12 Type 4 HDPe pipe to SABS 533.

All fittings shall be of "Plasson" compression type, conforming to ISO/DIS 3458.

All pipes shall be laid on a 100mm sand bedding cradle and covered with 300mm of sand or selected material.

All backfilling shall be to the engineer's specification and approval.

Pipe trenching and bedding:

AREA	MINIMUM COVER	BEDDING TYPE	MAIN FILL
Vehicle Traffic	1100	Flexible pipe bedding as per SABS 1200 LB	Soilcrete
Under surface bed	600		Soilcrete
Other areas	900		90% MOD AASHTO

No concrete shall come into direct contact with the HDPe pipe. At these points the fittings shall be wrapped with "Densopol 80 HT Tape" or similar approved.

Marker blocks shall be installed at all tees or changes of directions.

All pipe crossings under traffic areas shall be backfilled with soilcrete and compacted as specified.

All pipework shall be pressure tested with all joints uncovered to the satisfaction of the engineer.

Suitably sized air release valves built into valve chambers shall be installed at all high points of the pipe line.

15.5.2 Drainage Pipework

HDPe drainage pipework shall be "Geberit" or equal system utilising standard drainage fittings.

The pipe shall be annealed to eliminate residual manufacturing tension stresses.

The following jointing methods are acceptable for the pipe system depending on application:

Butt welding for general pipe joints
Electroweld sleeve coupling in areas of limited access
Ring seal socket for individual prefabricated sections
Expansion socket where movement is necessary
Screw threaded joint for detachable connections
Flange connections for connection to equipment

Joints shall be made with a smooth interior to ensure there is no restriction flow inside the pipes.

15.6 Vitrified Clay Pipe and Fittings

Vitrified clay pipe shall only be used for underground installations. The pipes and fittings shall strictly conform to SABS 559 as amended. The pipe and fittings shall have a minimum crushing strength of 45 kN/m.

The jointing method to be used shall be polypropylene couplings with integral rubber seal similar or equal to "Vitrosleeve" according to SABS 974.70 allowing up to 2.5^{o} angular movement per joint and 5mm line displacement per joint. The joint shall retain an effective water seal with respect to the above conditions with a 6 metre water head.

Pipes shall be cut by an approved pipe cutter after which the end shall be trimmed by means of a pipe trimmer to remove any sharp edges.

All fittings underground shall be of vitrified clay and shall comply to SABS 559.

15.7 Supercast Cast Iron Pipe and Fittings

Supercast iron pipes can be used for underground and above ground installations. Plain ended spun cast iron pipes and fittings manufactured from 150 Grade A grey iron in accordance with SABS 1034 shall be used. Fittings and pipes to be free of pinholes, blowholes, blemishes, flash and foundry sand and to have a smooth bore. All pipes and fittings to be sandblasted and coated on the inside and outside by submersion in a corrosion inhibited oxide primer or bitumen paint.

The pipes and fittings shall be joined by means of stainless steel neoprene couplings as supplied by the manufacturer of the pipe system. The coupling shall be installed according to the manufacturer's specification and be tightened with a torque wrench to a torque of 6.8 Nm.

Where cast iron stub stack overflow gullies are used with pipe materials such as PVC, a rubber O-ring shall be used to fit over the PVC pipe into the cast iron fittings. The joint shall be grouted up afterwards.

Above ground piping shall be bracketed with properly sized and designed brackets according to the manufacturer's specification at correct intervals.

15.8 uPVC Soil and Waste Pipes and Fittings

Where specified uPVC soil, vent and waste pipe systems can be used for underground and above ground drainage installations. This piping shall conform in all respects to SABS 791 for underground systems and to SABS 967 for above ground system.

All underground and soil pipe above ground pipes and fittings shall be joined by means of rubber ring seal couplings and fittings in accordance with the manufacturer's specification. All waste and vent pipe and fittings shall be joined by means of solvent weld fittings and couplings. The solvent weld glue to be used shall be as specified by the pipe manufacturer allowing for thermal contraction and expansion.

15.9 Structural Wall uPVC Pipes and Fittings

Where specified a structural wall uPVC drainage pipe can be used for underground drainage systems. This piping system shall be used with standard underground uPVC pipe fittings as specified under item 3.4, equipped with rubber ring joints. The pipe shall be equipped with z-lock type rubber ring joints.

16. VALVES FOR DOMESTIC WATER INSTALLATIONS

16.1 Gate Valves Underground in Valve Chambers to connect to uPVC Piping (65 NB and larger)

Gate valves to be equipped with non-rising spindle, spherical graphite iron body to SABS 936 Grade 42, cast iron nitrile butadine rubber covered gate, stainless steel spindle, nitrile butadine rubber 0-rngs and seals, cast iron bonnet and gunmetal thrust collar to BS 1400 LG2.

The valve shall conform to SABS 664 and/or 665, and shall be capable of withstanding a working pressure of 1600 kPa.

The valve shall be fitted with a square key spindle top to close the valve in a clockwise direction and socket ends to SABS 665 to fit uPVC Class 12 pipe and installed to detail.

16.2 Gate Valves Underground in Valve Chamber to connect to HDPE Piping

The gate valves shall be of the dezincified brass type with brass gate, brass body, non-rising spindle and BSO threaded socket ends. The valve shall conform to SABS 776/1965 Class 125. The valve shall be able to withstand a working pressure of 1600 kPa. The valve shall be fitted with a handwheel on an extended spindle shaft of +/-700mm to close in a clockwise direction and installed to detail.

16.3 Gate Valves Above Ground for Temperature up to 40^{o}C to connect to Steel Piping (65 NB and larger)

Gate valves to be equipped with non-rising spindle, spherical graphite iron body to ABS 936 Grade 42, cast iron nitrile butadine rubber covered gate, stainless steel spindle, nitrile butadine rubber o-rings and seals, cast iron bonnet and gunmetal thrust collar to BS 1400 LG2.

The valve shall conform to SABS 664 and/or 665, and shall be capable of withstanding a working pressure of 1600 kPa.

The valves shall be fitted with flanged ends to SABS 1123/1600 (1977), hand wheel to close the valve in a clockwise direction and installed in an upright position or side ways to a maximum 90^{o} from upright.

16.4 Gate Valves Above Ground for Temperatures above 40^{o}C to Connect to Steel Piping (65 NB and larger)

Gate valve shall be equipped with non-rising spindle, spherical graphite iron body to SABS 963 Grade 42, cast iron gate, gunmetal seat and gate rings, high tensile bronze spindle, cast iron bonnet and gunmetal thrust collar to BS 1400 LG2.

The valve shall conform to SABS 665 and shall be capable of withstanding a working pressure of 1600 kPa and a temperature of 90^{o}.

The valve shall be fitted with flanged ends to SABS 1123/1600 (1977), hand wheel to close the valve in a clockwise direction and installed in an upright position or side ways to a maximum 90^{o} from upright.

16.5 Gate Valves Above Ground to fit to Copper Pipes (65 NB and larger)

Gate valves shall be equipped with non-rising spindle, gunmetal bronze or dezincified brass body, gunmetal or dezincified brass gate, graphite asbestos packing in the gland.

The valve shall be fitted with a hand wheel to close in a clockwise direction and installed in an upright position or sideways to maximum 90^{o} from upright.

16.6 Gate Valves Above Ground to fit to Copper Pipes (65 NB and larger) continued

The valve shall be equipped with flanges to SABS 1123/1600, hand wheel to close the valve in a clockwise direction and installed in an upright position or side ways to a maximum 90^{o} from upright.

16.7 Gate Valves Above Ground for Temperatures up to 100^{o}C (up to 50 NB)

The gate valves shall be of the dezincified brass type with brass gate, brass body, non-rising spindle and BSP threaded socket ends. The valve shall conform to SABS 776 Class 125.''

The valve shall be able to withstand a working pressure of 1600 kPa.

The valve shall be equipped with a hand wheel to close in a clockwise direction.

The valve shall be installed in an upright position or sideways to a maximum of 90^{o} from upright and shall be so placed with other fittings to be removable without cutting the pipework.

16.8 Ball-O-Stop Valves (15mm Ø – 25mm Ø)

Ball-o-stop valve shall be a full-way ballcock type with BSP threaded ends. These valves shall conform to SABS 1056 Part 3 and shall be rated for a test pressure of 2000 kPa. Valve shall be chrome finished when exposed.

16.9 Angle Regulating Valves

Angle regulating valve shall be a 15mm Ø chromium plated angle regulating valve with a 350mm chromium plated copper tube and capnuts where required.

16.10 Valve Tag and Charts

Provide on all valves and controls, identifying numbered metal tags, including letter to indicate system, fastened by heavy brass hooks or chain.

Tags: Not less than 50mm sqaure, 1.25mm thick, aluminum with stamped numbers and letters filled in with black paint.

Provide separate diagrammatic charts showing essential features of each system with all valves and control lettered and numbered to correspond to designation on metal tags. Also furnish list of all valves and controls giving location and function.

Charts and lists: Type, size and character as approved. Mount in glazed metal frames permanently fastened in locations as approved by the consulting engineer.

17. STRAINERS

17.1 Strainers for Connection to Steel or uPVC Pipes (65 NB and larger)

This strainer shall be of the Y-type with cast iron body, stainless steel or bronze strainer element and shall be equipped with flanged ends to SABS 1123/1600)1977). The hole sizes of the strainer element shall be maximum 1mm Ø and be removable without dismantling of pipework. The strainer shall be suitable for a temperature of up to 90^{o}C at a 1000 kPa pressure rating and installed with the element facing downwards or a maximum

of 45 ^{o} sideways.

17.2 Strainers for Connection to Copper Pipes (65 NB and larger)

This strainer shall be of the Y-type with bronze or dezincified brass body, stainless steel element and must be equipped with flanged ends to SABS 1123/1600 (1977). The hole sizes of the strainer element shall be maximum 1mm in diameter. The strainer element shall be removable without dismantling of pipework. The strainer shall be suitable for a temperature of up to 90^{o}C at a 1000 kPa pressure rating and installed with the element facing downwards or a maximum of 45 ^{o} sideways.

17.3 Strainers for Connection to Steel and Copper Pipes (up to 50 NB)

The strainers shall be of the Y-type with bronze or dezincified brass body, stainless steel strainer element and must be equipped with BSP threaded socket ends. The hole sizes of the strainer element shall be maximum 0.8mm in diameter. The strainer shall be suitable for a temperature of up to 90^{o}C at a 1000 kPa pressure rating and installed with the element facing downwards or a maximum of 45 ^{o} sideways.

18. NON-RETURN VALVES

18.1 Non-Return Valves for Cold Water (65 NB and larger)

The non-return valve shall be of the spring loaded dual flap plate type fitted between two flanges. (Wafer)

The non-return valve shall be equipped with a cast iron body, aluminium bronze plates, stainless steel springs and neoprene seals on the plates. The valves shall be suitable for a working pressure of 1000 kPa.

18.2 Non-Return Valves for Hot Water (up to 100 Ø) and Cold Water (up to 50 NB)

The non-return valve shall be of the spring loaded piston type, with bronze or dezincified brass body, stainless steel spring and bronze disc with neoprene seal fitted with BSP threaded socket ends. The valve shall be suitable for a working pressure of 1000 kPa and a temperature of up to 90^{o}C. All valves shall be installed so as to be removable without extensive pipework removal.

19. AIR RELEASE VALVES AND VACUUM BREAKERS

19.1 Double Orifice Double Acting Air Release Valves with Sizes from 50 NB to 200 NB

The air release valve shall be fitted with small and large orifice. The air release valve shall be fitted with a cast iron body, stainless steel or fibre glass balls, integral shut off valve and flanged ends to SABS 1123/1600.

The valve shall be suitable for maximum pressure of 1600 kPa.

19.2 Single Orifice Air Release Valves for Main Water Lines with Sizes from 25 NB to 50 NB

The air release valve shall be fitted with a small orifice, cast iron body, fibre glass or stainless steel ball float and BSP threaded inlet.

When the valve is installed a shut off valve shall be installed on the inlet side.

The valve shall be suitable for maximum pressure of 1600 kPa.

19.3 **Single Orifice Double Purpose Air Release Valves for Domestic Water Lines up to 15NB**

The air release valves shall be fitted with a stainless steel float, brass or cast steel body with an integral shut off valve fitted.

The valve shall be capable to withstand a working pressure of 1000 kPa at 110^{o}C.

19.4 **Vacuum Breaker up to 40mm Ø**

The vacuum breaker shall be fitted with neoprene seal, spring loaded disc in a dezincified brass or bronze body. The valve shall seal water tight and shall be designed to withstand a working pressure of 1000 kPa and a temperature of 90^{o}C.

20. PRESSURE REDUCING VALVES

20.1 Combination Pressure Reducing Stations

Where a high peak flow can occur as well as a small flow and the small flow is out of the range of the large pressure reducing valve, a small PRV shall be installed in parallel with the large PRV. The two PRVs in parallel shall be set according to the manufacturer's specification.

20.2 Large Pressure Reducing Valves (65 NB and larger)

The pressure reducing valve shall be equipped with a cast iron body, neoprene – nylon reinforced diaphragm, bronze seal disc washer, stainless steel shaft and flanged ends. The valve shall be pilot operated and shall be designed to handle high flows at a minimum head loss.

The valve must be adjustable to handle a wide range of incoming pressure at a constant downstream pressure.

The valve shall be equipped with flanged ends to SABS 1123/1600.

20.3 Small Pressure Reducing Valves (15 NB – 50NB)

The pressure reducing valve shall be equipped with brass body, balanced single seat and integral strainer. The valve shall be able to handle a wide range of incoming pressure while the downstream pressure stays constant with maximum inlet pressure of 1000 kPa and a maximum water temperature of 40^{o}C.

The valve shall be equipped with BSP male threaded brass union couplings.

21. WATER METERS

21.1 Combination Water Meters

Where high peak flow as well as a small flow can occur, and the small flow is out of the registration range of large water meter, a small water meter shall be installed in parallel with the large water meter to cater for the small flows with integral automatic changeover valves. These valves shall be designed to have a minimum pressure drop at operating point.

21.2 **Water Meters (50 NB and larger)**

These water meters shall be of the dry type with all gears and transmission and roller counters in a dry head, and shall be equipped with flanged ends to SABS 1123, cast iron body with high quality corrosion proof coating. The meter must be protected from magnetic fields and must be sealed to prevent tampering with adjustments. The meter must be able to work up to a pressure of 1600 kPa under a maximum water temperature of $40^{o}C$. The scale of meter must be in m^3 and equipped with needle indicators reading in litres. Accuracy of meter to be not less than 98%.

The meters shall be installed with leading and trailing lengths of pipes to the manufacturer's specification.

21.3 **Water Meters (up to 50 NB)**

The metre shall be of the volumetric rotary piston type with brass body equipped with union couplers. The meter shall have an accuracy of not less than 09%. The meter must be able to operate up to a water pressure of 1000 kPa at a water temperature of $40^{o}C$.

The meters shall be installed with leading and trailing lengths of pipes to the manufacturer's specifications.

22. ADJUSTABLE BALANCING VALVES

22.1 Adjustable balancing valves shall be supplied and installed as indicated on the appropriate drawings. A portable differential pressure metre shall be used, with all the necessary pipes, shut-off valves and air release valves to set the balancing valves. A graph chart shall be supplied to indicate the flow units against the valve adjustment and as the pressure differential over the valve.

22.2 The pressure gauge shall be calibrated according to the current accepted SI units.

22.3 On completion of the project the chart shall be handed to the maintenance manager.

22.4 The calibrated adjustable balancing valves shall be of the angle valve type equipped with bronze valve body, bronze disc, internal seals with BSP threaded ends. The valve shall b fitted with stop cock connection ends on inlet and outlet onto which the differential pressure gauge can be coupled to. The valve shall be equipped with an indicator on the valve handle to show the position of the valve opening. The valve shall be suitable for operating at a temperature of $90^{o}C$ against a pressure of 1000 kPa.

23. DRAINAGE SYSTEMS

23.1 **General Requirements**

The complete sanitary drainage systems, including connections to main outfall sewer and drainage connections to plumbing fixtures, kitchen and other equipment requiring same shall be installed in accordance with requirements of the Authorities having jurisdiction and the National Building Regulations and Building Standards Act of 1977 as amended.

The Subcontractor shall arrange with the local authorities for all inspections and tests.

Before any part of a drainage system is permanently covered or otherwise rendered inaccessible it shall be inspected and approved by the local Authority and the Engineer.

All equipment, materials and labour necessary for inspection and testing as required shall be made available by the contractor.

All plumbing and drainage work shall be carried out under the direct supervision of a registered plumber and drain layer in terms of the requirements of the local authority and Act. A copy of the registration certificate of all persons carrying out or supervising such work shall be kept on site for inspection at all times. The contractor shall in addition be registered by the local authority.

23.2 **Drains**

All drains shall be laid in a straight line between points where changes of direction or gradient occur.

Where drains pass under any wall other than a free-standing wall such drain shall be of cast iron pipe and shall be completely encased in concrete not less than 100mm thick measured at the hub.

Where any drain passes under a building or where indicated, the pipe shall be cast iron and shall be encased in concrete, along its entire length, not less than 100mm thick measured at the hub. The drain shall be so arranged that all junctions, bends and access eyes are readily accessible.

Access to drains shall be in accordance with the requirements of the local authorities and Act.

Horizontal drainage piping shall be installed at a gradient not less than that indicated, unless approved by the Engineer.

All exposed drainage pipe and pipework within the building shall be spun cast iron pipe or HDPe drainage pipe as specified.

Underground piping external to the building shall, unless otherwise specified or indicated, be vitrified clay pipe or structural wall uPVC as specified.

Vent pipes shall be spun cast iron using approved drainage fittings.

Connections to fixtures shall be provided with approved type reseal traps and shall be installed to be readily accessible.

All pipe laying is to be carried out in accordance with the procedure described in SABS 058.

Laying is to commence at the points of junction with existing drains or at points of discharge.

Before each pipe is laid, it shall be examined to ensure that the bore is clean and any foreign material removed. Plug open ends and junctions, whenever work is suspended, to prevent the entrance of rubbish during construction.

Gulley traps are to be finest quality salt glazed stoneware with outlet jointed to drain and with hopper head fitted with cast iron pierced grating and frame, the whole set on and encased in cement concrete 1:3:6 carried up 75mm high as kerb, finished on exposed places with 20mm granolithic with angles rounded including excavation and casing.

Cleaning eye covers shall be cast iron A.B.C. covers and frames, jointed to top of drain with Gaskin and T.O.K. strip grooved for and including stopper with raised letters "C.E", cast on same, bedding in tallow and screwed to frame with gunmetal set screws. The frame shall be encased in cement concrete 1:3:6 finished on top with untinted granolithic

including excavation and casing.

Manholes, unless otherwise described, shall be constructed of precast reinforced concrete rings, with cast iron frames and covers, in accordance with the Drawings. The invert channels shall be smooth and semicircular in shape conforming to the inside of the adjacent sewer section. Changes in direction of flow shall be made with a smooth curve of as large a radius as the size of the manhole will permit. Changes in size and grade of the channels shall be made gradually and evenly. The invert channels shall be formed directly in the concrete of the manhole base, or shall be built up with mortar, or shall be half tile laid in concrete, or shall be constructed by laying full section sewer pipe through the manhole and breaking out the top half after the surrounding concrete has hardened. The floor of the manhole outside the channels shall be smooth and shall slope toward the channels not less than one inch per foot (1:12) nor more than (1:6). Free drop inside the manholes shall not exceed 450mm measured from the invert of the inlet pipe to the top of the floor of the manhole outside the channels, and drop manholes shall be constructed whenever the free drop would otherwise be greater than 450mm.

All manholes to be with stepirous fixed in the factory.

Where ground waters are suspected, a special concrete foundation must be built against the buoyancy forces. The calculation will be issued by the Engineer.

23.3 Vents

The drainage system shall, unless otherwise specified, be of the one pipe system and all necessary vents and anti-syphonage pipe shall be provided in accordance with the system requirements and in accordance with the relevant bylaws.

Vents extending above the roof level shall be located at least 3m away from any window, door or air intake opening, and shall be properly flashed.

Vent piping shall be run with long radius bends at changes in direction and shall be graded back towards the drain.

When the "so vent" system is used, the fittings shall be Besaans du Plessis "nu vent" or equal and shall be provided with openings as indicated or required.

When back to back W.C. arrangement is used, a double bend shall be provided between the W.C. outlet and the "nu vent".

23.4 Stainless Steel Floor Traps and Floor Chanels

23.4.1 Stainless Steel Floor Traps

Stainless steel floor traps shall be installed where indicated on drawings for kitchen, abattoirs, dining halls etc. These units to be manufactured according to the details supplied in the detail specification. The units are to be manufactured from 304 stainless steel with a load capacity of 1500 kg. The floor traps shall have minimum flow capacity of 3 litre/second.

23.4.2 Cast Iron Floor Traps

Cast iron floor traps shall be used where indicated on the drawings or specified. These units shall be manufactured out of cast iron as per detail supplied in the detail specification. The units shall be fitted with a water seal and a large sludge box and lid to be easily removable for maintenance purposes. The units shall be designed in such a manner as to provide access to the drainage system and to be used as a cleaning point.

23.5 Soilcrete

Soilcrete shall be used in trench backfilling where specified indicated and where sewer trench bottoms are below the 45^{o} angle of building foundations.

The compaction of the soilcrete shall be as follows:

Soilcrete shall consist of an approved soil or gravel mixed in a concrete mixer with 5% of Portland demand (per volume) and only sufficient water to give a consistency that will permit the soilcrete to be placed. Concrete vibrators shall be used, so that all voids between the pipes and excavation sides and between culverts in the case of multi-barrel culverts are properly fitted. The height to which the soilcrete shall be filled, shall be determined by the engineer or be as show on the drawings and any remaining backfill shall be carried out as described above using a granular material.

The aggregate must consist of approved soil or gravel containing stones not bigger than 38mm and with a plasticity index not exceeding 10. Detrimental percentages of silt or clay must be avoided and the aggregate shall be obtained from an approved source.

23.6 Testing of the Drainage Installation

The contractor is to carry out all the tests on the drainage installation as required by the Local Authorities and shall receive their approval before requesting final payment and hand over of the installation.

The Engineer shall be informed when the tests are to be carried our in order that he may witness and approve these.

All drains are to be tested by passing a ball, 20mm smaller in diameter than the internal pipe diameter, through the drain and it shall pass without assistance.

24. DOMESTIC WATER SUPPLY SYSTEM

24.1 General

Provide complete domestic hot and cold water supply systems, including connection to supply authority, hot water heating equipment and required hot and cold water connection to plumbing fixtures, kitchen and other equipment requiring same all as indicated.

Run piping free of traps wherever possible, and grade and valve for complete control and drainage of system with drain cocks at low points and at base of risers.

Provide on main water branches to dishwashers, domestic washing machines and where noted, properly sized shock absorbers.

24.2 Prevention of Water Contamination

Wherever possible, provide over-rim water supplies to plumbing fixtures and equipment. Provide necessary below-rim connections, water closet and urinal flush valves, hose bibs and hose connections with approved vacuum breakers and/or check valves as noted or required.

Kitchen or other equipment supplied under other divisions of work and/or by owner, and having below-rim water supply connections, may not arrive on job in code approved condition, in which case Subcontractor shall provide missing vacuum breakers and/or check valves, or re-locate same to code approved positions.

24.3 Pipe and Fittings

Unless otherwise noted hot and cold water pipe shall be copper tubing with cast bronze or wrought copper solder capillary fittings. Connection to valves and fittings shall be by means of copper to iron adaptors male or female as required. Cold water piping above 65mm shall be galvanised mild steel.

Exposed piping at plumbing fixtures shall be CP copper pipe with CP threaded cast brass fittings.

Make connections to equipment with flanges or unions and with threaded adaptors used for swing connections. Terminate noted plugged or capped connections in threaded plug or threaded nipple and cap as required, unless otherwise noted.

Provide insulating bushings, couplings, unions, or flanges where brass or copper piping connects to galvanised piping at location of equipment connection.

When copper pipe is built into walls, floors, etc. and when laid underground, the piping shall be wrapped for its entire built-in length with Denso tape or equal approved protective covering.

The use of brown paper or any building paper is forbidden.

24.4 Insulation

The Subcontractor shall provide insulation as specified herein on all hot water pipes and hot water heaters.

The Contractor shall provide a suitable storage area for all insulation on site prior to fitment. He will be liable for replacement of same due to damage, as determined by the Engineer, at his own expense.

Where pipes are installed in service ducts, ceiling voids and where specified shall be insulated with “Thermaflex” pre-formed pipe insulation sections. This insulation shall be used with pipe systems where the maximum temperature is $80^{o}C$, for temperature higher than $80^{o}C$ pre-formed fibreglass sections shall be used with galvanised sheet metal muffs.

All bends and T-pieces shall be cut in 45^{o} metre box to form a neat joint. All joints shall be glued together with a contact adhesive as supplied by the manufacturer. Pipe sizes larger than 50mm Ø shall be insulated with pre-formed fibreglass sections with canvas covers glued together with cold wood glue.

Thermaflex Thickness Table

Pipe Size (Steel)	Pipe Size (Copper)	Thermaflex Thickness
50mm Ø	54mm Ø	25mm Ø
40mm Ø	42mm Ø	25mm Ø
32mm Ø	35mm Ø	25mm Ø
25mm Ø	28mm Ø	20mm Ø
20mm Ø	22mm Ø	20mm Ø
15mm Ø	15mm Ø	20mm Ø

All hot water pipes in service tunnels, service corridors and where exposed to damaged and/or weather shall be insulated with pre-formed fibreglass sections covered with galvanised sheet metal muffs in a water tight manner. Sheet metal muffs shall be installed with the joints overlapping at least 50mm and the longitudinal overlap pointing downwards to prevent ingress of water. The sheet metal muff shall be strapped with 10mm galvanised straps by means of a strapping tool with a minimum of 2 straps/section. All pipe bends, T-pieces etc shall be insulated with at least 25 Ø fibreglass rope covered with

a 12mm thick layer of self setting fibre cement. A reinforcing gauze shall be wrapped over the fibre cement while wet and then painted with a mastic paint when dry.

Fibreglass Section Thickness Table

Pipe Size (Steel)	Pipe Size (Copper)	Thermaflex Thickness
100mm Ø	108mm Ø	65mm Ø
80mm Ø	76mm Ø	55mm Ø
65mm Ø	67mm Ø	55mm Ø
50mm Ø	54mm Ø	55mm Ø
40mm Ø	42mm Ø	55mm Ø
32mm Ø	35mm Ø	40mm Ø
25mm Ø	28mm Ø	40mm Ø
20mm Ø	22mm Ø	30mm Ø
15mm Ø	15mm Ø	30mm Ø

A protective coating equivalent to "Foster Sealfos Coating 30-36" or "Decadex Fire Check" shall be brush applied over the canvas. Coatings shall be applied in accordance with manufacturer's recommendations.

Exposed piping shall in addition be provided with 0,56mm thick galvanised sheet metal cladding over the insulation material. Bends shall be clad with Lobster Back bends also of 0,5mm thick galvanised sheet metal. Cladding shall be secured by stainless steel bands or non-ferrous pop rivets every 50mm.

Cladding shall be painted as previously specified for pipes.

24.5 Automatic Air Relief Valves

Provide automatic air relief valves, Sarco or equal, at all high points in hot water piping circuits and where indicated. Air relief valve shall be 15mm, suitable for a working pressure of 16 bar, with non-shock water. Drain piping shall be taken to discharge at a deep seal trap or point as indicated. A stopvalve is to be fitted on the upstream side of all air relief valves.

24.6 Trace Heater Tape

Where indicated hot water piping shall be traced with electrical trace tape. "RAYCHEM HWAT" or equal and approved, which shall automatically maintain a constant temperature of 50ºC. The tape shall be fixed to the pipe at least every 300mm with approved type adhesive tape capable of withstanding the rated temperature without damage.

The tape shall be installed in accordance with the manufacturer's instructions and shall be inspected and approved by the Engineer before insulation of the pipework.

The tape shall be rated for 220V and shall be limited in length to ensure a maximum of 15A supply. When this rating is exceeded the system shall be divided in separate supplies to limit the current.

The Plumbing Contractor shall provide all trace heating tape, end caps, junction splices, junction boxes, and all necessary fittings for the trace heating system as recommended by the supplier and specified by the Engineer.

The complete system, up to and including the connection to the electrical supply point shall be installed, tested, and commissioned by the Contractor.

Install and test the system in stages if so ordered by the Engineer to facilitate work of others. Repair defects disclosed by tests, or if required by the Engineer, replace defective work.

24.7 **Hot Water Circulators**

Provide and install where specified hot water circulating pumps, in-line type, with close grained cast iron casing, and bronze, balanced impellers. Pumps shall be of the capacity and head as indicated, and have spring loaded mechanical seals, with rubber ring rotating against stationary carbon seat.

24.8 **Immersion Thermostats for starting Pumps**

Provide for the automatic control of hot water circulators, immersion type thermostats in the return water line. Thermostat shall operate mercury switch, which shall start and stop the pump.

24.9 **Pressure Gauges**

Provide a pressure gauge on each water service at meter location, on discharge headers, on house and hydropneumatic tank pumps, on inlet and outlet of each master pressure reducing valve assembly, and where noted.

Pressure gauges shall be 80mm diameter with black enamel cast iron case, brass ring with heavy glass, phosphor bronze single spring Bourdon tube, phosphor bronze bushed rotary precision movement and suitable dial range with at least 1% accuracy with brass tee handle cock. Pressure gauges shall be calibrated in bars or mb.

24.10 **Thermometers**

Provide dial type thermometers in oversized tees and nipples on HW supply and return lines, and where noted.

Thermometers shall be 80mm diameter with CP brass case, threaded ring with heavy glass, vapour pressure or liquid actuated bronze single spring Bourdon connection with copper bulb.

24.11 **Tests**

Test piping and prove tight as specified and/or required by Authorities having jurisdiction; in presence of Engineer and said Authorities, who shall be given 48 hours notice in advance before tests are made. Make preliminary tests and prove satisfactory before requesting witnessing of final tests. Make tests in stages if so ordered by the Engineer to facilitate work of others. Repair defects disclosed by tests or if required by Engineer, replace defective work.

Subcontractor shall be required to attend with the Engineer and give all assistance required and provide such tools, materials, implements and instruments as are necessary for tests. The Engineer reserves the right to call for such additional tests, such as dynamic tests, as he may consider necessary.

Subcontractor shall be responsible for work of other Trades disturbed or damaged by tests or repair and replacement of work and shall cause work so disturbed or damaged to be restored to its original condition at own expense.

The pipe installation shall be hydraulically pressure tested by means of a suitable manually operated or mechanically driven pressure pump.

A pressure of at least 1.5 times the working pressure of the class rating of pipes, or fittings shall be applied for a period of time specified in the specifications or as recommended by the manufacturers.

Tests should not be performed against closed valves.

Leakage which occurs shall be measured and calculated and checked against the allowable losses.

If the completed section of pipe complies with all specifications and passes the tests and inspection, it could be approved and the contractor may be instructed to backfill the open sections of trench at the joints and connections, where applicable.

The contractor shall then proceed to build all the valve chambers, inspection chambers etc.

24.12 **Sterilising of Water Pipes**

Before any pipeline is taken into use, it shall be sterilised over its complete length and including the fittings. The pipe shall be filled with potable water chlorinated to a concentration of 15 mg of chlorine per litre of water which shall remain in contact with the inner surface of the pipeline for a period of not less than 24 hours. The pipeline shall be filled for sterilising in such a manner that no chlorine shock is created or air is trapped in the pipeline.

At least 14 days prior to the commencement of sterilising the contractor shall submit the full details of the proposed method of sterilising the pipeline to the engineer for his approval.

The contractor shall provide all necessary materials, tools, equipment and labour necessary to sterilise the pipeline. After sterilising the pipeline the contractor shall, at no extra cost, empty the pipeline and dispose of the water in a manner approved by the engineer.

The contractor may use the following products as a source of chlorine:

a) Chlorine of lime to SABS 295 yielding 33% free chlorine by mass.

b) Calcium hypochlorite to SABS 295 yielding 70% free chlorine by mass.

c) Chlorine gas applied by chlorinator.

After sterilisation, an approved water quality test to a minimum number of 10% of the total water points, randomly selected, evenly spread and marked on drawings, shall be carried out. These tests shall include a full bacteriological test as per SABS 241 and the results shall be handed to the engineer for approval. Each abortive test shall be for the contractor's account.

After pressure tests have been made, the unit to be disinfected shall be thoroughly flushed with water until all entrained dirt and mud have been removed before introducing the chlorinating material which shall provide a dosage of not less than 50 parts per million and shall be introduced into the water lines in an approved manner.

The treated water shall be retained in the pipe long enough to destroy all non-sporic-forming bacteria. Except where a shorter period is approved, the retention time shall be at least 24 hours and shall produce not less than 10 parts per million of chlorine throughout the line at the end of the retention period.

All valves on the lines being disinfected shall be opened and closed several times during the contract period. The line shall then be flushed with clean water until the residual chlorine is reduced to less than 1.0 parts per million. From several points the contractor shall take samples of water in properly sterilised containers for bacterial examination. The disinfection shall be repeated until tests indicate the absence of pollution for at least 2

days. The unit will not be accepted until satisfactory bacteriological results have been obtained. The contractor shall arrange for a field laboratory, approved by the Consultant, to conduct all bacterial examinations required.

It is required to take a control sample of the incoming water at the same time as the other samples are taken.

25. FIRE SYSTEMS

25.1 General

Materials and equipment shall be of a type and size approved by the local Fire Department, the Owner's Insurance Underwriters and the engineer.

Systems as installed shall meet the requirements of the local Authorities having jurisdiction and the Owners Insurance Underwriters and receive approval of same before final payment.

25.2 Pipe and Fittings

Pipework, above ground, shall be galvanised steel pipe to SABS 62 heavy.

Pipework, below ground, shall be uPVC Class 16.

Fittings shall be screwed or flanged as specified and shall be suitable for a WWP with non-shock water of 25 bar.

25.3 Valves

Valves shall be suitable for the pressure duty required, and shall be of a suitable pressure class, depending on the mounting location.

Valves shall be sealed or locked in the correct position by means of an approved lock and chain.

Hosereel valves shall be 20mm CP bronze shut off valves, globe type with threaded ends. Valves shall be "Hattersly" or equal suitable for a WWP of 16 bars with non shock water and shall be clearly marked with an arrow and the words "oop" - "open" in red. Valves shall be suitable for the installation of an approved sealing device.

25.4 Hose Reels

Hose reels shall be red enamelled type of all steel construction, and provided with wall mounting bases, spindles and glands and shall be securely fixed to the wall with suitable "rawl" bolts and plate washers.

Hose reels shall be fitted complete with supply pipe, nozzle cock and hose guide in conformity with SABS 543 and bear the SABS mark. Fire hose shall be reinforced rubber 20mm nominal bore, having 32mm outside diameter and shall be in 30m lengths, unless otherwise specified.

25.5 Fire Hydrant

Fire hydrant valves shall be 65mm angle type, with brass on gunmetal body and polished brass trim. The hydrant shall be provided with quick coupling female outlets with brass cap and brass chain.

Handwheel shall be cast iron, painted red and shall have the words "open" - "oop" together

with direction arrows embossed on the face. Hydrant shall be suitable for WWP of 18,5 bar with non-shock water and shall be tested to 20 bar.

Hydrants shall be in accordance with SABS 1128, Parts I and II and shall have the instantaneous pattern connection, unless otherwise specified.

25.6 Fire Extinguishers

Portable fire extinguishers shall be of the size and type specified and installed in the positions as indicated on the drawings.

Fire extinguishers shall be provided with brackets and fixed to and including 230mm x 760mm x 22mm chamfered oiled hardwood backboard bolted with and including four 9mm bolts with plate washers cut and pinned to brick or concrete wall.

Fire extinguishers shall be in accordance with and shall bear the SABS mark and shall be approved by the Authorities having jurisdiction over the site.

Soda acid water extinguishers shall be in accordance with SABS 889 and shall be of the gas cartridge type.

Dry powder type extinguishers shall be in accordance with SABS 810 and shall be of the gas cartridge type.

25.7 Testing

The entire fire reticulation system shall be pressure tested to a maximum pressure of 20 bar measured at the lowest point in the system and a minimum of 12 bar at the highest point. Where the head of water causes the maximum pressure to be exceeded, the system is to be tested in sections.

26. GAS INSTALLATION

26.1 General

Run piping free of traps with drain pocket consisting of nipple and cap at low points.

Pipework to be installed in accordance with the requirements of the supply authorities and to the approval of the Engineer. Installation shall be carried out only by registered gas piping fitters. Copies of their certificate of competence shall be submitted to the Engineer before installation work commences.

26.2 Pipe and Fittings

Pipe : Bare Steel. Fittings welded or flanged.

Provide copper union between nipples on equipment side of individual gas cocks.

26.3 Control Valves

Provide stop cock at connection to each piece of gas burning equipment.

Valves and stop cocks, except service cock : threaded or flanged iron body lubricated plug valve, 10 bars WOG class.

Attach wrench to each valve.

26.4 **Test**

Test gas piping with air at 1 bar which pressure shall be maintained for at least 30 minutes without drop.

While the pipework is under pressure, each joint on the system is to be checked using a suds mixture to ensure all joints are perfectly sealed.

27. SANITARY FITTINGS

Install and connect up kitchen and toilet fittings as specified in the schedules, or provided under work of other divisions and/or owner, and provide required trim and "P" traps for same as specified.

Provide water supply fixtures with stop valves. Exposed pipe fittings, traps, escutcheons, valves, valve handles and accessories, both above and below fixtures, shall be CP brass (covering tubes not permitted).

Water supply and drainage nipples shall be brought to the wall and covered by CP escutcheons.

Supply fixtures shall be renewable seat composition washer, all metal indexed handles and integral on separate screwdriven or lockshield stops. No manufacturer's name allowed on exposed portion of fixtures.

During course of construction, protect exposed fittings from damage and cover fixtures with wooden protection housings. Uncover and thoroughly clean fixtures and fittings when directed.

Fixture connections shall be at least as follows:

Fixture	Drain	Vent	CW	HW
Water Closets Flush Valve	100mm	50mm	32mm	-
Urinals	50mm	40mm	25mm	-
Showers	40mm	40mm	15mm	15mm
Wash Hand Basins	32mm	32mm	15mm	15mm
Bath	40mm	40mm	20mm	20mm
Sink	40mm	40mm	15mm	15mm

Sanitary fittings shall be installed as follows:

27.1 **Precast Concrete Wash Troughs**

Precast concrete wash troughs shall be bedded on top of pedestals which shall be bedded on floors in 1:3 cement mortar.

27.2 **Stainless Steel wash Troughs and Wash Hand Basins**

Stainless steel wash troughs and wash hand basins shall be fixed to walls on a pair of 20mm diameter galvanised mild steel pipe brackets with flanged ends cut and pinned 150mm deep into walls in 1:3 cement mortar.

27.3 **Acrylic Resinous Wash Hand Basins**

Acrylic resinous wash hand basins shall be fixed to walls on a pair of standard painted cast iron brackets screwed to underside of basin and bolted to wall with 6mm diameter expanding bolts.

27.4 Ceramic Wash Hand Basins

Ceramic wash hand basins shall be fixed to walls on a pair of standard painted steel or cast iron brackets bolted to wall with 6mm diameter expanding bolts.

27.5 Acrylic Resinous Baths

Acrylic resinous baths shall be bedded in 1:5 cement morar on three cross rows of bricks or bedded solid on a layer of dry river sand and fixed to wall with galvanised steel brackets under edges (in the middle of the sides against walls) bolted to wall with 6mm diameter expanding bolts and sealed along top against wall finishes with patent mildew resistant silicone rubber.

27.6 Washdown Closet Pans and Cisterns

Washdown closet pans shall be bedded on floors in 1:3 cement mortar. Cisterns shall be fixed to walls with 6mm diameter expanding bolts.

27.7 Ceramic Urinals

Ceramic stall and slab urinals shall be bedded on floors and against wall in 1:3 cement mortar. Slabs, channels, treads etc. shall be jointed in 1:3 cement mortar and pointed in white cement.

Ceramic bowl urinals shall be fixed to walls on standard steel brackets bolted to wall with 6mm diameter expanding bolts. Cisterns shall be fixed to walls on standard brackets bolted to wall with 6mm diameter expanding bolts.

27.8 Stainless Steel Urinals

Stainless steel urinals shall be bedded on floors in 1:3 cement mortar and with backs and sides against walls filled in with fine unreinforced concrete. Cisterns shall be fixed as cisterns for ceramic urinals.

28. WATER STORAGE GEYSERS

28.1 Domestic Geysers

The geysers shall be installed as indicated and specified on the drawings and this specification.

All work is to be executed in a first class workmanlike manner and all equipment supplied shall be of new high quality material, design and manufacture, suitable for providing an efficient, reliable and trouble free service.

It will be the contractor's responsibility to select such equipment and to position it into a building space as provided. Where no specified make or quality of material is directed, a standard article as approved by the engineer shall be supplied.

The contractor shall ensure, before ordering of equipment, that the plant room dimensions and access to the plant room are to his satisfaction. Special care shall be taken not to damage equipment during positioning and installation. All faulty and damaged equipment shall be replaced by new before handover (or made good, only if approved by the engineer).

All materials to be used shall be compatible with the total installation.

The water temperature of the geysers shall not be higher than 80^{o}C and shall be set at a temperature as indicated in the detail specification.

The piping to be used shall be as specified in the detail and standard specification for domestic hot and cold water installations.

The contractor shall ensure that the necessary equipment is installed to protect the geyser from over pressure and over temperature. The necessary test and approval certificates for the geysers shall be supplied to the engineer.

These geysers shall comply with SABS 151. The units are to be manufactured out of a steel cylinder welded by means of the MIG CO_2 process, the interior of the cylinder shall be porcelain coated by means of the vacuum process and the exterior shall be spray coated and fired to 870^{o}C. the unit is to be insulated with a high density insulation material. The insulation is to be covered with a 0.8mm fully bondirized steel with a baked enamel finish. The unit shall be equipped with wall brackets for mounting purposes.

Each geyser shall be equipped with an immersion element as specified, incalloy elements are to be used for hard water.

The elements are to be controlled by means of a fail safe thermostat which shall be adjustable between 40^{o}C and 75^{o}C. The geyser is also to be equipped with the following:

- Temperature and pressure relief set at 600 kPa and 97^{o}C
- 20mm dia in and outlet BSP thermal sockets
- Magnesium sacrificial anode

The unit shall be designed for a working pressure of 400 kPa. Each geyser is to be furnished with a 5 year warranty.

Geysers installed in ceiling voids and in areas where leaks can cause damage, shall be instaled with a drip tray. The safety and expansion relief valves and drip tray shall be piped to the outside or nearest drain point.

28.2 **Under Basin and over Basin Water Storage Heaters**

These water storage heaters shall comply with all the relevant IEC standards and Government Notice 466 (Electrical Safety Standard for Appliances). This specification covers geysers up to 30 litre in storage.

The unit is to be rated for a maximum operating pressure of 700 kPa.

The unit is to be manufactured out of a lap welded steel cylinder by means of the MIG CO_2 process. The unit is to be internally coated with two coats of thermofused porcelain with a magnesium sacrificial anode. Insulation material to be high density polyurethane foam. The outer casing shall be manufactured out of injection moulded ABS plastic finished in appliance white.

The unit shall be equipped with the following:

- 700 kPa safety valve
- Correctly sized expansion valve
- Direct immersion element

- Control thermostat adjustable between 40^{o}C and 75^{o}C with fusible link for over temperature cut

- 15mm dis BSP threaded female sockets for water in and outlets.

The units shall be furnished with a 5 year warranty.

28.3. **Industrial Hot Water Generators**

Hot water generators shall be semi pressure vessels of the vertical or horizontal configuration as indicated. The size and capacity of the generator shall be as indicated on the drawings.

The cylinders shall be manufactured in accordance with S.A.B.S. or equal code. Mild steel aluminium flame sprayed and epoxy coated after the surface has been shotblasted.

The vessels shall be of welded construction with dished ends to B.S. 5500 and shall be provided with welded flanged connections as indicated for heater batteries and all piping connections.

Screwed sockets may be welded into the vessel for instrument connections. Where these are provided, the insulation shall be applied around the connections and finished neatly with sheetmetal surround without sharp edges or protrusions.

The vessel shall be provided with a minimum 400 x 450mm oval manhole for inspection and cleaning.

The vessel shall be pressure tested to 1.1/2 times the working pressure but not less than 700 kPa.

The generators shall be provided with immersion heaters of the capacities indicated. Elements shall conform with S.A.B.S. or equal standard.

The tanks shall be insulated after installation with 50mm thick mineral wool with a density of 88kg/m^{3} or equivalent glass fibre insulation and covered with 0.8mm thick galvanised sheetmetal cladding, pop rivetted in position. Cladding shall be neatly installed without sharp edges or protrusions. Escutcheons shall be provided around all tappings.

The generator shall be provided with tapping for bulb connections for thermometers, thermostats, pressure gauges and any other instrumentation necessary or indicated.

The generator shall be provided complete with a safety valve set to release at 150 kPa above design working water pressure and shall be sized sufficient for the rate of heat rise provided by the element and the production of steam in the event of a failure. The discharge from the safety valve shall be taken without further connections to discharge in a place of safety but shall also be visible.

The generator shall be provided complete with thermostat to control the temperature of the water and to switch the element on in stepped sequence. The number of steps shall be as indicated. A safety thermostat shall be provided to trip all elements in the event of the water temperature rising too high. The safety thermostat shall be of the manual reset type and shall be set to operate at 70º C. All thermostats shall be set, sealed, and of a tamper-proof type.

Provide on top of each generator a dial type thermometer and pressure gauge.

Provide a control board to operate the boilers. The board shall be of the "Packaged" type incorporating prewired controls, circuit breakers, 3 phase magnetic contactors and all items necessary for the operation of the boiler. The element shall be wired in stop

configuration. Refer to the electrical section of this section for further details.

The installation of the boilers, control panel and wiring shall form part of this subcontract. Power shall be provided at the control panel however, final connection to the panel shall form part of this installation.

Shop drawings of vessel and control panel shall be submitted to the Engineer for approval prior to manufacture.

29. CONTROL PANEL AND ELECTRICAL WIRING INSTALLATION

29.1 General

The Subcontractor shall supply and install a complete 3 phase - 4 wire 400 Volt wall mounted control panel assembly to SABS 1180 which shall be complete with main isolator, contractor, circuit breakers, busbars, step controllers, temperature controllers, ammeters, current transformers, fuses, indicating lights, interlocking remote control wiring and interconnecting wiring as necessary. Spare fuses and indication lamps shall be provided as necessary.

The installation shall be installed in accordance with the latest edition of SABS 0142-1987, Code of Practice for the Wiring of Premises, as amended, as well as Local Municipal By-Laws and Regulations and Regulations of the Local Supply Authority.

The Subcontractor shall commission and test the entire installation in accordance with the requirements of the Local Authority, Supply Authority and the Engineer at his own expense. All test equipment shall be provided by the Subcontractor at his expense. Testing shall be carried out in the presence of the Engineer who shall be notified timeously of the dates of such tests in writing to allow them to be witnessed.

"As built" drawings of the switchboard shall be installed inside the panel and THREE sets shall be submitted to the Engineer on completion of the installation. The following information shall be indicated:-

a) A complete wiring diagram of the equipment indicating terminal numbers, numbers and colours of conductors connected to terminal strips and the numbers and colours of the conductors utilised for internal panel wiring.

b) All labelling information on a separate sheet.

c) The make, catalogue number and capacity of all equipment, including electrical equipment.

29.2 Surface Mounted Switchboard

Surface mounted switchboards shall be equipped with a 1,6mm² thick galvanised steel reinforced tray with gusseted corners. Securing lugs shall be provided for fixing the tray to walls or any other structure. A solid brass or cadmium plates steel earth connection stud and nut shall be provided.

All joints shall be welded. The tray shall be square and neatly finished without protrusions. The front tray sides shall be rounded with an edge of at least 20mm to accommodate flush doors. Removable panels shall be secured by means of "Camloc" or "Dzus" fasteners.

The switchboard shall be of ample size to accommodate all the necessary switchgear, control equipment etc. and shall be provided for heaters where specified to facilitate "load shedding".

Pilot lights shall be provided on the front panel to indicate power on, heater step on (one per step) and boiler high temperature trip.

All busbars, cables, wiring etc. shall be colour coded in accordance with the SABS requirements.

External wiring for low voltage, control interlocking, alarm, measuring and D.C. circuits shall terminate on numbered terminal strips of the "KLIPPON" or "ENTRELEC" or equivalent manufacture. The correct terminal size, as recommended by the manufacturer for each conductor to be connected shall be used throughout. The terminal numbers shall appear on the wiring diagrams of the switchboard. Terminals for power wiring shall be separate from other terminals. Terminals for internal wiring shall not be interposed with terminals for external circuits.

Labelling shall be Black on White ivorine except warning labels which shall be Red on White ivorine.

All metal components of the framework, panels and chassis shall be finished with a high quality
baked enamel finish. Prior to painting, all metal parts shall be thoroughly cleaned of rust, millscale, grease and foreign matter. Immediately after cleaning all surfaces shall be covered by an electrolytically applied rust inhibiting, tough, unbroken metal phosphate fibre and then thoroughly dried.

Within forty eight (48) hours after phosphating, a passivating layer consisting of a high quality zinc chromate primer shall be applied, followed by two (2) coats of high quality baked enamel to SABS 783 type 1. The minimum paint thickness after baking shall be 0,06mm and shall have a shock resistance of 25kg-cm or 0,9mm soft steel plate and scratch resistance of 2000 grams.

The electrical installation between the switchboard and the equipment shall comply with SABS 0142. Armoured cabling shall comply with SABS 150 and shall be neatly run on galvanised cable tray installed on walls and overhead providing a maximum headroom at all times.

Local isolation shall be provided at all items of equipment e.g. boilers, pumps etc. in accordance with the code of practice.

Earthing of non-conducting metal parts and equipment shall comply with the code of practice.

30. TRENCHES AND EXCAVATIONS

The following shall be in the classification of the materials to be excavated.

Material Class "C" shall comprise granite, chert, quartzitic sandstone, slate and rock of similar or greater hardness in undecomposed boulders exceeding 0,15m³ in volume, the practical excavation of which, in the opinion of the Engineer, would normally necessitate the use of explosives.

Material Class "B" shall comprise hard material other than that classified as Class "C" above, the economic excavation of which, in the opinion of the Engineer, warrants the use of pneumatic tools or mechanical breakers and shall include hard shale, compact ouklip and rock of similar hardness.

Material Class "A" shall comprise all materials to be excavated other than those classified as Class "B" or Class "C" above and shall include made-up ground, rubbish, gravel, sand,

shale and clay.

All items of drains, manholes and pipe excavations, etc. are measured as being in Class "A" material unless otherwise described.

If the contractor considers that any of the excavation encountered is in Class "B" or "C" material he shall immediately notify the Engineer and/or the Quantity Surveyor for a ruling; failing such notification the excavations shall be deemed to be in Class "A" material and shall be valued accordingly.

The contractor shall notify the Quantity Surveyor when the excavations, or parts thereof, are completed and before any filling is done, in order that all necessary site measurements may be taken.

The contractor shall notify the Engineer when the excavations, or parts thereof, are completed and ready to receive constructions. No work shall be built until the excavations have been approved.

Should any ground fall in (other than that required to be excavated) owing to omission or inadequacy of support or to any act, neglect or carelessness of the Subcontractor, such ground will not be paid for as excavations but it shall be dug out and deposited on the site (or carted away) and returned, refilled and rammed as directed and entirely at the contractor's expense.

No trench for any drain shall be excavated less than 530mm wide. The bottoms of trenches are to be well rammed and finished to regular and even falls, and the falls and the barrel of the pipes shall rest on solid ground and holes shall be cut around joints of sufficient size to enable the jointing and filleting to be properly performed.

All hollows, unnecessary excavations below pipes, soft and loose places or uneven bottoming in rock cutting are to be cleared out and filled in with cement concrete Class "15". Carefully fill in and pack around with soil for 600mm above pipes. Fill in and ram well the remainder of the trench in 230mm layers up to ground level. The contractor shall provide all necessary sight rails, boning rods, open or close planking and strutting, staging, etc.

The contractor shall ensure that the trenches are maintained in a safe condition at all times.

PART IV

Standard Quality Specification for

Steam and Condensate Reticulation

STANDARD QUALITY SPECIFICATION FOR STEAM AND CONDENSATE RETICULATION

1.1 DEFINITIONS

According to the manufacturer's instructions: The manufacturer's instructions at the time of tender.

Approval: Approval by the Department in writing and is limited to visual appearance of the work, material or components. Approval does not relieve the Contractor from compliance with the specification.

BS: British Standard.

Department: The Chief Engineer of the Gauteng Provincial Department of Public Transport, Roads and Works or his duly authorised representative/agent.

Drawings: Drawings forming part of the contract documents and any modification thereof or additions thereto delivered by the Department to the contractor during the execution of the works.

NBR: National Building Regulations.

Particular Specification: A specification that is drawn up as a supplement to the Project Specification to specify items for a particular contract not covered by the Project Specification. The Particular Specification has preference over the Project Specification.

Standard Specification: The latest edition (as revised) of the standard quality specification of the Department.

SANS: South African National Standards

SABS: South African Bureau of Standards.

SABS-CKS: Specifications prepared by the SABS mainly for the procurement of products for the use of government departments.

Specified: As specified in the Project Specification, Particular Specification, drawings, Bill of Quantities or in any other contract document.

1.2 SUMMARY OF SABS SPECIFICATIONS APPLICABLE TO THE STANDARD QUALITY SPECIFICATION FOR STEAM AND CONDENSATE RETICULATION

SANS 10064		:	The preparation of steel surfaces for coating
SANS 1200 HC		:	Corrosion protection of structural steelwork
SANS 1091		:	National colour standards for paint
SANS 12944-4		:	Paints and Varnishes –Corrosion protection of steel structures by protective paint system Part 4. Types of surface and surface preparation.
SANS 460		:	Plain ended solid drawn copper tubes for potable water.
SANS 1067 - 1		:	Part 1 – Compression fittings
SANS 1067 - 2		:	Part 2 – Capillary solder fittings
SANS 455		:	Covered electrodes for the manual arc welding of carbon and carbon manganese steels
SANS 10044		:	Welding : Parts I and 2
SANS 10238		:	Welding and thermal cutting processes – Health and safety
SANS 121		:	Hot-dip galvanised zinc coatings on fabricated iron and steel articles – Specification and test methods.
SANS 3575		:	Continuous hot-dip zinc-coated carbon steel sheet of commercial, lock forming and drawing qualities
SANS 1186-1		:	Symbolic Safety Signs Part I : Standard signs and general requirements.
SANS 62-1		:	Steel Pipes Part 1 : Pipes suitable for threading and of nominal size not exceeding 150 mm.
SANS 62-2			Steel Pipes Part 2 : Screwed pieces and pipe fittings of normal size not exceeding 150 mm.
BS 10		:	Specification for flanges and bolting for piping, valves and fittings.
BS 3601-22		:	Specification for carbon steel pipes and tubes with specified room temperature properties for pressure purposes
BS 4504		:	Circular flanges for pipes, valves and fittings (PN designated)
	3.1	:	Specification for steel flanges
	3.3	:	Specification for copper alloy and composite flanges.
BS 5000-99		:	Machines for miscellaneous applications.
BS EN 1561		:	Founding. Grey cast irons.
BS EN 1563		:	Founding. Spheroidal graphite cast iron.
BS EN 1982		:	Copper and copper alloys. Ingots and castings.
BS EN 10213-1		:	Technical delivery conditions for steel castings for pressure purposes. General.

BS EN 10213-2	:	Technical delivery conditions for steel castings for pressure purposes. Steel grades for use at room temperature and at elevated temperature.
ASTM B61	:	Standard Specification for Steam or Valve Bronze Castings.
ASTM B62	:	Standard Specification for Composition Bronze or Ounce Metal Castings.
ASTM A 126	:	Standard Specification for Gray Iron for Valves, Flanges, and Pipe Fittings.
ASTM A 216/A 216M	:	Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
ASTM A 389/A 389M	:	Standard Specification for Steel Castings, Alloy, Specially Heat-Treated for Pressure-Containing Parts, Suitable for High-Temperature Service.
ASTM A 395/A 395M	:	Standard Specification for Ferritic Ductile Iron Pressure – Retaining Castings for use at Elevated Temperatures.
ASTM F 1139	:	Standard Specification for Steam Traps and Drains.
ASTM F 1369	:	Standard Specification for Heaters, Convection, Steam and Hot Water.
ASTM F 1508	:	Standard Specification for Angle Style, Pressure Relief Valves for Steam, Gas and Liquid Services.
ASTM F 1565	:	Standard Specification for Pressure-Reducing Valves for Steam Service.
API 5L	:	Specification for line pipe.
OHS ACT	:	The Occupational Health and Safety Act, Act 85 of 1993.

STANDARD QUALITY SPECIFICATION FOR STEAM AND CONDENSATE RETICULATION

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LIST OF ADDENDUMS

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STANDARD QUALITY SPECIFICATION FOR STEAM AND CONDENSATE RETICULATION

1. PIPING

1.1 STEAM PIPING

Steam piping for steam over 120°C and up to 2000 kPa must be heavy walled, solid drawn steam quality tubes and must be free from defects.

Pipes up to 150mm must be black steel pipe to SANS 62, heavy class.

Pipes 200mm and over must be black steel pipe to BS 3601-22 or API5L.

Use eccentric reducers with the straight part at the bottom where the size of horizontal piping changes. Install pipes with a minimum slope of 1 in 240. Drain steam pipes by means of dirt pockets and steam traps at all low points in the system and as indicated on the project drawings.

1.2 CONDENSATE PIPING

Condensate pipes must be of heavy duty, solid drawn copper, class 2 according to SANS 460. The copper pipe must be suitable for steam services and must be suitable for a working pressure of at least 1000 kPa.

Refer to the Project Specification where stainless steel will be specified if required.

Condensate pipes can alternatively be of 304 stainless steel if specified in the Project Specification

Install approved vacuum breakers at the highest point on gravity return pipes.

Refer to the Project Specification for material requirements

Pumped condensate mains may be constructed from medium grade, solid drawn, steam quality tubes to SANS 62.

1.3 PIPE JOINTS

- **Joints on steam lines**

Side notes are explanatory only and do not form part of the contract. Underlined text is for the attention of the Engineer

Steam lines up to 40mm diameter may be screwed or welded.

Steam lines 50mm and larger may not be screwed. Joints may be welded or flanged. Flanges however may only be used if it is essential to remove sections of line.

Provide flanges (or unions for lines up to 40mm diameter) at valves, fittings and at points where dismantling of equipment is required for maintenance purposes.
Use only steam quality sealing tape for screwed joints on steam piping. Do not use hemp and red lead.

Flanges on steel pipes must be of steel according to BS 4504 and to BS10.

All flanged joints must be provided with a full face mineral fibre gasket with a thickness of not more than 3mm. Gasket material must be suitable for steam applications.

Use only unions with bronze or gunmetal seats suitable for steam. Union faces must be conical or spherically shaped.

Do not use malleable iron unions or unions with packings.

- **Joints on condensate lines**

Use only copper capillary fittings and bronze or silver solder joints. Use brass screw fittings only between copper to steel joints. Use only conical faced bronze unions on condensate lines.

- **Joints in roof spaces**

Weld all pipes of diameter 25mm and larger in roof spaces. Provide flanges at every branch connection. Provide all valves 50mm in diameter and larger with flanges. Follow the most direct, shortest but logical route. Do not obstruct access for workers.

1.4 BRANCH LINES

Take steam branch lines from the top of the main line to ensure no condensate carry-over.

Provide a T piece where branch is connected.

1.5 BENDS AND ELBOWS

Use full radius bends for all piping installations. Elbows may only be used in specific instances and only after approval has been granted in writing by the Department.

Side notes are explanatory only and do not form part of the contract. Underlined text is for the attention of the Engineer

1.6 PIPE EXPANSION AND CONTRACTION

Install expansion loops, off-sets and compensators on steam and condensate piping as indicated on the project drawings.

1.7 PIPE SUPPORTS, ANCHORS AND GUIDES

Provide pipe supports at the intervals as indicated in the following tables. Provide pipe anchors and guides in the positions as indicated on the project drawings.

Support horizontal steam pipes as follows:

Nominal Pipe Size	Maximum Span (m)
15 to 20	2,5
25 to 32	3,0
40 to 50	3,5
65 to 80	4,5
100 and Above	6,0

Support vertical piping with the first horizontal support just before and the second horizontal support just after the vertical pipe. Support the vertical pipe with guides at the same span as indicated for horizontal pipes.

The maximum support spacing for condensate pipes must be as follows:

PIPE NOMINAL SIZE	MAXIMUM SPAN
15 – 20 mm	1,0m
25 – 40 mm	2,0m
50 mm and over	2,5m

Manufacture pipe supports, anchors and guides according to standard drawings ME 04 06 01 to ME 04 06 08.

Side notes are explanatory only and do not form part of the contract. Underlined text is for the attention of the Engineer

2. THERMAL INSULATION

2.1 GENERAL

Thermal insulation work must be executed by specialists in this field. Manufacturer's recommendations regarding the application of insulation materials, cladding, adhesives, etc., must be strictly observed. Adhesives, sealants and coatings must be compatible with the insulation material. Insulation, adhesives and finishes must be resistant to rotting, mould, fungal growth, decay, or attack by vermin.

Pipe work and equipment must be tested, painted and inspected, and approved prior to the application of thermal insulation.

Supply certified tests from an approved body for the following:

- The thermal conductivity of the insulating material(s) at operating temperature

- The surface spread of flame index of the insulating materials, adhesives and other finishes.

2.2 PIPE WORK INSULATION

Use mineral wool or fibre glass for insulation. The density for mineral wool must be at least 185kg/m³ and for fibre glass at least 96kg/m³. Insulation thickness for these materials must be as follows:

PIPE DIAMETER	INSULATION THICKNESS
15 – 40 mm	40
50 mm and over	50

Obtain prior approval from the Department for other insulation materials than those mentioned above. Do not use insulation materials which, contains asbestos.

Side notes are explanatory only and do not form part of the contract. Underlined text is for the attention of the Engineer

Clad insulated piping with 0,5mm thick pre-rolled galvanised sheet metal. Secure sheet metal sections with bands and clips at not more than 450mm centres. The overlap between sections must not be less than 40mm.

Arrange sections to be water shedding. See ME 04 03 01 for detail.

Refer to the Project Specification for aesthetic requirements

Use stainless steel, chromadek or aluminium sheet metal sections for aesthetic reasons if specified in the Project Specification.

Elbows must be lagged with “lobster back” bends or alternatively insulating material must be wound around the bend and then plastered with hard setting compound and smoothly trowelled off. Waterproof the compound with a fibre glass membrane and acrylic waterproofing paint when set.

Do not insulate valves, unions, strainers, flanges, etc. Insulate dirt pockets. Weatherproof the ends of adjacent insulation and paint with acrylic waterproofing paint.

2.3 INSULATION OF CALORIFIERS

Secure a 50mm thick, 40 kg/m³ density, glass wool mattress to the calorifier’s shell. The thermal conductivity of the insulation must be approximately 0,045 W/m°C.

Clad the insulation with 0,9mm galvanised sheet metal with neat, preformed sections riveted in place. Do not paint the cladding.

3. VALVES

3.1 GENERAL

Valves must be of an approved manufacturer and must be suitable for steam and condensate applications. Pressure and temperature ratings must be according to the manufactures requirements for the system into which the valves are to be installed.

Matched flanges must correspond in construction and dimensions to flanges on equipment. Provide the correct bolts, nuts, washers, and packings.

3.2 VALVE CONSTRUCTION AND MATERIALS

Valve construction and materials must comply with the following specifications.

Side notes are explanatory only and do not form part of the contract. Underlined text is for the attention of the Engineer

Bronze Valves	:	BS EN 1982, ASTM B61 and ASTM B62
Cast Iron Valves	:	BS EN 1561 and ASTM A 126
S.G. Cast Iron Valves	:	BS EN 1563 and ASTM A 395/A 395M
Cast Steel Valves	:	BS EN 10213 Parts 1 & 2 and ASTM 216/A 216M

3.3 STEAM VALVES

All steam valves must be of the globe type with replaceable discs and seats. Seats must be manufactured from 304 stainless steel and discs must be manufactured from a high grade nickel alloy. Valve bonnets may be of the screw-in, union or bolted type.

Use PN16 rated steam valves on pipelines smaller than 100 mm diameter and with pressures up to 750 kPa. Use PN25 rated steam valves on pipelines 100 mm diameter and larger and with pressures up to 1200 kPa.

Hand wheels must be of no-heat design and may be of pressure die-cast aluminium or of malleable iron.

When specified valves must be provided with a back seating facility so that the gland packing can be replaced when the valve is fully open i.e. back seated.

Do not modify valves. Submit manufacturers detailed drawings to the Department for approval.

3.4 CONDENSATE VALVES

Condensate valves must be of the globe type with replaceable discs and seats. Seats must be manufactured from 304 stainless steel and discs must be manufactured from a high grade nickel alloy. Valve bonnets may be of the screw-in, union or bolted type.

Use the same valves on condensate pumped mains as for condensate lines.

Use PN16 rated steam valves on pipelines smaller than 100 mm diameter and with pressures up to 750 kPa.

Side notes are explanatory only and do not form part of the contract. Underlined text is for the attention of the Engineer

4. STEAM TRAPS

4.1 GENERAL

Specify the type of steam trap to be used in the Project Specification and on the project drawings

Refer to the Project Specification and the project drawings for the type of steam trap to be used. Steam traps must comply with ASTM F 1139.

Trapping arrangements for a particular pipe size must have the same overall dimension from union face to union face to ensure interchangeability for maintenance purposes.

Steam traps must be suitable for corrosive condensate having a pH value of approximately 5 and must be of stainless steel, bronze or gun metal, or high quality cast iron.

Do not use traps of brass or malleable iron. Trap components must be of stainless steel. Do not use bimetallic, liquid expansion or inverted bucket traps.

Size steam traps to suit the capacities indicated on the project drawings. Steam traps must be suitable for the system pressure and temperature and must be rated for operation between 35kPa to 1400 kPa gauge.

The Contractor must base his tender price on the trap types as indicated on the project drawings.

Final selection of the steam traps must be done in conjunction with a specialist supplier. Submit all steam trap selections and manufacturers data to the Department for approval.

For arrangement layouts see ME 04 02 01.

4.2 BALANCED PRESSURE THERMOSTATIC TRAP

Use these traps under conditions of constant pressure and where quietness of operation is required i.e. steam heaters etc.

Side notes are explanatory only and do not form part of the contract. Underlined text is for the attention of the Engineer

4.3 FLOAT TYPE THERMOSTATIC TRAP

Use these traps where quietness of operation is required i.e. intensive care wards and for drainage of systems where the pressure in the unit being drained can vary i.e. steam coils.

Do not use these steam traps on autoclaves.

5. NON RETURN VALVES

Use disc type wafer check valves or mushroom check valves rated for steam and condensate services.

Submit all final selections to the Department for approval.

6. PRESSURE REDUCING VALVES

Pressure reducing valves must comply with ASTM F 1565.

Reducing valves of up to 20mm in size may be of the direct acting type. Use only pilot operated type pressure reducing valves for larger sizes. All reducing valves must have replaceable seats.

Downstream pressures must not vary more than 0,5% over the range of 0 to 100% capacity. The pressure rise under dead end conditions must not exceed 1%.

Reducing valves must be selected in conjunction with specialist suppliers and must be suitable for the pressure, temperature and load requirements as indicated on the project drawings and specified in the project specification. Ensure that the suppliers provide the correct springs for direct spring diaphragm type reducing valves. These valves must be marked with a metal label indicating the spring range.

Provide capacity charts, drawings and other manufacturer's data to the Department for approval.

Side notes are explanatory only and do not form part of the contract. Underlined text is for the attention of the Engineer

Where two or more reducing valve arrangements of a particular size are installed they must have the same overall dimension between union faces to ensure interchangeability for maintenance purposes.

Install reducing valve arrangements as per the project drawings.

For arrangement layouts see ME 04 02 02.

7. SAFETY VALVES

Safety valves must comply with ASTM F 1508.

7.1 STEAM SAFETY VALVES

Install safety valves where shown on the project drawings. Set relief valves to be fully opened at 3% above the normal working pressure. The safety valve must be rated at 1,5 times the capacity of the reducing valve arrangement when installed after a pressure reducing valve.

Safety valves must be of the spring loaded pop type with lockable lever, bronze bodies and with screwed side discharge connections. Relief valve springs must be cadmium plated to prevent corrosion and valve seats must be of non-corrodible material.

The area presented by the valve in the fully open position must be less than the area of the discharge pipe. Full lift and relieving capacity must be obtainable on 3% accumulation. The discharge pipe must be of the same diameter or larger than the size of the safety valve.

Seal safety valves at their pre-set blow-off pressures by means of a padlock or sealing wire with lead seal.

Pipe the safety valve to atmosphere in the shortest possible but logical route, so that it cannot cause damage or injury to property or persons. Provide a 5 mm weep hole at the first bend at the riser.

7.2 HOT WATER SAFETY VALVES

The construction of safety valves on hot water systems must be the same as described for steam. They must however be proportional lift valves and must be of the pressure and temperature operated type suitable for the conditions specified in the project specification and on the project drawings.

Safety valves must be of the spring loaded type with lockable lever, bronze bodies and with screwed side discharge connections. Relief valve springs must be cadmium plated to prevent corrosion and valve seats must be of non-corrodible material.

Set these valves at 3% above the normal working pressure and set the temperature setting at 82°C. Pipe the discharge to the floor and terminate 25mm above the floor.

Side notes are explanatory only and do not form part of the contract. Underlined text is for the attention of the Engineer

7.3 COLD WATER SAFETY VALVES

The construction of safety valves on cold water systems must be the same as described for steam. It must however be proportional lift valves. It must be of the pressure sensitive type and suitable for the conditions specified in the project specification and on the project drawings.

Safety valves must be of the spring loaded type with lockable lever, bronze bodies and with screwed side discharge connections. Relief valve springs must be cadmium plated to prevent corrosion and valve seats must be of non-corrodible material.

Set these valves at 3% above the normal working pressure. Pipe the discharge to the floor and terminate 25mm above the floor.

8. STRAINERS

Strainers must be suitable for steam and condensate services and must be of the Y-leg type with stainless steel screens. The screens must be removable and screen perforations must not exceed 0,8mm where the strainer is installed prior to a reducing valve, 1,5mm for normal steam services or 3mm for water services.

Install the strainers with the leg in the horizontal position to prevent water logging during off range periods.

9. STEAM SEPARATORS

Install steam separators on steam lines where indicated on the project drawings. Separators must be suitable for steam services and must have cast steel bodies with flanged ends.

10. PRESSURE GAUGES

Pressure gauges for steam and water services must be of the Bourdon tube type with 10mm bottom entry connection and 100mm diameter dials marked in kPa.

Fit gauges with “U” or ring type siphon and cock. Glass covers must be easily removable without having to strip the complete gauge. The range of the gauges must approximate double the normal working pressure of the system.

Side notes are explanatory only and do not form part of the contract. Underlined text is for the attention of the Engineer

Gauges must be accurate within ± 2% over the complete range of operation. Provide a calibration certificate to the Department when requested.

The safe working pressure of the system must be marked in red on the dial.

11. THERMOMETERS

Thermometers must be of the dial type with 100mm diameter dials. Provide each thermometer with a stainless steel well. The wells are to be installed in compliance with the thermometer manufacturer's requirements.

Thermometers can have bottom or rear entry connections and must be installed in easily readable positions.

12. SIGHT GLASSES

Install single window sg iron, bronze or brass sight glasses where indicated on the project drawings. Sight glasses must be suitable for horizontal and vertical installation at a working pressure of at least 500 kPa gauge. The glass diameter must not be smaller than 50 mm diameter. Do not use combination check sight glasses.

13. STEAM EQUIPMENT

13.1 GENERAL

The equipment described in this clause utilises steam as the energy source, therefore its inclusion in this document as part of steam services.

The equipment described hereafter is often used in other services, e.g. steam fan convectors are used in central heating systems where steam is the energy source. In such cases, this specification must be read in conjunction with the relevant services specification.

Heaters must comply with ASTM F1369.

13.2 CALORIFIERS

Refer to the project specification for pressures, temperatures and capacities.

All calorifiers must be constructed in compliance with the pressure vessel requirements of the Occupational Health and Safety Act regulations (Act 85 of 1993).
Calorifiers must be suitable for the steam and hot water pressures and temperatures as specified on the project drawings and in the project specification. The capacity of the calorifiers must be as specified in the project specification.
Calorifiers must be corrosion protected inside and out be either galvanizing or polymer coating as per item 18.

Side notes are explanatory only and do not form part of the contract. Underlined text is for the attention of the Engineer

Provide fittings and equipment on calorifiers as indicated on standard drawings ME 04-04-01 and ME 04-04-02.

The steam battery must be manufactured from solid drawn tin coated copper tubing to SANS 460, class 2 or higher. These must be secured to the tube plate by means of expansion or screwed fittings. Either method must be guaranteed against leaks for 24 months.

All coils must be able to withstand a working steam pressure of at least 1200 kPa.

Install the calorifiers in such a position to ensure easy withdrawal of the heater battery.

13.3 FAN CONVECTORS

Fan convectors must be suitable for operation with a steam supply of up to 750 kPa and with a temperature up to 173ºC. Coils and fittings must be pressure tested to twice the maximum working pressure plus 350 kPa, i.e. to 1850 kPa (gauge).

Steam operated fan convectors must have single row, finned coils. The coil tubes must be made of solid drawn copper and the design must allow unrestricted expansion of each tube. Fins must be of copper or aluminium and must be securely attached to the tubes. Fan convector capacities must be based on air entering temperature of 15ºC, a steam pressure of 350 kPa gauge and with the fan speed at normal, with due allowance for system resistance.

Fan convector casings must be of powder coated, heavy gauge sheet steel and must be neat in appearance. The colour of fan convectors must be as specified in the project specification.

The depth of the fan convectors must not exceed 350 mm.

The type of fan convector required, i.e. wall mounted, ceiling mounted or recessed type must be as indicated on the project drawings and specified in the project specification. Use anchor bolts suitable for the wall material to mount the fan convectors against the wall.

Side notes are explanatory only and do not form part of the contract. Underlined text is for the attention of the Engineer

Bolt ceiling mounted units to the roof structure. Provide additional angle iron supports between trusses and support the units from the angle iron.

Fan convector units must be fitted with centrifugal fans and TEFC motors. Bearings must be sealed for life. Fans and motors must be mounted on anti-

vibration pads. The noise rating of the unit must not exceed 55 dB. Motors must be suitable for 220 V 50 Hz operation and must be protected against thermal overloading. The fan coil unit must be able to withstand high working temperatures.

Provide a washable filter for each unit. Filters must be easily removable.

Each fan convector must be fitted with thermostatic on/off control and fan speed control. It must be possible to operate the fans without heating.

13.4 UNIT HEATERS

Unit heaters must be suitable for the steam temperatures, pressures, air temperatures, etc., as stated for fan convector units above.

General construction and selection requirements must be as stated for fan convector units above.

All steam fittings and trap sets must be concealed in the unit cover.

Unit heater capacities must be as specified in the project specification.

Unit heaters must be of the horizontal discharge type with a minimum air flow of 0,2 m^3/s.

13.5 STEAM HEATING COILS

The capacities of steam heating coils must be as indicated in the project specification and on the drawings.

Steam coils may be constructed from the following materials. Tubes from copper, Fins from copper or aluminium and Frames from copper or stainless steel of at least 1,5mm thickness. Mount steam coils on frames which must be suitable for bolting to ductwork, unit casings, etc. Support coils on a rigid angle iron framework and tilt coils slightly to ensure proper condensate drainage.

Provide each coil section with inlet, outlet, vent, vacuum breaker and drain connections. Install valves, trap sets, instrumentation, etc., as per ME 04 04 04.

Steam coils must be suitable for the steam pressures and temperatures as specified in the project specification. Steam heating coils must be of the single pass type and each section must have supply and return connections. The coil design must allow for unrestricted expansion of tubes.

Side notes are explanatory only and do not form part of the contract. Underlined text is for the attention of the Engineer

Test all pressure parts of steam coils to a pressure of 1,5 times the normal working pressure.

The coil must be designed for a Safe Working Pressure of 1200 kPa.

The face velocity of heating coils must not exceed 2,5 m/s.

Protect coil face areas with galvanised sheet metal covers and remove the covers only when commissioning commences.

14. CONDENSATE TANKS

Refer to standard drawing no ME 04-05-01 and ME 04-05-02 for the construction of condensate and flash tanks.

Condensate tanks must be of 6mm thick steel all welded construction. Support the tank on a strong 50mm angle iron frame at approximately 500mm above floor level to ensure a flooded suction to the pumps. Provide all fittings as per the standard drawings.

Refer to the project drawings for the capacity of the condensate tank.

15. CONDENSATE PUMPS

Refer to the project specification for design capacities, pressures and temperatures

Condensate pumps can be of the electrically or steam driven type. Condensate pumps must be able to deliver the required capacity at the steam and condensate pressures and temperatures, as specified in the project specification.

Use pump and motor combinations with base plates and couplers. Mono block pumps may also be used provided that the design is of such a nature that heat is not transferred to the motor..

The shaft between the pump and motor must be fitted with a slinger ring.

Fit pumps with mechanical seals, bronze or stainless steel impellers and stainless steel shafts.

Lubricated pumps must be provided with oil or grease reservoirs with sufficient capacity for at least 6 months operation.

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Protect drives and couplers on base plate mounted units according to the Occupational Health and Safety Act, Act 85 of 1993.

If the pump is of the back pull-out type the common base plate or coupling

must be of such a design that removal of the pump base with shaft is possible without disturbing the motor.

Provide dowels for re-locating the pump and motor.

The pump and motor must be quiet in operation and the pump must run at maximum efficiency.

Condensate pumps must be suitable for pumping condensate at 2°C below boiling point at atmospheric pressure on site.

16. ELECTRICAL WORK AND CONTROLS

All electrical work must be according to the Department's Standard Quality Specification for Electrical Work. The contractor must submit wiring diagrams for approval. Electrical motors must conform to BS 5000-99. All electrical work will be inspected by the Department.

17. WELDING

Welding must be carried out in accordance with the current edition of SANS 10044 Parts I and 2 where applicable. Health and safety standards when welding or cutting must be according to SANS 10238.

Employ welders in possession of a valid, approved competence certificate where required by the Occupational Health and Safety Act, Act 85 of 1993, e.g. for welding on pressure vessels under supervision of a competent Inspection Authority.

The joints in the weld run, where welding has been recommenced, must be as smooth as possible and must show no pronounced hump or crater in the weld surface.

The profile of the weld must be uniform, of approximately equal leg-length and free from overlap at the toe of the weld. Unless otherwise specified the surface must be either flat or slightly convex in the case of fillet welds, and with a reinforcement of not more than 3mm, in the case of butt welds.

The weld face must be uniform in appearance throughout its length.

Side notes are explanatory only and do not form part of the contract. Underlined text is for the attention of the Engineer

Filler metal electrodes must be of an approved type for the material being used and must be kept in a dry condition. All electrodes must conform to SANS 455.

Allow for welded pipe joints (where chosen by the Department's Representative) to be X-ray tested by the SABS or other approved body or for joints to be cut for examination purposes. Remove these joints and make good at own cost.

All welds must show proper fusion.

18. CORROSION PROTECTION

18.1 GALVANISING

All hot-dip galvanising must be carried out in accordance with SANS 121 and SANS 3575 as applicable.

Component design, fabrication and inspection of articles for hot-dip galvanising must be done in accordance with SABS 0214.

The Department has the right to inspect all steel components before galvanising, and to reject or ask for remedial treatment of any material which, are considered to be unsuitable. This applies particularly to welds.

18.2 PAINTING

Prepare and paint all steelwork and pipe work prior to insulation as per the following SANS:

- The preparation of steel surfaces for coating : SANS 10064 and SANS 12944-4

Corrosion protection of structural steelwork : SANS 1200 HC

- National colour standards for paint : SANS 1091

Paint support structures and brackets black, unless specified otherwise in the project specification.

Side notes are explanatory only and do not form part of the contract. Underlined text is for the attention of the Engineer

19. NOTICES

Supply and install all notices and warning signs that are required by SANS 1186-1. Markings on equipment e.g. pumps, motors and vessels must be according to SANS 0147 and OHS Act.

All steam and condensate valves must be marked with the manufacturer's brand name, pressure and temperature ratings, material of body, disc, stem and seat, identification numbers, size and fluid recommendation.

20. STANDARD EQUIPMENT

Maker's nearest standard equipment will be considered. Submit for approval to the Department.

Side notes are explanatory only and do not form part of the contract. Underlined text is for the attention of the Engineer

LIST OF STANDARD DRAWINGS APPLICABLE TO THE STANDARD QUALITY SPECIFICATION FOR STEAM AND CONDENSATE RETICULATION

SYMBOLS

- ME 04 01 01-2 - Key to symbols

FITTINGS

- ME 04 02 01-2 - Trapping arrangements.
- ME 04 02 02-1 - Reducing valve arrangement.

PIPING

- ME 04 03 01-1 - Steam pipe insulation.
- ME 04 03 02-1 - Copper pipe joints.
- ME 04 03 03-1 - Destructive tests on pipe welds.

EQUIPMENT

- ME 04 04 01-1 - Calorifiers.
- ME 04 04 02-1 - Calorifier.
- ME 04 04 03-1 - Connections to autoclaves.
- ME 04 04 04-1 - Heating coil control piping.
- ME 04 04 05-1 - Steam humidification.

CONDENSATE

- ME 04 05 01-1 - Condensate collecting tank.
- ME 04 05 02-1 - Flash tanks.

PIPE SUPPORTS

- ME 04 06 01-1 - Pipe hanging assembly.
- ME 04 06 02-1 - Ceiling and Truss supports.
- ME 04 06 03-1 - Wall support.
- ME 04 06 04-1 - Master supports.
- ME 04 06 05-1 - Roller assembly.

- ME 04 06 06-1 - Sliding type support.
- ME 04 06 07-1 - Anchors.
- ME 04 07 08-1 - Road crossing for pipes.

SERVICE AND MAINTENANCE PROCEDURES SCHEDULE SHEET

FOR

STEAM AND CONDENSATE RETICULATION

ITEM NO.	SERVICE REQUIREMENT DATA	MONTHLY INTERVALS				
		1	3	6	9	12
1.	Inspect steam piping and equipment. Rectify leaks where required.	X				
2.	Check pipe and equipment insulation and rectify where required		X			
3.	Note and record steam pressures	X				
4.	Clean strainers on steam and condensate lines		X			
5.	Check condensate flow through sight glasses. Record satisfactory/unsatisfactory operation of steam traps. Rectify if required.	X				
6.	Check and record equipment pressures and temperatures.	X				
7.	Check and record space temperatures	X				
8.	Check for leaks at valve glands and tighten if required	X				
9.	Check operation of condensate pumps. Rectify leaks if required	X				
10.	Check operation of safety valves. Record results			X		
11.	Check and record operation of pressure reducing valves. Record upstream/downstream pressures.			X		
12.	Check paint work on brackets, supports and equipment and touch-up where required.					X
13.	Check condition of pipe supports and hangers. Make sure that pipe work can expand/contract freely					X
14.	Check condition of pressure and temperature gauges and replace where required.		X			
15.	Clean dirt pockets					X
16.	Check and clean fan convectors and unit heaters.	X				

COLOUR SCHEDULE FOR MECHANICAL INSTALLATIONS

PLANT ITEM	BASIC COLOUR (300mm Wide)	COLOUR CODE INDICATOR FIRST BAND (100mm Wide Centered on Basic Colour)	REMARKS
Medical Gas Piping			
Oxygen	White		
Carbon dioxide	Light stone (C37)	Light Brunswick green (H07)	
Nitrous oxide	Light stone (C37)	Ultra Marine (F09)	
High pressure compressed air	Arctic Blue (F28)	Salmon Pink (H40)	Mark: MA-HP in black
Low pressure compressed air	Arctic Blue (F28)	Black and White (50 mm wide each)	Mark: MA-LP in black
Vacuum	Primrose (C67)		
Vacuum receivers	Primrose (C67)		
Compressed air reservoirs (HP)	Arctic Blue (F28)	Salmon Pink (H40)	
Compressed air reservoirs (LP)	Arctic Blue (F28)	Black and White (50 mm wide each)	
Fire Protection Services			
Fire mains	Signal red (A11)	-	
Carbon dioxide	Light stone (C37)	Signal red (A11)	
General Pipe Services			
Drain pipes	Black	-	
De-mineralised water	Brilliant Green (H10)	White	
Compressed air	Arctic Blue (F28)		
Potable Water			
Cold	Brilliant Green (H10)	Cornflower (F29)	
Hot	Brilliant Green (H10)	Crimson (A03)	
Gas Lines			
Acetylene	Light stone (C37)	Maroon (A01)	
LPG	Light stone (C37)	-	Mark: LPG
Oils			
Diesel fuel	Golden brown (B13)	White	

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PLANT ITEM	BASIC COLOUR (300mm Wide)	COLOUR CODE INDICATOR FIRST BAND (100mm Wide Centered on Basic Colour)	REMARKS
Condenser Water System			
Condenser water supply and return pumps	Lime Green (H41)	-	
Chilled water pumps	Lime Green (H41)	-	
Chilled Water System			
All primary and secondary chilled water supply and return pipes	Ultra Marine (F09)		
Chilled water pumps	Ultra Marine (F09)		
Central Heating			
Supply	Verdigris green (E22)	-	
Return	Light Brunswick green (H07)		
Miscellaneous			
Air compressors, vacuum pumps, chillers, cooling towers, heat pumps, water pumps, etc.	Standard Manufacturers colours	-	
Brackets, supports, bases, base plates, pipe hangers	Black		
Pump and fan drive guards	Signal Red (A11)		
Steam Services			
Steam mains	Cladding colour	-	
Bends	Silver/Aluminium		
Condensate main	Copper pipe or Cladding colour as applicable	Crimson (A03)	
Steam Humidifiers	Heat resistant Aluminium	-	
Uninsulated pipes, steam traps and fittings (steam and condensate)	Heat resistant Aluminium	-	
Brass or bronze constructed steam traps, valves and fittings	Unpainted		
Hot well tanks	Heat resistant Aluminium	-	
Boilers: coal-fired, oil-fired or electrode	Bright stainless steel cladding		
Boiler front and back	Black		
Hot water storage vessels	Galvanised steel cladding		
Heat exchangers	Heat resistant Aluminium		
Blow down pipes	Heat resistant Aluminium		
Boiler feed water	Verdigris green (E22)		
Stokers, hoppers, conveyors (coal and ash)	Black		
Hot metal ducting	Heat resistant Aluminium		
Flues, stacks and grit arrestors	Heat resistant Aluminium		

Side notes are explanatory only and do not form part of the contract. Underlined text is for the attention of the Engineer

PLANT ITEM	BASIC COLOUR (300mm Wide)	COLOUR CODE INDICATOR FIRST BAND (100mm Wide Centered on Basic Colour)	REMARKS
Top 2 metres of :			
1. Mild steel stack	Matt black		
2. Stainless steel stack	-		
Hot surface of boiler controls and valves	Golden yellow (B49) with Signal red handles (A11)		
Hand rails and stanchions	Golden yellow (B49)		
Kick guards	Black		
Walkways	Black		
Plant Rooms			
Doors & Walls (internal)	Light Grey (G29)		
Steel roof trusses	Aluminium		
Floors	Light Brunswick Green (H07)		
Ceilings	White		
Electrical Services			
Electrical and control panels	Light orange (B26)		
Electrical panels fed with standby/UPS power	Signal red (A11)		
Electric duct heaters in plant rooms	Signal red (A11)		
Cable trays	Galvanised		
Electric motors	Light orange (B26)		
Air Conditioning/Ventilation Ducting			
Conditioned air	Arctic Blue (F28)		
Foul air	Biscuit (B64)		
Exhaust/Extract/ Recirculated air	Mountain Mist (G57)		
Outside air	Pastel Green (H65)		
Warm air	Pastel Yellow (C75)		

Notes:

1. Put directional arrows on all pipe lines : Stickers inside buildings
   : Paint on outside buildings

   Arrow width must be at least 12mm and arrow length must be 3 times the pipe diameter.

2. Provide colour coding and arrows at pipe branches, directional changes, both sides of wall/slab penetrations and at ± 10m intervals on straight runs.

3. Unless indicated otherwise in the Project Specification all pipework in plant rooms must be painted in full with the relevant colour code markings added as required.

4. Paint ducting only if specified in the Project Specification.

5. Apply the basic colour at intervals only unless specified otherwise in the Project Specification.

Side notes are explanatory only and do not form part of the contract. Underlined text is for the attention of the Engineer

PART IV

STANDARD TECHNICAL SPECIFICATION

FOR THE

MEDICAL GAS INSTALLATION

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1. WORKMANSHIP AND MATERIAL

The contractor shall be a recognised piped gas and vacuum installation firm specialising in this field.

The contractor shall employ only skilled artisans and technicians who are competent in this type of work and shall have served a recognised training course in medical gas pipeline installation. Details of the artisans' training to be submitted before work commences.

Material shall be new of best quality and available for medical gas installation.

2. PIPING

The routing of all oxygen, medical air and vacuum piping is shown on the drawings.

All piping shall comply with SABS 460-75, as amended 1979, BSS2781/72-C106 and shall be similar or equal to Maksal Type MG tubes for the conveyance of medical gasses. All pipes shall be marked by the manufacturer.

All sizes quoted are outside diameter, not nominal bore.

No joints in pipelines other than silver soldered capillary joints to terminal tail pipes, or a connection to a value in a box, should be buried in a wall, floor or partition. When this is unavoidable, the pipes shall be carried in a PVC sleeve. Where pipe work is installed in a wall, these shall be installed through PVC conduit.

All piping, valves and fittings to be used in this installation for the conveyance of the medical gases and vacuum shall be de-greased and oxygen clean.

All pipes delivered to site shall be bundled together and sealed with an adhesive tape marked "*medical gas pipes*".

All fittings and valves, as hereinafter specified, shall be supplied to site in sealed plastic bags.

Pipe caps shall only be removed and sealed bags shall only be opened on site when a pipe joint is due to be made.

All medical gas piping shall be adequately supported to prevent sagging or distortion. Pipe supports shall be at the following centres:

PIPE SIZE (mm O.D)	MAXIMUM INTERVAL VERTICAL RUNS (m)	MAXIMUM INTERVALS HORIZONTAL RUNS (m)
10	1,2	1,0
12	1,2	1,0
15	1,8	1,2
22	1,8	1,2
28	2,4	1,8
35	2,4	1,8
42	3,0	2,4
54	3,0	2,4
67	3,6	3,0
76	3,6	3,0

Supports for surface pipe work shall provide clearance to permit painting of the surface. Supports should be of suitable material and, where necessary, treated to minimise corrosion and prevent electrolytic action between pipes and supports.

All piping which passes through wall or concrete slabs shall be encased in PVC sleeves of a size larger than the diameter of the pipe to allow for expansion and contraction.

Only capillary hard solder fitting for M.G. Copper Classes 0 shall be used. The fittings shall be degreased similar to the medical grade copper tubing.

All piping joints, except those at equipment requiring screw, flare nut or flange connections, shall be made by using wrought copper capillary sockets with internal stops.

Compression unions shall be of the Cone type or Yorkshire N° 111 or similar and equivalent.

Self fluxing silver solder having physical properties equal to Afrox Solveroid and a melting point of 450°C shall be used to make these joints. No borax and alcohol mixtures or resin and similar paste fluxes may be used.

The recommended heating source shall be an oxygen-acetylene flame.

The use of excessive flux shall be avoided and the correct amount of solder must be used in order to give a good joint but prevent excess material running into the pipe line.

All screwed joints shall be made with a tape suitable for oxygen use.

All visible piping shall be colour coded as further specified.
Interior wall mounted piping shall be secured in bronze, brass or white plastic sparge type holder bats. Pipe runs in covered ways under eaves and on the outside of buildings shall be secured in brass sparge type bats.

All copper piping shall be cut with sharp wheel pipe cutters to provide full bore of pipe at cut. Hacksaws will not be permitted to avoid metal filings in pipes. All burrs shall be removed.

3. ISOLATING VALVES

Isolating valves shall be installed wherever shown on the drawings. They shall be of a size equal to that indicated for the pipe line in which they will be installed.

All valves except those in the gas-bank room and the plant room shall be housed in a metal tray, as indicated on the drawing and hereinafter specified.

All isolating valves for gases shall be of the diaphragm type with bronze bodies and diaphragms for the gas handled. They shall be suitable for a working pressure of 1 000kPa gauge.

Valves for the vacuum shall be of the through-way Ball cock type with neoprene or nylon rings and with a clear indication of the "*OPEN*" and "*CLOSED*" positions. Globe valves which positively open the seats are also acceptable. They shall, however, only be mounted with their spindles horizontal. Diaphragm valves and taper through-way valves are not permissible for the vacuum service.

All valves for gas and vacuum up to and including 19mm shall be provided with a mounting flange. Pipe lines shall be properly secured by holder bats in close proximity on either side of each valve.

Valves shall be secured into the pipe line by one of the following methods:

3.1 Gas Line Service up to 25mm Diameter

(a) Capillary silver soldered joints. This method is only acceptable for valves specially made for this type of coupling and with the correct size of sockets for the pipe i.e. 0,025 - 0,1mm clearance.

(b) Flare nut compression ring connections for valves specially fitted with them.

(c) Screw connection. Here o-ring or taper unions with silver solder capillary outer-halves for connection to the piping shall be used

3.2 Vacuum Line Service

Only methods (b) and (c) above shall be used for vacuum valves up to 28mm Diameter.

For valves 28mm diameter and over, valves shall be flange coupled. Flanges on pipe lines shall be silver soldered and neoprene gaskets shall be installed between flanges.

4. ISOLATING VALVE BOXES

Isolating valve boxes shall be installed where shown and as detailed on the drawings.

Each box shall be constructed of 1,2mm thick powder coated white sheet steel. All isolating valves shall be mounted on a 1,6mm back-plate. A hinged access door shall be provided complete with switchboard panel type turn-key lock.

An engraved name plate shall be fitted to the door of all valve boxes to read as follows:

Authorised Persons Only
Medical Gas
Isolating Valves
Do Not Close

Engraved ivorine name plates shall be provided inside the cabinet to identify each valve and the valves shall be painted according to the colours specified in Fig 1 of SABS 06-19 57

A notice indicating the room or ward fed shall be fixed inside the box.

Valve boxes shall be installed with their lower edge not less than 2m above floor level.

5. MEDICAL GAS OUTLET POINTS

Medical gas outlet points shall be installed in one of the following ways as indicated on the drawings and shall be Afrox Heyer or equivalent. SABS approved.

* Surface mounted

* Flush Mounted

* Mounted in bedhead units

* Mounted in medical gas pendant/boom arms.

Medical gas outlets must conform to the S.A.B.S. specification SABS 1409 - 1986.

Medical gas outlet points and probes must feature the following:

1) Non-interchangeability between probes and valve housings, and non-interchangeability between valve housings and back bodies between the various gas types.

2) Quick release of the probe with single handed operation.

3) Provide for installation of a non-return valve in the backbody to facilitate maintenance of the outlet point without interruption of gas supply to other medical gas outlet points.

4) Probes with fitted ball-type non-return valves which present uncontrolled whipping of male probe hose connections after release (except vacuum probes).

5) Colour coding and labelling of each type of medical gas outlet point.

6) All backbodies are identified by locating index pins and are name stamped.

7) Unique shape of the valve housing to ensure non-interchangeability of probes.

8) Locating holes in the valve housing which match only the index pins of the correct type of backbody.

9) Both surface and concealed (flush) mounted points are covered and protected by either a cover box or plate. In either case the cover box/plate is a one piece "wipe clean" plastic cover which is colour coded and marked with the name of gas in both official languages.

10) Provision for the installation of a blanking plate to the backbody to prevent damage to entry of dirt during installation and for pressure testing purposes.

Medical gas outlet points when surface or flush mounted should be installed at a height of approximately 1,5m above finished floor level.

When a group of outlet points are installed adjacent to each other the order from left to right shall be:

a) Oxygen

b) Nitrous Oxide

c) Vacuum

d) Air Low Pressure

e) Air High Pressure

f) Other medical gases (e.g. scavenging, Entinox, etc.)

6. STRAINERS

Pipe strainers shall be well supported to allow for cup removal without distortion of piping.

Strainers shall be fitted before all automatic control valves, traps and pressure regulators unless a strainer is incorporated in the latter.

7. NON-RETURN VALVES

Non-return valves shall be provided where indicated on the drawings and shall be similar or equal to Broomwade type with patent thin plate valve and noiseless in operation.

8. GAS CYLINDER MANIFOLD INSTALLATION

Oxygen and Nitrous Oxide manifolds shall be provided to connect equal banks of gas cylinders to provide equal "duty" and "reserve" storage capacity. The manifolds shall be provided with an automatic change-over from "duty" to "reserve" banks of cylinders.

The automatic change-over shall occur at a cylinder pressure which will ensure the greatest possible utilisation of the contents of the cylinder banks.

Means shall be provided for manual change-over from one half of the manifold to the other if this becomes necessary.

8.1 Pressure regulating valves shall be capable of maintaining the indicated delivery pressure within ± 0.14 bar of the valve setting up to the maximum flow rate of the system, providing the gas cylinder pressure is above change-over pressure. There shall be separate pressure regulating valves of each cylinder bank and the control system should be designed so that the cylinders of one bank can be changed or the pressure regulator for one bank can be overhauled without loss of continuity of the gas supply. A non-return valve shall be inserted between each cylinder tail pipe and the manifold to minimise loss due to the leakage.

8.2 Means shall be provided so that an emergency supply of gas is available in the event of manifold failure. This will also permit the coupling of a gas cylinder, via a pressure regulator and excess pressure relief device, to act as a temporary source of supply while the manifold is isolated for repair or maintenance.

8.3 The delivery pipe line from the manifold shall be fitted with a self-closing pressure relief valve of a type which can be locked or sealed and set to lift at a pressure of 25% above the designed distribution pressure. The valve should be of brass or bronze and designed and de-greased for oxygen service and should be installed immediately upstream of the emergency supply panel. It should have a flow capacity at least equal to that of the pressure regulator immediately upstream of it. The discharge pipe shall be at least one size larger than the main pipe line. This discharge pipe line shall be vented to atmosphere, outside the building, in an area where discharge of oxygen will not constitute a fire risk, where no hazard will arise from the discharge of nitrous oxide and where it is not liable to injure personnel when discharging. It shall be well clear of any openable window or air intake. The ends of the discharge pipe lines shall be turned downwards to prevent the ingress of dirt and moisture and so placed and protected that frost cannot form or be collected upon them.

8.4 Three pressure gauges shall be provided on each automatic manifold and these should be marked to show the gas which they are to supply. Two shall indicate the pressure, one on each high pressure side of the manifold, the third shall show the supply pressure. The gauges shall be de-greased for oxygen. They shall be marked with a band in the operating range.

9. IDENTIFICATION OF PIPELINES

All medical gas pipelines should be colour coded in accordance with BS1710 as indicated in the table below. Pipelines in unoccupied areas shall be left unpainted.

However, they shall be colour coded by means of bands at regular intervals (so that identification can take place easily without having to trace the pipeline) at valves, branches and before and after passing through walls.

Identification labels are to be applied on each pipeline at regular intervals and adjacent to isolation valves. Each label shall be correctly colour coded, shall indicate the type of gas in the pipeline and shall have provision to indicate the direction of flow of the gas.

GAS	**BAND 1**	**BAND 2**	**BAND 3**
Oxygen	White	-	-
Nitrous Oxide	Ultramarine Blue	-	-
Vacuum	Primrose Yellow	-	-
L.P. Air	Black	White	-
H.P. Air	Black	White	Black
Scavenging	Light Orange	-	-
Entinox	White	Ultramarine Blue	

NOTE: Each band to be not less than 50mm and to be continuous around the circumference of the pipe.

10. **CLEANLINESS**

It is stressed that during the installation of medical gas pipelines, care is taken to ensure that dirt, oil, etc. are not allowed to enter the pipeline, valve, etc.

Pipe caps should not be removed until the pipe is to be installed and after installation open ends are to be blanked off/capped to prevent the entry of dirt, etc.

Should on site cleaning of piping, valve, etc. be necessary then the equipment to be washed with a suitable solvent, 1,1,1, methaline chloride. The residue remaining upon evaporation of the solvent shall not exceed 0,0376 g/m² of interior surface. The bore of the tubing shall be cleaned free from deleterious films and deposits.

Upon completion of the installation the entire system must be blown clean using medical grade compressed air to remove any dirt/slag etc. that is in the system.

11. **ALARM SYSTEMS**

11.1 General

Medical gas alarm systems shall fulfil the following two functions:

a) Routine indication that any of the medical gas supply systems has gone from normal to fail and that appropriate action should be taken.

b) Indication that there has either been a complete failure or a failure on the system is imminent.

Medical gas alarm panels (main and slave panels) shall be located in areas as indicated on the drawings.

Medical gas outlet points when surface or flush mounted should be installed at a height of approximately 1,5m above finished floor level.

11.2 Design

Medical gas alarm panels shall be designed to monitor all the piped medical gases in the hospital and must indicate when the medical gas status goes from normal to fail, as follows:

Oxygen Nitrous Oxide Manifold - Right Bank	-	Normal/Fail
and Entinox (each separately indicated)- Left Bank	-	Normal/Fail
Vacuum System -	-	Normal/Fail
Compressed Air Plant	-	Normal/Fail

The alarm panel should indicate the failure of any of the medical gas as follows:

a) When the medical gas bank is exhausted, the green light indicating normal condition is extinguished and the flashing red light indicating fail condition comes on.

b) As soon as the medical gas is exhausted and the flashing red light comes on, an audible alarm is actuated which can only be muted by pushing an accept button.

The flashing red light must continue to flash until the fault is rectified.

Should a second medical gas fail before the first gas fault is rectified, the flashing red light for second failed gas will come on and the audible buzzer will be re-activated.

The alarm panel shall include a test button so that the function of all circuits (including audible alarm) can be tested.

The equipment utilised and design of the system must be fail safe so that in the event of a damaged cable, etc., an alarm condition will be activated.

The equipment utilised must be such that preventative maintenance checks can be done without disrupting the supply of gases to the hospital.

The medical gas alarm panel shall also have the following features:

a) Mimic display of the various gases monitored complete with the correct colour codes.

b) Liquid crystal display which:

During normal condition will display that all systems are correct.

In the event of a failure (in addition to the flashing red light and audible alarm) the L.C.D. will display which gas service has failed (e.g. oxygen manifold - right bank - fail) and will instruct a responsible person what corrective action to take (e.g. phone Mr X on Ext. 117 - After Hours 888-8888).

12. SYSTEM TESTS AND COMMISSIONING

12.1 General

All manifolds, compressors, air driers, vacuum pumps, pipelines, etc. must be tested for satisfactory operation prior to handing over to the hospital authorities.

While it is the responsibility of the contractor to hand over the system in correct working order to the hospital, the final responsibility rests with the hospital to ensure that:

a) The system is leak tight

b) All plant items are monitoring the status of the medical gases correctly.

c) Adequate gas continuity tests are conducted to ensure no "crossing over" of gas pipelines has occurred with possible dire results.

d) The system in general is in a safe and good working state.

12.2 Tests Conducted Prior to the System Being Formally Handed Over.

The following tests must be carried out by the contractor and witnessed by authorised representatives of the hospital before the final hand over of the installation.

a) Pressure drop test to determine leakage in pipelines only.

b) Pressure drop test to determine leakage in the complete installation.

c) Check for satisfactory mechanical operation and non-interchangeability for each outlet point by means of test probes.

d) Continuity test (anti-confusion test) to check for any crossed pipelines which could lead to fatal consequences.

e) Check pressure, flow rate and pressure drop at each outlet unit.

f) Check satisfactory operation of manifold changeover system.

g) Check satisfactory operation of liquid oxygen, compressed air and vacuum plants and all manifolds (including emergency supply manifolds).

h) Check performance of alarm signalling system.

i) Purge the completed installation with medical air.

j) Purge the completed installation with the working gases.

If the relief valves cannot be set to protect the installation during the pressure test they should either be temporarily replaced by others which can withstand the test pressure or be blanked off.

Copies of the witnessed and signed tests are to be included in the Operating and Maintenance Manuals.

Leak testing of each complete system from point of supply (i.e. manifold) to outlet points must be conducted over a period of twenty four hours utilising a pressure recorder to monitor any loss in pressure. Suitable compensation in accordance with the gas laws must be made for temperature fluctuations during the test period.

Each pipeline system must be pressure tested to 10 bar or 1,5 times normal working pressure whichever is the greater.

Vacuum pipelines should be tested at 6 bar.

12.3 Tests of formal Handing Over of the Installation

Upon completion of the tests outlines in 13.2 and prior to the installation being commissioned and used the following tests will be conducted and be witnessed by both the contractor and hospital authorities.

a) Using a suitable oxygen gas analyser each medical gas outlet point will be checked for the identity of the gas at the outlet point. Should there be more than one gas which will register zero on the oxygen analyser, the system tests must be done by pressuring one system at a time.

b) Each outlet point will be tested for correct operation using the appropriate male probe adaptor.

c) A flow meter, pressure gauge probe assembly shall be plugged into each medical gas outlet. A flow of 30 litres per minute shall be recorded to a pressure drop not exceeding 35kPa.

A record of each medical outlet location (Room N° etc.) and the result of the above tests will be made and witnessed upon the completion of the tests.

The original is to be retained by the Hospital Administrator and copies are to be included in the Operating and Maintenance Manuals.

Contractors will provide at least two copies of detailed Operation and Maintenance Manuals as further specified.
The contractor will be responsible for instructing the responsible person from the hospital in the correct operation and maintenance of the medical gas installation.

13. OPERATING AND MAINTENANCE MANUALS

The contractor shall provide three copies of the Operating and Maintenance Manuals of the system upon completion of the medical gas installation.

The O & M Manuals must include:

13.1 Description of the System/s

13.2 Equipment Data:

Manufacture and Address
Model Numbers
Size and Rating
Spares - list of spares and supplier's name and address

13.3 Operating Procedures:

Start and Stop Procedures
Abnormal and Emergency Operating Procedures
Adjustment and Regulations
Safety Devices and Settings

13.4 Maintenance:

Routine Maintenance Schedules
Maintenance Procedures and Check Lists

13.5 Drawings:

Complete set of "as installed" drawings and "as built" wiring diagrams.

13.5.1 Copies of Test and Commissioning Data

14. OXYGEN SUPPLIES

Oxygen shall be provided by means of 2 x bottle rack including all fittings and accessories as indicated on the drawings and specification herein. The number of bottles per rack will be as detailed in Part V of this specification.

The system shall be arranged to operate as duty and standby and shall be installed in the position indicated.

Although materials and equipment to be utilised in medical gas installations are covered further in this specification, it must be stressed that all equipment used in medical oxygen systems is degreased for oxygen service, using only approved materials and procedures and must be clearly marked: *OXYGEN SERVICE - DO NOT OIL*.

15. NITROUS OXIDE SUPPLY

Nitrous oxide shall be provided by means of 2 x bottle racks including all fittings and accessories as indicated on the drawings and specified herein. The number of bottles per rack will be as detailed in Part V of this specification.

The system shall be arranged to operate as duty and standby, and shall be installed in the position indicated on the drawing.

16. COMPRESSED AIR SUPPLIES

Two compressed air supplies are required as follows:

1) 700 kPa supply to theatres for pneumatic tools (Designated HA).

2) 400 kPa supply to all areas as indicated (Designated LA).

The medical air compressors supply system shall consist of the following:

1) Two identical compressors each rates at 75% of the design maximum flow at normal operating pressures.

   The compressors should be controlled so that the standby compressor will cut in when the lead compressor cannot satisfy the demand.

2) Two after coolers - one for each of the compressors.

3) Two air dryers, each air dryer sized to cope with the output of both compressors running simultaneously.

4) Two full sets of filters in parallel so that one set of filters can be maintained or repairs without interrupting of restricting the supply of air to the hospital.

5) Each set of filters will be able to handle the output of both compressors running simultaneously.

6) A suitable sized air receiver to provide "storage" of air to help limit the number of starts and stops of the compressors.

16.1 Air Compressors

Medical compressed air should not contain oil or oil vapours in excess of the limits specified and should be dust free and dry. Compressors may be of an approved oil lubricated type, carbon ring or water sealed type provided that the appropriate eliminators are provided for oil droplets, oil mist, water droplets and solids as indicated before.

P.T.F.E. ring compressors should not be used because of the risk of the production of offensive and toxic gases of the rings become overheated.

Oil lubricated compressors include screw type, reciprocating and Rotary vane machines.

16.2 After Coolers

After coolers shall be provided and may be air cooled or water cooled. The temperature of the compressed air leaving the after coolers should be approximately 8°C to 15°C above that of the cooling medium, and about 35°C to 40°C in summer.

Each after cooler should be fitted with an automatic drain trap. The auto-drain should be lead via a tun-dish to the nearest drain point.

16.3 Air Receivers

The receiver shall be of welded construction with dished ends, tested and stamped by an Independent Inspection Authority in terms of the most recent Machinery and Occupational Safety Act (1983). It shall be fitted with a safety valve set at a pressure 10% above the cut-out pressure of the compressors and a 75mm diameter dial pressure gauge with gauge cock. The maximum working pressure shall be marked in red.

The receiver shall be galvanised internally and externally. The tank shall be painted with a suitable metal primer undercoat and final enamel coat. The pipe connections to the receiver shall be resilient to absorb vibration.

The receiver shall be fitted with an automatic drain which is piped to a suitable drain point.

16.4 Air Dryers

The system shall be provided with air dryers of the refrigerated type.

16.5 Air Filtration

It is important for all the reasons stated in the previous sub-sections that the quality of air at the point of use is at the highest level possible. Filtration of the air is therefore vital to remove:

* Moisture
* Solids
* Oil and oil vapour

To achieve medically pure air from an air compressor supply three stages of filtration shall be utilised:

"*COARSE FILTRATION"*

This involves the use of a suitable bulk coalescing filter complete with auto drain and relief valve to remove bulk solids and liquids down to 1 micron. (Domnick Hunter grade A0 filter.)

"*FINE FILTRATION"*

A final stage coalescing filter capable of removing particles down to 0,1 micron complete with autodrain and relief valve must be used. (Domnick Hunter grade AA filter.)

"*OIL ABSORPTION FILTRATION*"

It is advised on all compressor installations (even if oil free machines are used) oil vapour removal filters are installed to remove any oil vapour carry-over. These filters filter down to 0,1 micron. (Domnick Hunter grade AC filter.)

It is important that the compressed air filter elements are replaced on a routine basis to prevent the element becoming clogged, thereby causing a pressure and flow drop, or carry-over of contaminations.

A differential pressure gauge (or a suitable pressure gauge system to determine pressure drop shall be fitted across each filter.

16.6 Air Pressure Regulators

The air compressor supply system shall supply both high pressure and breathing air to the hospital.

The main air supply pipeline will divide in the plant room with regulators to reduce to the correct pressures in the respective pipelines.

It is important that the regulators are:

a) Adjustable within the desired pressure range.

b) Sized to ensure minimum and constant pressure drop across the regulator.

c) Constructed from materials suitable for medical air systems - i.e. diaphragms, seats, etc. will not release any toxic substances.

d) Sized to ensure minimum restriction occurs across the regulator.

e) Cleaned as for oxygen - this is to prevent contamination of the pipeline by any residual oil from manufacture.

A safety valve shall be fitted down stream of the low pressure regulators to protect (in the event of regulator failure) breathing apparatus, cuffs, etc.

The safety valve must be set to lift at a pressure of approximately 5.5 bar. It shall be sized to handle the full flow upstream of the regulator. The discharge pipe shall be vented to a safe area and the end of the pipe turned downstream to prevent the ingress of dirt and moisture.

16.7 Control System

The control system of an air compressor supply system must include/provide/perform the following:

a) Control the two compressors so that one compressor is duty compressor and the other compressor is standby.

b) When the duty compressor cannot cope with the demand the standby compressor will cut in.

c) Provide for auto/manual/off control of the:

- Compressors
- Air Dryers

d) Provide ammeters for each compressor.

e) Provide hour run-meters for each compressor and air drier.

f) Have indication for run and trip conditions for compressors and air dryers.

g) Emergency stop button.

h) Have a timer to automatically alternate the duty and standby compressors and air dryers on a weekly/monthly basis.

i) Provide the necessary inputs to the medical gas alarm system.

The electricity supply to the compressors and air dryers shall be taken from an "essential" circuit on a standby supply.

17. VACUUM SYSTEM

17.1 General Design

The medical vacuum system shall be designed to maintain a vacuum of approximately 400mmHg below a standard atmospheric pressure of 760mmHg (i.e. an absolute pressure of approximately 360mmHg) in the pipeline at the most remote outlet points. The system shall be as indicated.

17.2 Vacuum Pumps

The vacuum system shall be operated by at least two identical pumps. Each pump shall have a capacity equal to 75% of the total design flow. This capacity will usually result in one pump being adequate to meet the demand actually arising at any one time. Each pump should be designed for continuous operation at this load.

17.3 Vacuum Receiver

A vacuum receiver should be provided to provide "storage", so that the duty pump does not run continuously on light loads. Typically vacuum pumps shall run continuously when the load is in the range of about 25% to full load. The receiver should be designed to comply with the latest requirements of the Machinery and Occupational Safety Act (1983).

The receiver capacity shall be sufficient to ensure that the number of stop/start cycles does not exceed 10 per hour (or the maximum number of start/stops specified for the pumps).

17.4 Bacterial Filters

Filters shall be provided in parallel between the vacuum bottle trap and the receiver. The arrangement and capacity of the filters shall be such that one filter may be serviced without interrupting or restricting the vacuum service as a whole. The filters shall have a penetration not exceeding 0,05% when tested by the sodium flame test in accordance with B.S. 3928. Proper arrangements shall be made for safety when changing the filters.

17.5 Control System

The control system of a vacuum supply system shall include/provide/perform the following:

a) Control the two vacuum pumps so that one pump is the duty pump and other pump is standby.

b) When the duty pump cannot cope with the demand the standby pump will cut in.

c) Provide for auto/manual/off control of the vacuum pumps.

d) Provide ammeters for each vacuum pump.

e) Provide hour run-meters for each vacuum pump.

f) Have indication for run and trip conditions for each vacuum pump.

g) Emergency stop button.

h) Have a timer to automatically alternate the duty and standby vacuum pumps on a weekly/monthly basis.

i) Provide the necessary inputs tot he medical gas alarm system.

The electricity supply to the vacuum pumps shall be taken from an "essential" circuit on a standby supply.

18. MEDICAL GAS BEDHEAD PENDANTS

Medical Gas Bedhead and Pendants are supplied by others with cut out for gas points and outlets. The contractor shall supply and install the terminating point including outlet points to the bedhead or pendant units.

19. SCOPE OF WORK

19.1 The sub contractor shall provide a safe, complete and fully functional medical gases installation and shall conform to the following:

19.2 SABS 0224 medical gas pipelines systems.

19.3 Occupational Health and Safety Act (Act No. 85 of 1993) as amended.

19.4 Standard Specification for Electrical Installations pertaining to mechanical equipment.

19.5 SABS 099-1974 The Construction of Air Receivers.

19.6 SABS 1453-1988 Copper tubes for Medical Gas and Vacuum Systems.

19.7 SABS 763-1977 Hot-dip (galvanised) zinc coatings.

19.8 SABS 1062-1985 Vacuum & Pressure Gauges.

19.9 SABS 1409-1986 Outlet Sockets and Probes for Medical Services used in Hospitals.

19.10 SABS 0142 Wiring of Premises.

19.11 CKS 64-1967 Compressed Air for Breathing.

19.12 CKS 605-1987 Medical Gas Regulators.

19.13 R158 Regulations - Hospital Norms.

PART 4

STANDARD TECHNICAL SPECIFICATION

FOR

LIFT INSTALLATION

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4.1 GENERAL

The Standard Technical Specifications are to be read in conjunction with the Detailed Technical Specifications as the latter are intended to amplify the former; only those portions of the General Technical Specifications which apply to the actual project involved shall be pertinent.

Where Detailed Technical Specifications are at variance with General Technical Specifications, the former shall prevail as its contents relate directly to the specific project.

The specification is intended to cover the complete installation of the lift installation and its equipment. It is intended to outline the minimum equipment required, but does not necessarily cover all the details of the installation design and construction.
It is acknowledged that such details are recognized as being the exclusive responsibility of the lift contractor who is more familiar with the product offering intricacies and installation methodologies.

The contractor may not however deviate from the following which are detailed in the detailed specifications;

A) Load capacities,
B) Speeds,
C) Control systems,
D) Materials and finishes,
E) Performance
F) Installation criteria as may be applicable.

In all cases where a device or part of the equipment is referred to in the singular, it is intended that such reference shall apply to identical installations or devices which are required to complete the total installation.
For Example; where information on a singular lift is specified in a duplex pair, the specification shall apply equally to the duplicate lift unless otherwise stated.

Where the manufacturer's requirements or design parameters may be in conflict with this specification, this specification shall have precedence.

Note: The intention of this specification is to call for equipment that is currently available in the South African or International market.
It is designed to establish the minimum requirements with regard to the end product from a selection of manufacturers and suppliers where their product offering can be evaluated against measurable criteria.

It is the intention that the successful contractor will be responsible for the complete scope of this tender. Where in these specifications it is provided for something to be done it shall be the responsibility of the Lift Contractor to do so. This applies to those scopes of works that may be required to be sub-contracted to other specialist contractors, such as shop fitting, minor building patch up works, painting and so forth. Such items are not to be omitted from the tender and are to form part of the contract sum unless the specifications expressly state that someone else is responsible for those items.

4.2 COMPLIANCE WITH REGULATIONS & QUALIFICATIONS

4.2.1 The installation shall be erected and carried out in compliance with:

(a) The SANS Code of Practice 0142 as amended

(b) Occupational Health and Safety Act 85 of 1993 as amended

(c) All applicable SANS1545- Parts, EN81 Electric Lifts and Service Lifts as amended

(d) The Local Municipal Bye-Laws and regulations as well as the regulations of the Local Supply Authority

(e) National Building Regulations and Building Standards Act, 1977 (Act 103 of 1977)

(f) The Local Fire Regulations

(g) The Regulations of the Post & Telecommunications.

(h) The Standard Regulations of any Government Department or Public Service company where applicable.

(i) All applicable SANS Code of Practice or Regulations for disabled.

Note: It is the duty of the Contractor to timeously inform the Consulting Engineer in writing whether by design or unintentionally there is any portion of this specification that does not fully comply with any applicable regulation. The Contractor shall provide proof that his product offering fully complies with all of the relevant statuary requirements.

4.2.2 In addition the contractor shall issue all notices and pay all the required fees in respect of the installations to the Local Authorities, and shall exempt the Employer and Consulting Engineer from all losses, costs or expenditure which may arise as a result of the contractor's negligence to comply with the requirements of the regulations enumerated in paragraph 4.4.1.

4.2.3 It shall be assumed that the Contractor is conversant with the abovementioned requirements. Should any requirement, bye-law or regulation, which contradicts the requirements of this document, apply or become applicable during erection of the installation, such requirement, bye-law or regulation shall overrule this document and the contractor shall immediately inform the Consulting Engineer of such a contradiction. Under no circumstances shall the contractor carry out any variations to the installation in terms of such contradictions without obtaining the written permission to do so from the consulting engineer.

4.2.4 The Contractor shall furnish a document which gives a complete description of all equipment wherein the product proposed does not comply with the specification or information provided in this document, or is in conflict with the work of other trades as specified or shown in other Works Information. Failure for furnish such a document shall be interpreted to mean that the Contractor agrees to meet all requirements of the Specification.

The Contractor may not offer alternative equipment and/or shaft and motor room designs in a covering letter, drawings or tender supplementary documentation, without making specific reference to such deviations.
It is expected that the Contractor will disclose any deviation from the specification and submit supporting documentation motivating the offer of alternatives. The Consulting Engineer reserves the right to include or disqualify the tender, should in his opinion the offering is not in the best interest of the Employer. This is expanded in the next section.

4.3 DEVIATIONS TO SPECIFICATIONS CRITERIA

Where the words for approval or approved are used and it is desired to substitute a different make or type of apparatus from that specified, all information pertinent to the adequacy and adaptability of the proposed equipment shall be submitted to the

Consulting Engineer for approval prior to the equipment being ordered or released for manufacture.

Approvals for equipment specified or proposed substitutions shall not be given merely upon the submission of Manufacture's part names, detailed documentation together with motivation to accept the substitution shall be required.
Approvals for all equipment submitted as a substitution for that specified or shown on the drawings may be granted if such equipment meets the intended and anticipated requirements pertaining to performance, reliability, operation, space conditions, weight, and quality of equipment.

4.3.1 Deviations without written acceptance from the Consulting Engineer from the Scope of Works and Information shall not be accepted. The Contractor shall verify in the tender covering letter, that they have read and understand the content, meaning and intentions of the Tender Document and have tendered accordingly.

4.3.2 Where technical specification cannot be met in terms of specific design requirements; substitution or alternative equipment will be considered with the provision that the proposed substituted equipment will not in any form or manner reduce the intended performance, operation, duty- rate, redundancy and reliability of equipment of the final installation. Deviation or substituted equipment not clearly shown and detailed in a covering letter under the headings, 'DEVIATIONS' shall not be considered or accepted and could result in the disqualification of the tender.

4.3.3 Tender supplementary documentation, brochures etc showing the technical details such as load, speed, dimension sizes, performance and operation of the equipment offered and Contractors conditions of Contract, shall only serve as an informative supportive documentation in terms of the equipment offered, program, organization and staff, and alternatives offered and shall not be considered an acceptable qualification in terms of the Detailed Specification. Equipment offered as substitution that does not comply with Item - 4.3.2 of this specification, whether or not shown in the supplementary document shall not be accepted.

4.3.4 It is acknowledged that the lift technology is advancing with the introduction of new designs, equipment and components.
This specification provides for minimum technical requirements with respect to design, operation, reliability, performance and after service requirements. The Employer and Consulting Engineer reserve the right to reject in whole or part thereof any product offered that in their opinion does not comply with this specification. The following equipment components offered in terms of this specification shall be clearly detailed in the tender supplementary documentation and shall be confirmed by the Contractor as the most modern, latest, technically advanced and most reliable equipment available:

- Car and landing signals,
- Car and landing call button units,
- Door drive equipment,
- Door protection devices,
- Control equipment,
- Drive equipment,
- Intercom equipment.

4.3.5 Approval for alternative equipment shall be by the Consulting Engineer in his capacity as the Employers representative. Contractors are welcome to seek approval for alternatives; however the Contractor shall be liable for all costs associated with providing alternative equipment that has not been duly authorized with any recourse back to the Employer or Consulting Engineer.

4.4 ALTERNATIVES COSTS

4.4.1 The Employer or Consulting Engineer may consider alternatives based on grounds of cost if alternatives do not negatively affect the specified performance levels, operation, reliability, duty-rate, and product expectation. Without deviating from the Main Offer, Contractors' are to provide the following information for any alternative offered;

- Cost breakdown,
- Cost to fix local content,
- Forward cover as specified,
- Programme as specified,
- Statement of installation as specified,
- Maintenance cost as specified,
- Technical information and pamphlets as specified.

Provide a deviation schedule and show all costs in the Contact Price Summary which can be found at the end of the document

It is noted that all alternatives presented and accepted by the Employer and Consulting Engineer shall comply in full with the Conditions of contract as contained in this specification and shall not be limited to performance, operation, reliability, duty rate and quality of equipment.

4.5 DRIVE MACHINE

The main driving machine shall be gearless with a synchronous permanent-magnet motor. It shall be provided with a dual solenoid service and emergency brake of a disc or drum configuration. The machine must be of a design which can be mounted in the hoist way.
Bearings are to be liberally dimensioned and provided with automatic lubrication. Machine for all intents and purposes should be as maintenance free as is practically possible and comply fully with amended provisions of the applicable SANS code.

4.6 GEARING

If applicable;
The worm and its shaft shall be turned and machined from one piece of high quality steel. The worm wheel must be provided with a phosphor bronze rim with machined teeth. The worm wheel shaft shall run in sleeve bearings, while double thrust ball bearings must be provided to take up the axial thrust. Thrust bearings shall be removable without complete dismantling of the machine.

The gearing must be enclosed in a cast iron case, provided with automatic oil lubrication.

This case is to be equipped with lids for easy inspection of the gear, and provided with an oil level indicator as well as oil filling and draining openings.

As an alternative, the machinery may be supplied with roller bearings instead of sleeve bearings provided silent operation can be guaranteed.

4.7 VVVF DRIVE MOTOR

The main driving motor shall be VVVF closed loop AC driven specially designed to operate at low speed controlled by variable voltage combined with variable frequency. The main driving motor shall be compatible for Variable Voltage, Variable Frequency AC drive of the squirrel cage multi-pole shunt wound type, specially designed for lift

hoisting work, and so dimensioned, that no parts of the motor can become overheated under normal site and service conditions.

4.8 DRIVE SHEAVE

The drive must consist of a traction sheave in which the requisite number of grooves has been cut to suit the number and size of ropes used. This sheave is to be mounted on the same shaft as the worm wheel or drive machine, which ever is the case. The shaft shall have an outer bearing with automatic lubrication. The driving sheave shall be easily removable for renewal of the grooved rim.

4.9 BRAKE

The brake drum may be incorporated in the coupling between the worm shaft and the driving motor or for gearless applications as part of the sheave drive. The brake may be operated by a DC solenoid. The brake must be easily adjustable and one half of it must be capable of holding the car in case of failure of the other half. The brake arrangement must be so designed and installed that should the worm shaft shear, the brake will be prevent the traction sheave from turning.

4.10 HAND TURNING GEAR

Provision shall be made for a safe method of turning the machine by hand so that the lift car can be moved manually from the lift motor room or top floor landing to the nearest landing to facilitate evacuation of passengers.

4.11 CONTROLLER

The controlling mechanism for Motor Room Less type lift shall not be mounted on the main machinery but is to be assembled as part of the top floor landing door framework.

Contacts breaking heavy currents shall be provided with magnetic blow-outs or arc chutes. All contact surfaces shall be of silver, except those for heavy currents, where carbon to silver or carbon to copper surfaces may be used. Copper to copper contact will not be accepted.

Wearing parts must be easily renewable. If applicable, flexible connections must be used for all moving contacts and currents shall not be carried by springs or joints.

For the wiring of the controller, fire resistant cables are to be used.

The controller must incorporate all switchgear and relays necessary for the operation and protection of the lift, and must be so designed that it will automatically bring the car to rest in the event of any of the following occurrences:

4.11.1 Interruption of the power supply to the machinery or interruption of any one phase of the main supply.

4.11.2 Operation of the governor due to over-speed condition.

4.11.3 A reversal of power supply phase/s.

4.11.4 Interruption of car door or landing door locks

4.11.5 Overload of drive motor

4.11.6 Interruption of terminal limits

All terminals of the machinery and the control gear must be marked with a distinctive letter or number and corresponding markings shall appear on the engineering installation drawings.

4.12 OPERATION

The operation of the lift/s shall be Collective – Selective – Simplex, Duplex or Group control and operation system whereby a common pushbutton control panel/s for the lift/s is provided on the landing at each floor level.

The landing panel shall be equipped with both UP and DOWN call buttons except on terminal floors where Single call buttons depicting the reversed direction of travel shall be installed.

Landing and car calls shall be continuously registered by the controller so that landing calls are allocated to both cars so as to avoid waiting time.

When the car reaches that landing the call must be automatically cancelled to prevent the other lift car/s from duplicating the call.

4.13 CAR CONTROL BUTTONS

The operating panel in each of the lift cars shall be equipped with the following controls:

4.13.1 A number of pushbuttons corresponding to the number of floors served.

4.13.2 A button clearly marked ALARM to sound a battery operated bell mounted on top of the lift car in a position indicated by the Consulting Engineer.

4.13.3 A door OPEN and a door CLOSE button.

4.13.4 A key operated bypass switch to separate the controls of collective operation.

4.13.5 A key operated switch for the car lighting.

4.13.6 A tumbler switches to operate the lift car fan.

4.13.7 Any other pushbuttons which may be necessary should first be reviewed by the consulting engineer

4.13.8 Independent reservation key switch operation shall be provided in the car operating panel.

All these pushbuttons shall be micro touch sensitive type and shall blend with the overall design of the car interior as described and shall each be fitted with an LED indicator showing that the call has been registered.

4.13.9 A set of car control buttons termed “Car Top Station” for up and down operation of the car shall be fitted into a dustproof control box positioned above the roof of each of the car/s.

These controls shall override all other travel controls and assist in manually operating the car travel in the shaft for maintenance and inspection of the shaft.

A 15 Amp 3-pin switched industrial metal clad socket outlet as well as a bulk head light fitting for 100 watt ES incandescent lamp and switch is to be provided above the platform adjacent to the controls.

Immobilizing switches located on the top of the lift car shall also be fitted for inspection purposes.

4.14 LANDING CONTROL BUTTONS

These pushbuttons shall be micro touch sensitive type to match other similar items of equipment and shall be mounted into a sheet metal front for flush mounting into the face-work of the piers between the lifts in the inline position. Each button shall be provided with an LED indicator showing that the call has been registered.

The lower and upper terminal stops shall only have one pushbutton each while the intermediary stops shall have an UP and DOWN pushbutton each with LED indicators.

On the Ground Floor a Fireman's control station with toggle switch recessed mounted behind a flush glass fronted box shall be installed in the lift lobby.

The face plates of all these landing control buttons shall be stainless steel "Brushed Satin" finish.

4.15 SIGNALS

The following signals and indicators shall be provided:

4.15.1 In the Car

(a) Illuminated travel direction indicators with arrows mounted on the car operating panel.

(b) An illuminated position indicator to be provided in each car to indicate the landing served.

(c) Signal to indicate that the lift is overloaded

(d) Signal to indicate that the lift is on reservation service

(e) Signal to indicate that lift is out of service

(f) Signal to indicate that Fireman's service has been activated and lift is returning to designated floor.

4.15.2 On Each Landing

(a) Illuminated direction of travel indicators with arrows each with electronic gongs to announce car arrival shall be fitted above each landing door of each lift.

(b) The micro pushbutton station/s.

(c) Each lift landing shall be provided with an illuminated multi-position indicator indicating the position of each car. These indicators shall be flush mounted above each landing door of each lift.

4.16 OPERATING INSTRUCTIONS

All operating instructions and engravings on the operating panel of each of the cars shall be in English.

Alternatively:

Universal language pictograms may be used with English only for the inscription plate.

2.17 LIFT CARS

Each of the lift cars shall conform to the following requirements:

2.17.1 Construction

GENERALLY

The body of the car shall be self-supporting and insulated against transmission of noise and tenderers shall submit various designs, brochures and illustrations as well as the required technical data on the lift car and alternatives which have been included in their tender.

2.17.2 Car Frame

The car frame shall consist of rolled steel sections, channel and angle folded and welded with substantial reinforcement and braced to prevent distortion and to relieve the car enclosure of all strains and unwanted movement during travel.

4.17.3 Platform

The platforms shall consist of a layer of wood flooring laid down on a structural steel framework which is then covered with moisture resistant chipboard not less than 20mm thick.

4.17.4 Roof

The roof of each car shall be provided with a suitably constructed and reinforced platform above the ceiling to carry the weight of 3 men of an average weight per man of 75kg who shall be carrying out the maintenance and inspection work to the shaft.

4.17.5 Car Body

The car body shall be constructed from 14 gauge sheet metal panels with rubber insulation between the metal parts to ensure low vibration and limited noise transmission. For painted finishes, the panels must be thoroughly bonderised before painting and the outside of the car shall receive a coat of rust preventative paint. The interior finish and decor to the lift car shall be fitted to interior of the car body.

Observation lifts shall have minimum 6mm laminated safety glass panels.

2.17.6 Ceiling and Lighting

Ceiling and Lighting final finishes shall be approved by the Architects. For tendering purposes the minimum standard shall be illuminated ceiling with insert diffuser panels or acrylic cylinders shall be provided to suit the interior decor of the car. Similar or equal to ceiling type C108. The lighting within the car shall be fluorescent tubes with electronic ballast or down lighters to give a minimum of 50 Lux.

In the event of a mains failure an emergency battery powered light source will be provided that complies with the minimum standards stipulated in SANS codes.

2.17.7 Ventilation

A single speed fan shall be mounted above the lighting diffuser to give adequate ventilation controlled by a toggle switch mounted in the control panel in the wall of the car.

2.17.8 Control Panel

The car control panel shall form part of the car front or side wall and shall extend from the car floor kick-plate up to the ceiling.

The cover shall be movable or hinged for easy access to the controls and wiring and finished in stainless steel brushed satin finish.

The components of the control panel shall be:

(a) Digital car position indicator.

(b) Maker's nameplate inscribed with service instructions, nominal load, number of persons and official registration number.

(c) The operating section containing buttons for landings with LED indicating call registered, alarm button, touch buttons for door opening and closing, key switches as required, overload indicator etc.

(d) No smoking sign.

(e) A recessed Telephone cabinet to accommodate an intercom telephone handset or normal telephone hand set linked to the PABX system or security room. (this item should be confirmed in the detailed specification guide.

(f) For Hospital applications, a recessed box with a hinged door to accommodate emergency oxygen bottle.

2.17.9 Hand Rails

A handrail shall be provided, manufactured from stainless steel or aluminum in "Brushed Satin" finish and shall be fitted around all three sides of the lift cars.

In the event of semi scenic cars being provided the handrail at the rear of the car shall be strengthened and securely fastened to the side and rear wall of the cars.

4.17.10 Kick Plate

A stainless steel kick plate at least 150mm high shall be fitted to extend around all three sides of the lift cars at floor level.

4.18 CAR AND LANDING DOORS

These doors shall be specified according to shaft requirements with finish to architect's requirements.

All doors are to be constructed of hollow metal adequately soundproof and suitably reinforced to ensure rigidity.

All car doors are to be power operated and provided with a mechanical attachment which shall open and close car and landing doors simultaneously.

The doors shall be interlocked by electronic mechanical locks, so arranged that no landing door can be opened unless the car is opposite the landing and that the car cannot be started unless all doors are closed and latched.

The locks shall be substantially constructed, sufficiently strong to withstand the shock of the repeated opening and closing of doors. The locks and contacts shall be so enclosed as to prevent accidental contact by any person using or working the lift. When the car arrives at the landing, car and landing doors shall start opening while the car is leveling.

When the lift button is initiated and the doors begin to close, it must be possible to quickly reverse and open doors.

Th prevent injury to passengers, the leading edges of the car doors shall have a full curtain detector, so adjusted that when the closing door meets an obstruction it shall automatically re-open.

In the event of a power failure it must be possible to open car and landing doors from inside the car, provided it has stopped within a reasonable distance of a landing level, i.e. within the leveling zone. Door release keys for opening landing doors from the landing are to be provided to the client and the tenderer shall provide training in the use thereof.

4.19 LANDING ENTRANCES

At all landings served by all lifts, extended aluminum sills with anti-slip tread are to be provided. The sills must be securely fixed to the building construction and must line up with the final floor finish. Floor nibs for the attachment of sills will not be provided.

At each landing the entrances shall be provided with simple but robust stainless steel architraves finished in “Brushed Satin”.

2.20 DOOR HANGERS AND TRACKS

Each car and landing door must be equipped with suspension hangers and rollers running on suitable tracks. The rollers must be adjustable and shall be suitably protected against dust and dirt. The hangers must be easily accessible.

The hanger housing shall be of steel, suitable reinforced and shall be adequately supported and securely fixed in position.

4.21 FASCIA PLATES

Plates not less than 16 gauge, reinforced where necessary, shall be fitted on the inside of the shaft between all entrances, extending from the hanger housing to the sill above. The plates shall be at least 150mm wider than the shaft openings. The plates must be coated with rust-resisting paint.

4.22 SAFETY DEVICE

Each lift shall be provided with a safety device, fitted to the underside of the car, and designed to bring the car gradually to a standstill without shock, when the speed in the downward direction becomes too great. Details of the type of “safety” offered must be given.

4.23 GOVERNOR

Each lift must be provided with a tension type governor, driven directly by an independent rope attached to the car, and adjusted to interrupt the motor supply when the car speed exceeds the normal speed by approximately 15% and to apply the safety device when the over-speed is approximately 25%.

4.24 GUIDES

The guides for each car and counterweight shall consist of planned steel tees with milled, tongued and grooved joints. Metal splice plates shall be at least 300mm long. The bases of each set of guides shall be bolted to horizontal steel channels fixed to the pit floor. Side counterweight arrangements shall have a dual purpose bracket that combines both counterweight guide rails, and one of the car guide rails to building fastening.

4.25 BUFFERS

Two heavy spring or oil buffers or equivalent are to be provided for each car and for each counterweight.

The buffers shall be so adjusted that in case of over-travel no parts of the counterweight or car will touch the shaft ceiling, and that the retardation of the car does not exceed the limits laid down in the SABS 1545, EN81 or British Standards Safety Codes.

4.26 COUNTERWEIGHTS

Each counterweight shall consist of a structural steel frame, in which independent cast iron weights are to be assembled.

When lift shafts are above occupied floors, the counterweights are to be fitted with a safety device to prevent the counterweight falling freely.
Counterweight screen is to be provided in the pit and counterweight is to be painted chevron black & yellow.

4.27 GUIDE SHOES

The shoes shall be of the spring loaded type, provided with automatic oil feed lubrication.

The shoes shall have ample bearing surfaces, and shall be easily adjustable and removable for renewal.

4.28 HOISTING ROPES

The ropes shall be of the best quality steel wire rope available, and total the required number for the duty load of the lift. Ropes of 8/19 construction are preferred.

Rope equalizers are to be so designed that each rope can be individually adjusted.

Equalizers reducing the suspension to a single bolt or shaft will not be acceptable.

Contractor shall state if other suspension technology is to be used and provide details for approval of the consulting engineer.

4.29 LIMIT SWITCHES

Each lift shall be equipped with limit switches which will automatically stop the car at the terminal landings independently of the operating controller.

In addition final shaft limits are to be provided which shall disconnect the drive motor supply in the event of a control malfunction.

4.30 TRIP RECORDER

A suitable trip recorder shall be provided for each lift.

4.31 WIRING

Except for the flexible cable for the connections from the side of the shafts to the lift cars, all other wiring is to be carried out in pvc conduiting, screwed tubing or in folded metal or PVC ducting.

Should screwed conduit be used then a liberal number of inspection fittings must be provided and the tubing must be of such diameter that the wiring can easily be renewed.

Sheet metal ducting for the control circuits in the shafts and motor rooms is permissible provided this ducting complies with the requirements of the electrical code of practice.

Cable lugs shall be used for all stranded wires, and small wires shall be connected with suitable terminals.

All tubing and ironwork shall be thoroughly earthed in accordance with the regulations.

4.32 PAINTING

All ironwork and the floor of the lift machinery room & shaft, except contact surfaces of the guides shall be painted with two coats of best quality paint.

4.33 TOOLS

Only if applicable, these shall be in the motor rooms comprise of a complete set of large tools and special devices shall be provided mounted on a suitable tool board which is to be fixed to the motor room wall. Tenderers must state what tools will be provided.

4.34 ESCALATORS

NOT APPLICABLE

4.35 TENDER DRAWINGS AND TECHNICAL INFORMATION REQUIRED

Tenderers must submit with their tender, detailed drawings showing the proposed lift and/or escalator installation and the layout of the motor room.

A detailed description of the lift and escalator installation offered, and of the method of operation must be furnished.

In addition tenderers must complete the technical data schedules attached to this specification.

Failure to submit any of the required information may disqualify the tender.

4.36 ENGINEERING INSTALLATION DRAWINGS

The drawings listed below shall all be prepared by the Lift Contractor and shall consist of:

2.36.1 General Arrangement Drawings

General arrangement drawings of both the electrical and mechanical systems indicating all equipment, testing, inspection, instrumentation, position and all access requirements.

Three copies of each shall be submitted before construction is commenced, but at least four weeks after the tender has been awarded and the Lift Contractor appointed.

4.36.2 Detail Design Drawings

The following detail design drawings shall be prepared and three copies of each shall be submitted for approval before construction is commenced.

4.36.2.1 ELECTRICAL SYST**E**MS

General Arrangement Drawings
Schematic and Circuit Diagrams
Interconnection Diagrams

4.36.2.2 MECHANICAL SYSTEMS

General Arrangement Drawings
Load and Force Diagrams
Structural Steel Support Drawings

4.36.3 Builder's Work Drawings

These shall be based on the general arrangement drawings and shall show all the work to be done by others (holes in concrete, pockets, frames masonry holes, bases etc. as well as sizes, capacities and position of service connections by others for these contract works).

Five copies of each shall be submitted for approval before these are forwarded to the Builder for construction purposes.

4.36.4 Shop Drawings

Shop drawings which are based on the general arrangement drawings showing in detail the construction and all parts of the works, methods of assembly, erection and construction, thickness and types of materials, finishes, details of supports and anchorage, points, connections, welds, fabrication, fastenings, gaskets, sealants, reinforcements and all other pertinent details.

Three copies of these drawings are to be forwarded to the consultants for record purposes.

4.36.5 Wiring Diagrams

Wiring diagrams shall be prepared by the Lift Contractor indicating schematic and circuit layouts for all the equipment. Motor kilowatt and ratings for all circuit breakers and protective device settings shall be stated.

Three copies of each of these diagrams shall be provided to the consulting engineers for record purposes and a further copy of each printed by a permanent process shall

be mounted behind a glass fronted frame fastened in a prominent position to the wall inside the lift motor room.

4.36.6 **As-Built Drawings**

The Lift Contractor shall keep a drawing record of all the deviations during construction from the General Arrangement plans originally prepared and shall mark those onto a set of "AS-BUILT" drawings indicating the exact positions of such items as conduit cable and ducting routes, joints, draw boxes etc.

These drawings shall be neatly prepared on transparent plastic for permanent record and shall be handed over to the consulting engineers at the completion of the Works and shall form a portion of the relevant clause of the handing and taking over of the installation.

4.37 **OPERATING AND MAINTENANCE MANUALS**

The Lift Contractor shall prepare and supply three copies of the Operating and Maintenance Manuals specifically for this installation.

The manuals shall include the following information:

4.37.1 Detailed general arrangement and wiring diagrams as well as as-built drawings as described above.

4.37.2 Schedule of recommended spare parts necessary for at least a two year period of operation.

4.37.3 Schedules of manufacturer, address of local agent for each item of equipment and spare parts.

4.37.4 Schedule of recommended lubricants.

4.37.5 A preventative maintenance programme for all equipment.

A draft copy of the manual shall be submitted to the consulting engineers for approval before the final issue of the three copies of the Operating and Maintenance Manual.

2.37.6 Copies of all applicable type test certificates

2.37.7 Copy of Annexure A

2.37.8 Copy of Annexure B

2.37.9 Copy of lift registration document

2.37.10 Original rope certificate

2.37.11 Contact details for emergency call outs

2.37.12 Maintenance and operating documentation of any auxiliary equipment installed

4.38 **MAINTENANCE TOOLS AND EQUIPMENT**

The Lift Contractor shall provide all tools and equipment necessary for the proper and efficient execution of all construction and maintenance.

A complete set of all special tools required for the maintenance, operation and dismantling of all equipment shall be provided by the Lift Contractor. These items

shall be neatly stored on a hanging tool rack fastened in a convenient position to the wall of the lift motor room.

Duplicate sets of keys to all doors fitted to control panels, instrument cabinets and locks shall be supplied by the Lift Contractor.

4.39 SPART PARTS

The Lift Contractor shall include in his contract for the supply and provision of spare parts such as fuses, links, contacts, contactors, PC boards etc., and the like as are normally provided for maintenance of the equipment of the installation and the consulting engineers shall have the right to select such spare parts as deemed necessary for the proper care of the system. The lift contractor will provide guarantees that all parts will be available for a period of not less than 20 years.

4.40 NOISE AND VIBRATION

The equipment and plant provided shall be free from noise and vibration. If in the opinion of the consulting engineer any equipment, plant or apparatus operates with or transmits from it such noise and vibration to be objectionable then it will be necessary to rectify or replace such equipment or plant so that the service operates at conditions acceptable to the engineers.

The measures taken where necessary whether specifically stated in these documents or not to ensure quiet vibration free operation of the installation include for soundproofing of plant rooms, mounting of equipment on anti-vibration mountings, insertion of vibration isolators of the correct type, suspension of pipework, ducting and the like on suitable vibration excluding isolators so as to exclude the transmission of vibrations to the structure to which they are attached.

Remedial measures taken to achieve satisfactory noise and vibration levels shall be at no additional cost to the employer.

4.41 NOTICES AND LABELS

All notices and danger signs including prohibited, unauthorized entry, electric shock, procedure in case of fire, emergency telephone numbers etc., shall be provided by the Lift Contractor, securely fastened and displayed in prominent positions by him.

All manufacturers' nameplates shall remain intact and not removed from any plant or equipment. These nameplates shall have the ratings, type and model number as well as the manufacturer permanently embossed. The nameplates shall be securely fastened with screws or rivets to the main frames of the equipment.

The switchboards shall be fitted with clearly engraved labels identifying the switchgear and panels mounted above and in front of each panel respectively.

The lettering shall be engraved onto white-black-white Traffolite. Embossed and glued labels provided with adhesive material for fastening is not accepted.

The wiring of all switchboards and control circuits shall be marked with numbered porcelain or other approved ferrules to facilitate circuit identification.

4.42 RECORDS

The Lift Contractor shall provide and keep permanently on site a lift operation record book, besides the Operating and Maintenance Manual previously described.

The lift record book shall clearly show all visits, repairs, services, overhaul, maintenance, lubrication and inspections carried out as well as such stoppages and the remedial measures taken to repair and avoid such occurrences from re-occurring.

This book shall be signed by authorised persons only and be available for inspection by all such persons at all times.

4.43 NAME BOARD

The Lift Contractor shall if so required, provide and erect where directed, maintain and remove on completion of the Works ONE name board of The Association of South African Consulting Engineers official design, with the description of the work, names of the consulting engineer and the name of the lift contractor painted thereon in English, by a qualified sign writer. The board is to be painted in two colours.

2.44 DETAILED SPECIFICATIONS

Refer to Section 2A for detailed specifications with respect to requirements for each lift or installation.

PART V

DETAILED TECHNICAL SPECIFICATION

INTENSIVE CARE UNIT
MECHANICAL SERVICES INSTALLATIONS

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	5b – Detailed Specifications for Lift Installations	28
	5c – Detailed Specifications for Medical Gas Installation	19
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PART V

DETAILED SPECIFICATION FOR

HEATING VENTILATION AND AIR CONDITIONING INSTALLATIONS

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1.0 SCOPE OF WORK

The subcontract, as detailed in these specification documents and the accompanying drawings, comprises the manufacture, supply, transport and delivery to site, offloading, hoisting, installation, testing, setting into operation, leaving in complete working order, guarantee and the maintenance of the entire air conditioning and ventilation plant and, except so far as the subcontract otherwise provides, the provision of all labour, materials, subcontractor's equipment and everything, whether of a temporary or permanent nature required in and for such manufacture, supply, transport and delivery to site, offloading, hoisting, installation, testing, setting into operation, leaving in complete working order, guarantee and maintenance so far as the necessity for providing the same is specified in or reasonably to be inferred from the contract.

All building work shall be excluded in the contract unless specifically included. All such work, as later herein specified as being specifically excluded from this contract, shall be carried out by others in accordance with the drawings and details provided by the Engineer or the Subcontractor as applicable and approved.

2.0 PROGRAMME

The subcontract shall be carried out in accordance with the Main Contractor's programme. The building is in an advanced stage of construction and work on site can commence immediately.

Tenderers are to submit their proposed programmes with the submission including delivery times and anticipated installation periods.

The Subcontractor shall be required, within two weeks after acceptance of his tender, to submit to the Engineer for his approval a programme showing the order in which the Works will be executed. The programme shall be drawn up in consultation with the engineer and client.

Such programme shall show the times for the preparation of drawings, ordering and delivery times promised by the suppliers for each major item of plant, manufacturing and delivery times for all manufactured items, installation times and the programmed dates for testing and commissioning the plant.

3.0 DRAWINGS

3.1 Tender Drawings

The drawings accompanying this specification, as numbered below, shall be deemed to indicate the general layout and requirements only and are not shop drawings.

The Engineer shall provide the Subcontractor, free of charge, with one set of specification documents, to include all tender drawings.

3.2 Builder's Work Drawings

The Subcontractor shall provide details of works required by others for the air conditioning and ventilation installations. These shall be submitted for approval before issue.

Such builder's work drawings shall indicate the location and extent of all foundations, bases, openings, timber frames and all other builder's work and the capacities and/or dimensions of all electrical and water supply points, the method of terminating such supplies and the position of the connection points, the position and dimensions for all water drainage connections and any other work to be provided by others for the works, as detailed in these specifications.

The drawings shall be drawn to scale and in sufficient detail to enable the Main Contractor to execute the work without any misunderstanding.

Within a reasonable period after receiving such drawings, the Engineer shall signify his approval, or otherwise, and one signed copy of each approved drawing shall be returned to the Subcontractor.

When approved, the following number of copies of each such drawing shall be delivered to the following:

Architect: 1 Paper Print

Consulting Engineer: 1 Paper Prints + 1 electronic version in dwg (AutoCAD 2007) format
Main Contractor 2 Paper Prints
Quantity Surveyor 1 Paper Print

3.3 Shop Drawings

The Subcontractor shall submit to the Engineer, for approval, duplicate copies of all shop drawings as required for the manufacture and installation of the works or as the Engineer may reasonably require.

All shop drawings for work outside of plant rooms shall be drawn to a scale of not smaller than one in fifty and all drawings of work within plant rooms shall be drawn to a scale of not smaller than one in twenty-five. All details shall be drawn to a scale to show the detail required.

Within a reasonable period after receiving such drawings, the Engineer shall signify his approval, or otherwise, in writing and one signed copy of each approved drawing shall be returned to the Subcontractor.

The Subcontractor shall not, unless otherwise directed by the Engineer, in writing, commence with any work prior to the approval of the relative shop drawings. Work installed prior to the approval of shop drawings shall be liable to rejection by the Engineer and removal and/or replacement by the Subcontractor, at his cost, if it is considered by the Engineer to deviate from the Specification.

The Subcontractor shall also supply additional copies of all approved drawings in accordance with the requirements of Part IV (Operating and Maintenance Instructions) of the Specifications.

Drawings approved as above described shall not be departed from except as authorised by the Engineer.

The Engineer shall have the right at all reasonable times, to inspect at the factory of the Subcontractor, all drawings of any portion of the Works.

3.4 Mistakes in Drawings

Any expense resulting from an error or omission in or from delay in delivery of the drawings shall be borne by the Subcontractor.

The Subcontractor shall be responsible for any discrepancies, errors or omissions in the drawings and other particulars supplied by him whether such drawings and particulars have been approved by the Engineer or not, provided that such discrepancies, errors or omissions are not due to inaccurate information or particulars furnished in writing to the Contractor by the Engineer. The Employer shall be responsible for drawings and information supplied in writing by the Engineer and for the details of special work specified.

3.5 Schedule of Drawings

Drawing Nº	Description
MA 1105/000 – 100	HVAC Schematic layout
MA 1105/000 – 101	HVAC Notes, Legend & Symbols
MA 1105/008 – 102	ICU Ward – HVAC Ground Floor Plan
MA 1105/008 – 103	ICU Ward Roof Layout Plan
MA 1105/008 – 104	ICU Ward – HVAC First Floor Plan

4.0 DESCRIPTION OF THE INSTALLATION

This is an existing hospital located in the North West Region in Rustenburg. The building lies between Heystek Street, Nelson Mandela drive and Kloof Street.

4.1 INTENSIVE CARE UNIT BLOCK

This is an existing 2 storey building for which 1st will be converted to an ICU and section of ground floor will be extended and converted to ICU. The HVAC plant will comprise as follows:

4.1.1 Patient space

3 x Air cooled Heat pump chillers feeding 3x 100% fresh air Air handling units of cooling capacity as detailed in the BOQ complete with ducting and ancillaries for a complete installation

The Air Handling units and chillers will feed the medical areas of the ICU. All this will be connected and controlled via a building and management system. All the Chillers and Air handling units will be connected to the generator to ensure no power disruptions. The BMS and controls will be connected in such a way that allows the continuous operation of the ICU in case of power disruptions.

The Air Handling units will be 100 fresh air with heat recovery system and the units will pump the required air via externally insulated ducts with balancing dampers to various diffusers which will air condition the required spaces.

4..1.2 Non-Patient Spaces

VRV system. With ceiling cassette units

Non-Medical spaces will be air conditioned via a VRV system which will supply various indoor units for each particular space.

4..1.3 Ventilation

Various fans will be installed to ensure adequate ventilation, this via disc valves, dropper ducts with OBD grilles at the bottom and grilles with balancing dampers as well as velocity control dampers and sensors in the theatres.

5.0 TYPICAL DETAILS

5.1 Ductwork

The subcontractor is to note that all shoes provided for duct take-offs to diffusers etc, are to be generously formed to minimise pressure drop. Similarly, all trouser pieces and bends are to be fitted with turning vanes.

5.2 Insulated Flexible Ductwork

Shall be class 1 fire rated.

5.3 Duct Insulation

All ductwork shall be externally insulated.
All supply ducts penetrating the walls shall be provided with 2 hour rated fire dampers to close automatically in the event of a fire.

Fibreglass density shall be a minimum of 24kg/m³ for internal insulation and external insulation in unexposed areas.

Thermal conductivity shall not exceed 0,037 W/m°K.

In unexposed areas such as roof spaces, etc., external insulation shall be protected with an aluminium foil cover. These shall be strapped at intervals not exceeding 500mm.

All air conditioning ductwork externally insulated shall be provided with a continuous vapour barrier, sealed with adhesive aluminum tape or equal.

The vapour barrier shall comply with the flammability requirements for sealing membranes.

Particular care shall be taken with insulation at ductwork joints to ensure maximum possible insulation of duct surfaces.

Duct insulation shall be 50mm thick.

External insulation in shall comprise 50mm thick polystyrene, with Fix bond membrane & PK835 water proof coating, colour grey.

Horizontal surfaces and joints in the sheet metal cladding shall be such that they shed water.

5.4 Air Terminals

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Duct and diffuser electric heaters where specified will be single element 230 Volt within line Klixon auto reset overheat stat. AHU over heat stats shall be manual reset type.

Concealed fixings on vertical grilles are required. All grid cores shall have a narrow white aluminium frame and white aluminium cores. All weather louvres and door grilles shall be epoxy powder coated to the architect's colour specification. Door grilles shall have screw fixings.

5.5 VRF Indoor Units

The VRF air conditioning systems for the non-patient spaces shall consist of one heat recovery outdoor unit for each zone serving multiple indoor units able to provide either heating or cooling simultaneously to the rooms.

A number of different types and capacities of indoor units shall be served from each single outdoor unit, via a single refrigerant circuit and each indoor unit shall be controlled individually.

The compressor shall be equipped with an inverter controller that changes the rotation speed to follow the variations in the cooling or heating loads.

The refrigerant circuit shall be extendable up to 100 meters, with a level difference of 50 meters, without any oil traps with the indoor unit below condensing units. For indoor units above the condensing units the level difference shall be 40 meters.

The VRF systems shall be capable of operating continuously at ambient temperatures of -5°C in the heating mode.

The refrigerant should be R 410A, or equally environment friendly refrigerant. R22 will not be accepted.

5.6 VRF Outdoor Units

The outdoor units shall be the factory assembled modular type housed in a sturdy weatherproof casing constructed from rust-proofed mild steel panels and coated with baked enamel finish. They shall be suitable for side-by-side installation.

Each module shall be equipped with two scroll compressors. The outdoor units shall be capable of serving indoor units ranging in capacity from 2.2kW to 28kW.

The noise level shall not exceed 58dB(A) at normal operating conditions measured away and 1.5 meters above the base of the unit.

6.0 Detailed Specification

6.1 Air Handling Unit

The Air Handling units must have the following specification:

6.1.1 Schedule of Air Handling Unit

DESCRIPTION	QTY
AHU1 (1st Floor beds 5 to14) Supply Air Quantity: 4,125m³/sec Percentage Fresh Air: 100% Cooling Capacity:80kW Type: Horizontal Heating capacity:90Kw Refrigerant: 410A **Air Filtration: 3 stages** Primary G3: Yes Secondary F8: Yes HEPA HEPA-H12): Yes Partitions are sealed to the internal side of the exterior wall, roof and floor panels to ensure zero air by-pass. Magnehelic gauges across filter bank, Pressure gauges and thermometers 50 mm thickness of insulation Damper motors on mixing box dampers and bypass dampers, Intake Weather louvres on plenum boxes or fresh air units, variable speed drive, Plenum lights in each chamber with light switch per light, and all appurtenances necessary for complete operation Use: for outdoor use The AHU must be the heat recovery type with a Heat recovery wheel, it must come	1

complete with pressure switches for filters and fans, fan motors and inverters. • Electrical control panel complete with Direct Digital Control (DDC) controller › Internal fitting of all sensors and pressure measurement devices › Built-in temperature, humidity and CO2 sensors › Internal electrical wiring for all components. Mixing box with damper and factory-mounted actuators. Supports and fixings, Magnehelic gauges across filter bank, 1.5D Eurolon infill, Return air fans, vibration isolation, supports, , variable speed drive, Plenum lights in each chamber with light switch per light, Damper motors on mixing box dampers and bypass dampers, Intake Weather louvres on plenum boxes or fresh air units, pressure gauges and thermometers and all appurtenances necessary for the safe and efficient operation of the system. Installed	
AHU1 (1st Floor beds 5 to14) Supply Air Quantity: 4,125m³/sec Percentage Fresh Air: 100% Cooling Capacity: 80 kW Type: Horizontal Heating capacity:90Kw Refrigerant: 410A **Air Filtration: 3 stage** Primary G3: Yes Secondary F8: Yes HEPA HEPA-H12): Yes Partitions are sealed to the internal side of the exterior wall, roof and floor panels to ensure zero air by-pass. Magnehelic gauges across filter bank, Pressure gauges and thermometers 50 mm thickness of insulation Damper motors on mixing box dampers and bypass dampers, Intake Weather louvres on plenum boxes or fresh air units, variable speed drive, Plenum lights in each chamber with light switch per light, and all appurtenances necessary for complete operation Use: for outdoor use	1

The AHU must be the heat recovery type with a Heat recovery wheel, it must come complete with pressure switches for filters and fans, fan motors and inverters. • Electrical control panel complete with Direct Digital Control (DDC) controller › Internal fitting of all sensors and pressure measurement devices › Built-in temperature, humidity and CO2 sensors › Internal electrical wiring for all components. Mixing box with damper and factory-mounted actuators. Supports and fixings, Magnehelic gauges across filter bank, 1.5D Eurolon infill, Return air fans, vibration isolation, supports, , variable speed drive, Plenum lights in each chamber with light switch per light, Damper motors on mixing box dampers and bypass dampers, Intake Weather louvres on plenum boxes or fresh air units, pressure gauges and thermometers and all appurtenances necessary for the safe and efficient operation of the system. Installed	
AHU03 (1st Floor bed 1-4 & Isolation wards) Supply Air Quantity : 2.4m³/sec Percentage Fresh Air: 100% Cooling Capacity: 45 kW Type: Horizontal Heating capacity:55Kw Refrigerant: 410A Air Filtration: 3 stage Primary G3: Yes Secondary F8: Yes HEPA HEPA-H12): Yes Partitions are sealed to the internal side of the exterior wall, roof and floor panels to ensure zero air by-pass. Magnehelic gauges across filter bank, Pressure gauges and thermometers 50 mm thickness of insulation Damper motors on mixing box dampers and bypass dampers,	1

Intake Weather louvres on plenum boxes or fresh air units, variable speed drive, Plenum lights in each chamber with light switch per light, and all appurtenances necessary for complete operation Use: for outdoor use The AHU must be the heat recovery type with a Heat recovery wheel, it must come complete with pressure switches for filters and fans, fan motors and inverters. • Electrical control panel complete with Direct Digital Control (DDC) controller › Internal fitting of all sensors and pressure measurement devices › Built-in temperature, humidity and CO2 sensors › Internal electrical wiring for all components. Mixing box with damper and factory-mounted actuators. Supports and fixings, Magnehelic gauges across filter bank, 1.5D Eurolon infill, Return air fans, vibration isolation, supports, , variable speed drive, Plenum lights in each chamber with light switch per light, Damper motors on mixing box dampers and bypass dampers, Intake Weather louvres on plenum boxes or fresh air units, pressure gauges and thermometers and all appurtenances necessary for the safe and efficient operation of the system. Installed	

6.2 Air Cooled Water Chillers

Type: Air cooled Reversible Heat Pump water chiller

Clivet or equally approved Air-cooled reversible heat pump
Cooling capacity 80KW and Heating capacity 90Kw :
Unit to come with fully factory charged refrigerant (R410A) or any other environmentally friendly refrigerant.
Unit to come inclusive of LCD control Unit and must be Designed for outdoor installation. Unit must employ modular Scroll technology with several compressors, electronic expansion valves and plate evaporators with highly efficient heat exchange. Installed complete with all appurtenances for the safe and efficient operation of the chiller including connections to the pipework and electrical systems and all interlocks between chiller and pumping equipment to ensure the systems operate safely and efficiently.
COP should not lower than 3.1 and IPLV not lower than 4.0, Unit to be supplied complete with Antivibration pads and spring Isolator.

Maximum acceptable unit dimension as follows 6400(L)x 2400(w)x 2700(H), Maximum operating weight 5300kg. Maximum Power 380V/3/50Hz/310Kw

6.3 VRV units

The HVAC system will consist of outdoor units connected to multiple indoor units via refrigerant piping to provide cooling and heating to individual non-Patient zones. The outdoor units should modulate capacity based on the requirements of the individual zones, to enable saving energy by not always running at 100% capacity and improving occupant comfort by maintaining temperature as needed in each individual zone.

Outdoor unit

Heat recovery type: Simultaneous cooling and heating

Cooling capacity: 45Kw

Heating Capacity: 65Kw

Refrigerant: environmental friendly refrigerant

Indoor units

The units will be of the ceiling cassette type

Capacities: As per contract drawings.

Control: individual zone controlled through wall mounted hard wired controllers as per drawings

6.4 Controls

All theatre/ ICU units shall be provided with a remote temperature adjustment switch which shall be mounted in the control panel in the Nurses' Station. In addition, temperature indication shall be provided in the ICU and the panel in the Nurses' station. Humidity indication is required in the air conditioning unit panel only. Remote switching of the unit is to be done from the Nurses panel. The unit fans shall run continuously to ensure that the area is kept sterile. Details of the switch and indicator cut outs are to be provided to the panel manufacturer so these can be incorporated.

It is noted that after sales service and response to system failures is an important consideration when approving suppliers and full details of this as well as the equipment, must be submitted with any application for approval.

The capacities given are nominal capacities and have been corrected for altitude and design conditions. Where the supplier has units that differ from the rating by more than 5%, refer to the engineer for reference to the heat load calculations.

Condensate shall be run to the nearest drain in the ceiling void. It is noted that deep beams are present and drains will need to be run through cored holes together with the refrigeration pipework.

Condensate drains shall be uPVC with solvent welded fittings. Branch pipes shall be at least 28mm and mains 50mm diameter.

Tenderers attention is drawn to the specialised nature of the refrigeration system and the need for technicians to be trained in the system. This extends to the installation, commissioning and maintenance of the system all of which require skills of a high level.

Allowance shall be made in the pricing for any sound treatment to the fan to ensure that noise levels specified in this space are not exceeded.

The units shall incorporate phase failure and voltage measurement to shut down the machine should a phase reversal or failure event occur, or the supply voltage fluctuates by not more than 10% of the normal supply

The units shall incorporate a fire relay to shut down the plant in the event of a signal from the fire detection system. The signal shall be brought to the units by the fire detection contractor, and this shall be terminated in the panel by the air-conditioning contractor. The signal shall be 24VDC and shall be fail safe. In addition, a thermostat shall be provided in the extraction air unit which shall monitor the return air temperature and shut down the plants should the temperature of the return air stream exceed 45^{o}C

The equipment offered must be configured to fit in the plant space provided and any additional ducting required, over that indicate on the drawing, to suit the equipment offered must be included in the rate for the equipment.

Spares shall be provided at the end of the 12-month warranty period as follows:

- Matched sets of belts for each drive having these.
- A spare bearing for each size of bearing used in the installation.
- Pilot light bulb for each light.
- Complete set of filters.

6.5 Fire Shutdown Relay

The Electrical Sub-contractor will provide a fire shutdown relay in the distribution board to cut the power to the air conditioning units under fire alarm conditions. After the power cut the air conditioning units shall be re-started manually. This does not apply to UPS and Data Rooms etc. where the air conditioning units shall be re-started automatically.

6.6 Pipework

The drawings indicate positions where the A/C units are to be installed. No pipework shall be visible after installation of the A/C units. Pipework shall pass through walls behind the A/C units or where indicated into ceiling space above these units. It shall be the responsibility of the Mechanical Sub-contractor to ensure that the builder provides all necessary holes in the walls and floors and installs sleeves in the correct positions. Details are to be shown on the Builder's Work drawings.

The Mechanical Sub-contractor shall allow for ø 50 mm PVC main condensate drain piping and ø 20 mm PVC branch piping from all units to ground level complete with inspection eyes generally as shown. Supports shall be provided at a maximum spacing of 1.5 metre for ø 20 mm and 2 metres for ø 50 mm piping to prevent sagging. Condensate pipes shall be installed at a uniform fall of 1:100 minimum.
All drainage systems shall be pressure tested to ensure that no leaks occur. Where copper pipes are used these shall be insulated by means of 15 mm thick polyethylene foam, "Thermaflex" or other approved and vapour sealed to avoid condensation forming and dripping onto the ceilings.

Refrigerant piping shall be neatly supported on galvanized cable tray, or other approved support system and shall be separated from the power/control cables. These pipes shall be tagged at 5 meters maximum centres to facilitate identification. The cable tray/support system shall be suspended from the structure at 2 metre centres maximum, with suitable fixings/clamps and M8 minimum galvanized rods.

Where refrigerant and condensate pipes and cables serving high wall or under ceiling split units are exposed they shall be run in white PVC trunking on the wall.

6.7 Electrical Works

The Mechanical Sub-contractor shall be responsible for all the electrical work associated with the Air Conditioning System, including the control panel and wiring and connections between the control panel and the outdoor & indoor units and the remote control units.

6.7.1 Power Supply

The Electrical Sub-contractor will provide a 400/230-volt, 3 phase, 50 Hz, 4-wire power supply, plus earth up to the control panel located adjacent to the outdoor units as indicated on the drawings. The Electrical Sub-contractor will connect to the isolator and earth strip in the control panels.

6.7.2 Control Panel

The control panel shall be of the factory assembled surface mounted type constructed from galvanized mild steel sheet and finished with three layers of baked enamel.

The position of the control panel is shown on the drawing. The top of the panel shall be at approximately 2000 mm above floor level to facilitate access. Details shall be shown on the Builder's Work Drawings.

6.7.3 Local Isolators

A local isolator shall be provided at each indoor and outdoor unit to allow individual isolation and safety protection for maintenance of these units.

6.7.4 Wiring and Cables

Power cables shall be PVC SWA PVC cable and control wiring shall be in PVC insulated. Wiring sizes for each circuit shall relate to the circuit breaker rating and shall take into account the current regulations for each application.

A continuous bare copper earth wire of the same cross-sectional area as the phase conductor shall be installed with each circuit and terminated at the earth strip at the control panel or isolator as applicable. Alternatively one core of a multi-core PVC SWA PVC cable may be used for this purpose.

Wiring and cables from the control units to the equipment shall be run in galvanized conduit or where run on surface in galvanized trunking. Alternatively, where concealed, the wiring shall be neatly supported and strapped on a galvanized cable tray, separate from the refrigerant pipes and shall be neatly run in white PVC trunking. Where run extremely on surface they shall be neatly run in galvanized metal trunking.

7.0 DESIGN CONDITIONS

7.1 Site Conditions

Altitude	: 1200m above sea level
Summer Outside Design Temperature	: 35°C db 24°C wb
Summer Inside Design Temperature	: 21°C db 50%RH
Winter Outside Design Temperature	: 5°C
Winter Inside Design Temperature	: 21°C db 50%RH
Electricity Supply	: 380-volt, 3 Ph, 50 Hz, 4 wire
Lightning Conditions	: Severe

7.2 Internal Conditions

TEMPERATURE :

Ward areas : 22°C DB +/- 1,5 ° C

Normal Theatres/ICU 18°C DB +/- 0,5 ° C,

Humidity : 50% RH +/- 5%

Humidity control is required in the theatre units and must be controlled to 50% ±5%.

NOISE LEVELS

ICU/Theatre : NC 32

Wards : NC 35

Toilets and public areas : NC 38

No plant shall exceed the minimum ambient noise level measured at the boundary by more than 5dbA

Provision shall be made in the tender pricing for any and all sound attenuation in equipment and ductwork to ensure these noise levels are not exceeded. Make sure the equipment offered is designed to reduce the noise generated.

8.0 SCHEDULE OF EQUIPMENT

As detailed in BOQ

PART V

DETAILED SPECIFICATIONS
LIFTS

FOR THE INTENSIVE CARE UNIT ICU

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5.1 GENERAL

This section of the specification shall be read as an amplification of the previous sections with particular reference to the project being tendered upon. In all cases the installation standards detailed in the Standard technical Specifications shall be adhered to unless specifically mentioned to the contrary in this section.

5.1.1 Work Required:

1. The work required under this section consists of all labour, materials and services required for the complete installation (including operational verification) of all the equipment required for the Lift(s) as specified herein.

2. All work shall be performed in a first class, safe and workmanlike manner in accordance with internationally recognised quality standards.

3. In all cases where a device or part of the equipment is herein referred to in the singular, it is intended that such reference shall apply to as many of such devices or parts as are required to make complete installation.

5.1.2 Related work not specified herein:

The following named items are requirements that relate to the successful completion of the project that are performed by trades other than the lift manufacturer/installer.

1. Construction Facilities and Temporary Controls: protection of floor openings and personnel barriers; temporary power and lighting.
2. Earthwork: excavation for elevator pit.
3. Cast-In-Place Concrete: Lift pit, and elevator machine foundation.
4. Unit Masonry: masonry hoist way enclosure, building-in and grouting hoist way doorframes, and grouting of sills.
5. Supports for entrances, rails and hoisting hook at top of elevator machine room.
6. Cementitious Waterproofing: waterproofing of elevator pit.
7. Heating, Ventilating, and Air Conditioning: ventilation and temperature control of elevator equipment areas.
8. Electrical:
   a. Main disconnects for each elevator.
   b. Electrical power for elevator installation and testing.
   c. Disconnecting device to elevator equipment prior to activation of sprinkler system.
   d. The installation of dedicated GFCI receptacles in the pit and overhead (with Machine room-less).
   e. Lighting in controller area, machine area and pit.
   f. Wiring for telephone service to controller.
9. Emergency (Standby) Power Supply Systems: emergency generator for elevator operation.
10. Fire Alarm Systems: The installation of fire and smoke detectors at required locations and interconnecting devices; fire alarm signal lines to contacts in the machine room.
11. Telephone Systems: required emergency communications equipment.

5.1.3 Applicable Codes:

All Lifts supplied shall comply with applicable building codes and lift codes applicable to the Republic of South Africa , including but not limited to the following:

(a) The South African National Standard SANS 10142: Code of Practice for Electrical Installations as amended

(b) The Occupational Health and Safety Act as revised

(c) SANS1545, EN81 for Electric Lifts and Service Lifts as amended

(d) The Local Municipal Bye-Laws and regulations as well as the regulations of the Local Supply Authority

(e) National Building Regulations and Building Standards

(f) The Local Fire Regulations and Codes relevant to lifts

(g) The South African Regulations of the Post & Telecommunications as applicable

(h) The Standard Regulations of any Government Department or Public Service company where applicable.

(i) Building & Facilities Regulations, providing accessibility and usability for the Physically Handicapped

NOTE: It is expected that the Tenderer is familiar with the legislation and standards applicable to Lift Installations for South Africa.

5.2 DESCRIPTION OF PROJECT

This is an existing hospital located in the North West Region in Rustenburg. The building lies between Heystek Street, Nelson Mandela drive and Kloof Street. The Works consist of a refurbishing an existing building into a ICU Ward.

DESCRIPTION OF LIFT INSTALLATIONS

One new MRL Duplex Electric Traction Passenger/Stretcher Lift, will be installed to replace an existing old lift at the new building.

5.3 COMMENCEMENT OF INSTALLATION

Refer to Main contract Preliminaries

5.4 **SCOPE OF WORKS**

The following needs be achieved with the new installations:

- Power savings will be up to more than half of the current power consumption
- The new installations should contribute towards the green environment and less energy consumption.
- People With Disability-EN81 and Fire and Building Regulations

Lifts companies are to acquaint themselves with the sites i.e. storage area, hoarding and walkways, security etc. No claims will be entertained after the tender award based on the above.

5.5 **SCHEDULE OF DRAWINGS**

Drawings to be provided.

5.6 SYSTEM DESCRIPTION

TECHNICAL SPECIFICATION

No. & Type Of Lift	: One (1) MRL Passenger/ Bed Lift
Fire Rating	: 120minutes
Traction Machine Type	: Permanent Magnetic Gearless Traction Machine.
Capacity/Load	: 24 Persons 1600kg
Speed	: 1.0 m/sec
Control	: AC Variable Voltage Variable Frequency Control.
Floors/Openings	: 2:2 (in line).
Floor Served	: G & 1st
Travel	: +- 6000 TBC
Operation	: Simplex Full Collective.

CAR EQUIPMENT & ACCESSORIES

Car Internal Dimension	: 1800mm (W) x 2700mm (D) x2400mm (H) to accommodate most beds with staff and medical equipment.
Car Ceiling	: Indirect fluorescent lighting with suspension ceiling.
Ventilation	: Electric blower with slit vents.
Car Flooring	: Durable vinyl tiles
Car Sill	: Extruded aluminium.
Side Walls	: Hairline Stainless steel finish.
Rear Wall	: Hairline Stainless steel finish
Front Return & Car	: Hairline Stainless steel finish. Transom Panel

Handrail	: Hairline Stainless steel finishes at rear wall below the mirror.
Car Position Indicator	:Dot matrix display type incorporated into Car Operating Panel
Car Operating Panel (COP) with Braille.	: Round Micro Push Buttons with call accept lights
Alarm	: Siren and interphone provided.
Arrival Signal	: Arrival chime provided on top of car.
Car Door Operation	: Automatic AC VVVF door operator to close and open car and hoist way door.
Door Safety Device	: Full height sensor door safety device provided.

HALL EQUIPMENT

Architrave	: Splayed frames on all Floors
Sill Material	: Extruded aluminium
Landing Door	: All Floors
Door Opening	:Two (2) panels automatic centre opening sliding door in st/steel at least 1370mm (W) x 2100mm (H)
Landing Call Station	:Round Micro Push Buttons with call accept light build in Braille.
Hall Signalization	: Arrows, Gongs and Pos Indicator Build In Call Station Face Plate

SHAFT SIZE

Shaft size min	: 2400mm (W) x 2900mm (D)
Machine Room Location	: Located inside the shaft
Pit Depth	: 1600mm
Overhead	: 4400mm
Power Source	: Three (3) Phase and Neutral, AC 380V±5%, 50 Hz
Lighting	: Single Phase – AC 220 V, 50 Hz
Lighting in Hoist way	:Provided with cover within the hoist way one at every stop
Interphone System	: Three (3) stations provided.
Overload Device	: Buzzer with overload indicator.
Overload Non- Start	: Provided.

Fire Emergency Return	: Provided signal contacts operation and cabling to lift control panel to be provided by others).
Fireman Operation	: Provided
Fireman Switch	: Provided.
Emergency Power Operation	: Provided in accordance to local regulation (however, signal contacts, cabling and standby Generator of sufficient capacity to be provided by others).
Emergency Battery Unit	: Self contained emergency lighting
Car Fan / Light Shut Off	:Automatic switches off when no call is registered after a predetermined period of time.
Automatic Rescue Device	: Provided.
Voice Annunciator	: Provided.
Automatic Parking	: Provided
False Call / Anti Nuisance	: Provided. Cancellation
Continuity of Service	: Provided.
Phase Reversal / Failure	: Provided.
Independent /Attendant	: Provided. Service
Full Load By- Pass	: Provided.

5.6.2.7 Performance:

1. Car Speed: $\pm$ 3 % of contract speed under any loading condition or direction of travel.
2. Car Capacity: Safely lower, stop and hold up to 125% of rated load capacity.

5.6.2.8 Ride Quality:

- Vertical Vibration (maximum): 12 – 17 milli-g
- Horizontal Vibration (maximum): 10 – 15 milli-g •

Vertical Jerk (maximum): 1.4 $\pm$ 0.3 m/ sec^3

- Acceleration/Deceleration (maximum): 0.8 $\pm$ 0.13 m/ sec^2 •

In Car Noise: 50 – 55 dB(A)

- Stopping Accuracy: $\pm$ 5 mm
- Re-levelling Distance: $\pm$ 10 mm

5.6.2.9 Operation: Duplex Collective Operation

Utilizing a microprocessor-based controller, the operation shall be automatic by means of the car and hall buttons. In the absence of system activity, one car can be made to park at the pre-selected main landing. The other (free) car shall remain at the last landing served. Only one car shall respond to a hall call. If either car is removed from

service, the other car shall immediately answer all hall calls, as well as its own car calls.

5.6.2.10 Operating Features :

- Full Collective Operation
- Fan and Light Protection with Operating Switches.
- Independent Service.
- Smoke detection cut out by means of external detector
- Top of Car Inspection.
- Provision for external Intercom System
- MRO Manual Rescue Operation
- Load weighing Bypass

5.6.2.11 Operation Features

Automatic Standby Power Operation.

This operation shall return each car automatically to a designated landing when the system is initially switched to standby power. One or more cars are returned at a time. Preference is given to loaded cars over empty cars in order to reduce passenger wait times. A car must respond by beginning to move toward the designated landing within a pre-determined time. If a car does not respond, it is automatically placed in a "Not Available" mode while other car is moved. If a car was not returned to the designated landing on the first try, a second attempt is made. If the second attempt is not successful, the car will remain in a "Not Available" mode and can only be moved by manual means. Once each car has returned to the designated landing, the doors will remain open for a predetermined amount of time.

When all cars have successfully returned to the designated landing or have attempted to move twice, automatic selection of the car(s) to run on normal operation will occur.

If for any reason a car selected for normal operation under standby power is delayed for 60 seconds, the car will be placed in a "Not Available" mode and another car will be selected for normal operation based on the priorities listed above.

5.6.2.12 Door Control Features:

Door control to open doors automatically when car arrives at a landing in response to a normal hall or car call.

Elevator doors shall be provided with a reopening device that will stop and reopen the car door(s) and hoist way door(s) automatically should the door(s) become obstructed by an object or person.

A micro button fitted on the car operating panel shall override the closing function and re-open the door when pressed continually.

5.7 SUBMITTALS

5.7.1 Product Data: Submit manufacturer’s product data for each system proposed for use. Include the following:

- Signal and operating fixtures, operating panels and indicators.
- Cab design, dimensions and layout.
- Hoist way-door and frame details.
- Electrical characteristics and connection requirements.
- Expected heat dissipation of elevator equipment in control room space and machine space (BTU).
- Colour selection chart for Cab and Entrances.

5.7.2 Shop Drawings: Submit approval layout drawings. Include the following:

- Car, guide rails, buffers and other components in hoist way.
- Maximum rail bracket spacing.
- Maximum loads imposed on guide rails requiring load transfer to building structure.
- Clearances and travel of car.
- Clear inside hoist way and pit dimensions.
- Location and sizes of access doors, hoist way entrances and frames.

5.7.3 Operations and Maintenance Manuals: Provide manufacturer's standard operations and maintenance manual.

5.8 QUALITY ASSURANCE

5.8.1 Manufacturer: Lift manufacturer shall be ISO 9002 certified.

5.8.2 Installer: Lift shall be installed by the manufacturer.

5.8.3 Permits, Inspections and Certificates: The Lift Contractor shall obtain and pay for necessary Municipal or State Inspection and permit as required by the elevator inspection authority, and make such tests as are called for by the regulations or such authorities. These tests shall be made in the presence of such authorities or their authorized representatives.

5.9 DELIVERY, STORAGE AND HANDLING

5.9.1 Should the building or the site not be prepared to receive the lift equipment at the agreed upon date, the lift contractor will be responsible to store the equipment off the premises.

5.9.2 Neither the Client or the Main Contractor will be responsible for any equipment stored on or off site

5.9.3 The Lift Contractor will be shown by the Main Contractor, where the lift equipment can be stored on site.

5.9.4 The Lift Contractor shall at all times be responsible for his storage area and take the appropriate Actions to ensure that the equipment is safe and secure from damage and theft.

5.9.5 The Lift Contractor will at all times be responsible for ‘House Keeping’ within his storage area and Handling of Materials.

5.10 WARRANTY

5.10.1. The lift contractor’s acceptance is conditional on the understanding that their warranty covers defective material and workmanship. The guarantee period shall not extend longer than one (1) year from the date of completion or acceptance thereof by beneficial use, whichever is earlier, of each elevator. The guarantee excludes: ordinary wear and tear or improper use, vandalism, abuse, misuse, or neglect or any other causes beyond the control of the elevator contractor and this express warranty is in lieu of all other warranties, express or implied, including any warranty of merchantability or fitness for a particular purpose.

5.11 MAINTENANCE & SERVICE

5.11.1 Free Maintenance service consisting of regular examinations and adjustments of the elevator equipment shall be provided by the lift contractor for a period of Twelve (12)

months after the elevator has been turned over for the customer's use. This service shall not be subcontracted but shall be performed by the elevator contractor. All work shall be performed by competent employees during regular working hours of regular working days and shall include emergency 24-hour call back service. This service shall not cover adjustments, repairs or replacement of parts due to negligence, misuse, abuse or accidents caused by persons other than the elevator contractor. Only genuine parts and supplies as used in the manufacture and installation of the original equipment shall be provided.

5.11.2 A copy of the lift manufacturers recommended maintenance schedules and procedures will be required as a part of the hand over documentation together with the estimated annual cost of maintenance after the free service and guarantee period has expired.

5.11.3 The lift control system must:

Provide in the controller the necessary devices to run the elevator in inspection operation.
Provide on top of the car the necessary devices to run the elevator in inspection operation.
Provide in the controller an emergency stop switch. This emergency stop switch when opened disconnects power from the brake and prevents the motor from running.
Provide in the event of a power outage, means from the controller to electrically lift and control the lift brake to safely bring the lift to the nearest available landing.
Provide the means from the controller to reset the governor over speed switch and also trip the governor.
Provide the means from the controller to reset the emergency brake when set because of an unintended car movement or ascending car over speed.

5.11.4 Tenderers must furnish in their tender the address of their branch office from where maintenance service will be undertaken and from where emergency call-back service will be given.

5.12 BUILDING ALTERATIONS

Small building alterations will if agreed to be arranged by the Consulting Engineers. Tenderers must however clearly state in their tender and indicate on their drawings the extent of any building alterations which they may require so that these building alteration costs can be assessed when tenders are compared.

Building alterations, for which requests are submitted by the successful tenderer after he has been notified of the acceptance of his tender, will be arranged but the cost thereof will be for the Lift Subcontractor's account and his final account will be adjusted accordingly.

5.13 WORK ARRANGED BY THE BUILDER

5.13.1 The provision of temporary and permanent electrical supply in the lift shaft fed from a generator power supply and positioned adjacent to the lift Contract's main switches.

5.13.2 The provision of the shafts and lift pits.

5.14 SETTING OUT OF WORK

The Lift Contractor will be responsible for the correct setting out of any holes and hoisting hooks that may be required in the lift wells or floors.

The Lift Contractor must on appointment provide detailed shop drawings of shaft requirements and check during construction on the actual dimensions of the shafts and the lift shaft openings as early as practical, and every effort must be made to avoid cutting the concrete or making changes.

5.15 DAMAGE TO BUILDING

The Lift Contractor will be held responsible for any damage caused by him or his workmen to the building.

The builder will arrange for making good any such damage at the Lift Contractor's expense.

5.16 ELECTRICAL SUPPLY

The Electrical contractor shall provide, as part of his Contract, a power supply to the lift as well as a separate lighting and power in the lift shaft and pits.

Full details of the electrical requirements required are to be submitted with the tender.

5.17 DESIGN SPECIFICATIONS

Provide Machine Room-Less traction passenger lifts. The control system and car design based on materials and systems manufactured specifically for this type of lift that are based on a standard product range offered by the Tenderer.

Specifically, the system shall consist of the following components:

- An AC gearless machine using embedded permanent magnets mounted [Machine Room-Less] at the top of the hoist way.
- Polyurethane Coated Steel Belts or traction ropes for elevator hoisting purposes.
- Micro-processor control system
- VVVF closed loop motor drive and control

5.18 EQUIPMENT: CONTROL ROOM COMPONENTS

Controller: A microcomputer based control system shall be provided to perform all of the functions of safe elevator operation. The system shall also perform car and duplex or simplex operational control.

A micro-processor based control system will be provided to perform all the functions of safe elevator motion and elevator door control. This will include all of the hardware required to connect, transfer and interrupt power, and protect the motor against overloading.

A micro-processor controlled solid-state converter will be provided to apply variable voltage variable frequency to the elevator motor. The converter will during the acceleration and retardation periods, gradually change the voltage applied to the elevator motor without interruption of power to the motor.

- All high voltage contact points inside the controller cabinet shall be protected from accidental contact in a situation where the controller doors are open.
- Controller shall be separated into two distinct halves; Motor Drive side and Control side. High voltage motor power conductors shall be routed so as to be physically segregated from the rest of the controller.
- Field conductor terminations points shall be segregated; high voltage (>30 volts DC and 110 VAC,) and low voltage (< 30 volts DC)
- Controllers shall be designed and tested for Electromagnetic Interference (EMI) immunity according to the EN 12016 (May 1998):

Drive: A Variable Voltage Variable Frequency AC drive system shall be provided.

5.19 **EQUIPMENT: MACHINE, GOVERNOR & SAFETY DEVICES and TERMINAL BUFFERS**

5.19.1 Machine:

AC gearless machine, with a synchronous permanent-magnet motor, dual solenoid service and emergency disc brakes, mounted at the top of the hoist way and so designed so as to capable of withstanding the loads as indicated by the manufacturer.

5.19.2 Governor & Car Safeties: The governor shall be a tension type governor.

The car safety will be provided to stop the car when excessive descending speed is attained. The safety will be operated by a centrifugal speed governor located at the top of the hoist-way and connected to the governor the through a continuous steel rope. A switch will cut off the power to the motor and apply the brake prior to application of the safety.

5.19.3 The car frame, which supports the car platform and enclosure, will be of structural steel and equipped with guides and manufacturer's car safety device mounted on the car platform.

5.19.4 Buffers, Car and Counterweight: Compression spring type buffers shall be used.

5.20 **HOSTWAY**

5.20.1 Hoist way Operating Devices:
1. Emergency stop switch in the pit
2. Terminal stopping switches.

5.20.2 Positioning System: Consists of an encoder, reader box, and door zone vanes.

5.20.3 Guide Rails and Attachments: Guide rails shall be Tee-section steel rails with brackets and fasteners. Side counterweight arrangements shall have a dual-purpose bracket that combines both counterweight guide rails, and one of the car guides rails to building fastening.

5.20.4 Traction Hoist ropes or Coated Steel Belts: Polyurethane coated belts with high-tensile-grade, zinc-plated steel cords.

5.20.5 Governor Rope: Governor rope shall be steel and shall consist of at least eight strands wound about a sisal core centre.

5.20.6 Fascia: Galvanized sheet steel shall be provided at the front of the hoist way.

5.20.7 Hoist way Entrances:

1. Frames: Entrance frames shall be of bolted construction for complete one-piece unit assembly. All frames shall be securely fastened to fixing angles mounted in the hoist way and shall be of UL fire rated steel.

2. Sills shall be extruded aluminium

3. Doors: Options for the entrance doors shall be as stipulated in each system description above for each lift.

4. Fire Rating: Entrance and doors shall be UL fire rated for 1-1/2 hour.

5. Entrance Finish: The options for the entrance finishes are indicated above.

6. Note: Tenderer shall provide price for wrap around entrance frames as an option.

7. Sight Guards: Sight guards will be furnished with any metal finish door. Powder-

coated or stainless steel matching sight guards will be furnished to match the doors.

5.21 **EQUIPMENT: CAR COMPONENTS**

5.21.1 Car frame and Safety: A car frame fabricated from formed or structural steel members shall be provided with adequate bracing to support the platform and car enclosures. The car safety shall be integral to the car frame and shall be of a flexible guide clamp type.

5.21.2 Car Cab: The car cab finishes shall be a stated above with options and brochures to be provided.

5.21.3 Car Front Finish: Options to be provided as requested above

5.21.4 Car Door Finish: options as stipulated to be provided.

5.21.5 Car Top: With reference to the option for glass car finishes, the Tenderer is to provide layout of car top for architectural purposes to fit in with the general build architecture.

5.21.6 Ceiling Type: Tenderer to provide brochure with options available in their product range.

5.21.7 Emergency Car Lighting: Is not required as this lift will be on a separate generator supply.

5.21.8 Emergency Pulsating Siren: Siren mounted on top of the car that is activated when the Alarm button in the car operating panel is engaged. Siren shall have a rated sound pressure level of 80 dB(A) at a distance of 3.0 m from the device. Siren shall respond with a delay of not more than 1 second after the switch or push button has been pressed.

5.21.9 Fan: A 220 VAC fan will be mounted to the structural ceiling to facilitate in-car air circulation, meeting code requirements. The fan is to produces airflow rates of 5.8 and 7.4 m^3/min on low and high setting respectively. The fan shall be rubber mounted to prevent the transmission of structural vibration and will include a baffle to diffuse audible noise. A switch shall be provided in the car-operating panel to control the fan.

5.21.10 Handrail: Handrails shall be provided on the side walls and rear wall of the car enclosure. Handrails shall be round (40mm) diameter extruded aluminium handrail with a satin stainless-steel finish. Handrail ends are to be capped with hemi-sphere shaped end-caps having the same finish and material as the handrail.

5.21.11 Threshold: aluminium

5.21.12 Guides Shoes: Rubber roller guides or sliding shoes shall be mounted on the top and the bottom of the car and counterweight. Car roller guides shall be at least (76mm) at the top of the car, and similar at the bottom. The counterweight roller guides shall be (76mm) at the top and the bottom.

5.21.13 Platform: The car platform shall be constructed of at least 2 layers of plywood and 2 layers of 81mm thick aluminium laminate for a total thickness of 38mm. Load weighing device is a requirement in this contract.

5.21.14 Certificate frame: Manufacturers name plate and lift details are to be part of the COP panel.

5.22.14 A recessed receptacle to house an emergency oxygen bottle shall be provided at the rear of the lift car. The exact size shall be provided prior to ordering. The receptacle shall not be an on-site retrofit but shall be delivered from the factory installed.

5.22.15 A recessed receptacle to house a telephone shall be provided next to the car operating panel. As per 5.22.14 above, receptacle shall not be an on-site retrofit.

5.22 **EQUIPMENT: SIGNAL DEVICES AND FIXTURES DETAILS**

5.22.1 Car Operating Panel: A flush car operating panel shall be provided which contains all push buttons, key switches, and message indicators for elevator operation. The car operating panel shall have a stainless-steel finish to match the wall panels.

- Applied car operating panel shall be furnished. It shall contain a bank of round metal mechanical illuminated buttons. Flush mounted to the panel and marked to correspond to the landings served, an emergency call button, door open and door close buttons, and switches for lights, inspection and the exhaust fan. The emergency call button shall be connected to a bell that serves as an emergency signal. All buttons to have raised numerals and Braille markings. Red LED halo illumination with Flat Flush targets. Target finishes: satin stainless steel.

The car operating panel shall be equipped with the following features:
Standard:

- Raised markings and Braille shall be provided to the left-hand side of each push-button.
- Car Position Indicator at the top of and integral to the car operating panel.
- Door open and door close buttons.
- Light key-switch.
- Fan key-switch.
- Independent Operation key-switch.
- Elevator Data Plate marked with elevator capacity and car number.
- Illuminated alarm button with raised markings.

Hall Fixtures:

- Hall fixtures shall be provided with necessary push buttons and key switches for elevator operation.
- Hall fixtures shall feature round mechanical buttons marked to correspond to the landings, in raised fixture housings.
- Buttons shall be flat flush in vertically mounted fixture. Hall Lanterns and Position indicators shall be illuminated by means of LED.
- Fixture shall be satin stainless-steel finish.

Car Direction Lantern:

A directional lantern shall be provided in the car COP.

And

Hall Lanterns and Chime:

A directional lantern visible from the corridor shall be provided at each hall entrance. When the car stops and the doors are opening, the lantern shall indicate the direction in which the car is to travel and a chime will sound.

Hall Position Indicator is to be centred above the entrance.

Combination Hall Position Indicator and Hall Lantern at each floor entrance will be permitted.

5.23 **GUIDE RAILS**

"Steel T" guide rails for the car and counterweight with all necessary steel brackets for attaching the guide rails to the hoist-way, fitted with sliding guide clips for both Car & Counterweight with at least two brackets per guide length. Hollow guide shall only be accepted on the counterweight and not for speeds above 1m/s.

5.24 **CAT LADDER**

A cat ladder extending from the bottom floor served to the pit bottom and shall be provided by the lift contractor in each lift shaft. If this ladder is removable, a cut-out protection switch shall be fitted that will disconnect the control for the main drive motor and prevent the lift from moving until the ladder is replaced in its fixing position.

5.25 **SHEAVES**

Should main, counterweight or deflector sheaves be required, they will be grooved for correct number of hoist ropes. The sheaves will be provided with steel shafts mounted in the roller bearings with provision for rope retainers to prevent the ropes from jumping off the sheave in the event of slack rope.

5.26 **BRAKE**

The brake will be spring applied and electrically released and designed to hold the car under the variable loads. A brake release mechanism shall be provided on the top floor for emergency release operation. The brake arrangement shall be such that should there be a failure of any sheave drive machinery; the brake must be positioned to hold the car stationary in the event of this machinery breaking. If this cannot be achieved then a rope clamp safety must be provided.

5.27 **AUTOMATIC SELF-LEVELLING**

The elevator will be provided with automatic self-levelling that will bring the elevator car level with the floor landings +/- 3 mm regardless of load or direction of travel.

5.28 **TERMINAL AND FINAL LIMITS**

Terminal limit switches will slow down and stop the car automatically at the terminal landings and final limit switches to cut off the power and apply the brake automatically should the car travel beyond the terminal landings. Terminal limits shall comply with latest revision of standards applicable to these lifts.

5.29 **OPERATION – FULL COLLECTIVE**

The car shall not be started unless the car door is in the closed position and all hoist-way doors are locked in the closed position.

Operation shall be automatic by means of the car and landing buttons. Calls registered by the momentary actuation of the car or landing buttons shall cause the car to stop in the order in which the landings are reached in each direction of travel. All stops shall be subject to respective car or landing buttons being actuated sufficiently in advance of the arrival of the at that landing to enable the stop to be made. The direction of travel for the idle car shall be established by the first car or landing button actuated.

"Up" landing calls shall be answered while the car is traveling up, and "down" landing calls shall be answered while the car is traveling down. The car shall reverse after the uppermost or lowermost car or landing call has been answered, and proceeds to answer car calls and landing calls registered in the opposite direction of travel.

If the car without registered car calls arrives at a floor where both up and down hall calls are registered, it shall initially respond to the hall call in the direction that the car was traveling. If no car call or hall call is registered for further travel in that direction, the direction lanterns, if furnished, will indicate the changed direction when the car call is registered.

A time-limit relay will hold the car for a few seconds at the landings at which stops are made to enable passengers to enter or leave the car. Pressure of a car button from another landing before this time elapses will cause the car to start, provided the car door and hoist-way doors are closed. When the car has answered the farthest call, this interval will permit a car button call to be registered to establish the direction of car travel, even if other calls are registered.

5.30 COUNTERBALANCE

A structural steel frame counterbalance to be provided with sufficient, "calculated number", of filler weights, according to the duty load of the lift.

5.31 ELECTRIC DOOR OPERATOR FOR CAR AND HOSTWAY DOORS

An electrical door operator, for opening and closing, the car and hoist-way doors.

The equipment will consist of a door operator on the lift car, operating the car door when the car is stopping at a landing. The car and hoist-way doors will be mechanically connected and will move simultaneously in opening and closing.

The car and hoist-way door will be power opened and power closed and will be checked in opening and closing with a controlling mechanism.

The hoist-way door will be provided with an interlock which will present movement of the car away from the landing until the door is locked in the closed position.

An electric contact for the car door will be provided which will prevent car movement away from the landing unless the door is in the closed position.

Switches will be provided in the lift machine room to control the operation of the doors.

The car and hoist-way doors will open automatically as the car is stopping at a landing. The doors can be stopped and reversed during their closing motion.

Should the main power supply fail, the door operator is so designed that the door can be manually opened from within the car.

The landing doors shall be fitted with a mechanical weighted arrangement that shall ensure that the landing doors close with sufficient force to latch the doors closed freely when not coupled to the car operator. In the event of air cord breakage, a mean must be provided of ensuring that the lift does not move away from the floor, i.e. both door panels must at all times be closed properly before the lift shall be permitted to move.

5.32 LOAD WEIGHING DEVICE

A load weighing device shall be fitted which will prevent the automatic doors from closing when the lift duty load is exceeded.

5.33 CAR PLATFORM

The platform will consist of a structural steel frame covered with suitable floor covering. The platform will rest on rubber pads which are supported on an auxiliary steel frame fastened to the car frame.

5.34 **LIGHT FIXTURE**

A decorative light fixture will be furnished in the car connected to 220volt supply outlets provided by the purchaser, located in the shaft. The lift lighting will be supplied from the buildings emergency power generator supply.

5.35 **FASCIA PLATES:**

Steel fascia plates and hanger covers will extend the full width of jamb opening plus the width of the jamb flanges and from frame headers to the nosings of the sills above. The fascias cover plates and jamb flanges provide a continuous steel hoist-way lining.

5.36 **E P O: EMERGENCY POWER OPERATION**

In case of regular power supply shutdown this feature is to provide the following operations,

- The standby generator shall continue to operate the lift.
- The return to full normal operation is done automatically when regular power supply is re-established.

5.37 **E F O: EMERGENCY FIREMEN'S OPERATION / E F S: FIREMEN SERVICE**

EFO and EFS are similar operations used in case of fire. In both cases the car is called to a specific floor (Firemen Floor).

- In case where EFO is specified the car will ONLY be called to that floor and then stay idle.
- In case where EFS is specified the car can be put at full disposal of the Fire Department.

The Firemen operation or service is initiated by a switch and a double knock fire detection condition automatically (depending on local code regulations). Each unit specified with EFO and/or EFS has its own switch.

RETURN OF THE CAR TO THE FIREMEN FLOOR:

In both cases, EFO and EFS, this operation is the same and operates as follows:

Operation of the special switch, the respective car will:

- Travel non-stop to the Firemen floor if it has been traveling towards this floor.
- Stop at the nearest floor, reverse without opening its door, and start non-stop towards the Firemen floor if it has been traveling away from that floor.
- Close its door immediately if the doors are completely opened. If the doors have started to open, they open completely and then re-close. The elevator then travels non-stop to the Firemen floor.
- From the moment the emergency operation has been initiated, the car hall calls, the emergency stop button, the door opening button, the detector, safety show and light ray become inoperative.
- The Firemen operation has priority over all other operations except for: - Top of car inspection (TOC)

- Side emergency exit operation (SEE)
- Electrical recall operation (ERO)
- Fireproof doors (FPD)

- With EFS upon arrival the car opens its doors and is switched to independent service.

Use of the car by the Fire Department (EFS) – is switched manually in the car(s) to be used by the Fire Department.

RETURN TO NORMAL OPERATION:

The car will be permitted to return to normal operation only when it is at the Firemen floor and the Firemen switch is switched back to "NORMAL" operation.

5.38 **WIRING**

The installation will be wired throughout using suitable cable run in approved ducting and wire ways where necessary. Interconnections between the ducting and the devices will be plastic sheathed cable.
Contractors will at all time abide by applicable wiring regulations.
Note that under no circumstances will cab tire which is not run in approved wire ways be accepted.

All surface cables must be terminated with cable glands.

5.39 **Tools**

Lift contractor to detail and describe tools which will be provided.

5.40 **Spare Parts**

Lift contractor to schedule spare parts provided with lift installation.

5.41 **Shaft Size**

Is the size and location of the shaft accepted by the lift contractor?

5.42 **Builder's Work**

Lift contractor to state the Builder's Work required to be undertaken by the builder as required to be carried out.

5.43 **SCHEDULE OF DEVIATIONS**

Alterations by Tenderer

State any deviations from the specification:

If none state NIL _____

Signature of Tenderer: _____

Name of Tenderer: _____

Address of Tenderer: _____

_____

_____

_____

Official Stamp: Date: _____

5.44 **SPECIALIST FIRM OF CONTRACTORS**

5.44.1 Lifts Installation

The contractor shall state herein the name of the lift contractor who will be executing the installation as specified:

5.44.1.1 Name of Contractor: _____

Address: _____

_____

_____

5.45.1.2 Registered Offices: _____

_____

_____

Telephone Number: _____

5.45.1.3 Tender Board Grading: _____

5.46 **PREVIOUS PROJECTS UNDERTAKEN**

5.46.1 Summary if Previous Projects Undertaken

Names of at least two projects undertaken previously by your firm in Johannesburg, together with names and addresses of the clients and of the consulting engineers to whom reference may be made regarding your firm. The projects names must be of similar nature to the project included in this document.

5.46.1.1 Project 1

Name of Project: _____

Place: _____

Name of Client/Consultant: _____

Address: _____

_____

_____

Telephone: _____

Size of Project: _____

Contract Value: _____

5.46.1.2 Project 2

Name of Project: _____

Place: _____

Name of Client/Consultant: _____

Address: _____

_____

_____

Telephone: _____

Size of Project: _____

Contract Value: _____

PART V

DETAILED SPECIFICATION

FOR THE ICU

MEDICAL GAS INSTALLATION

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5.2 SCOPE OF WORK

5.2.1 The Subcontract, as detailed in these specification documents and the accompanying drawings, comprises the manufacture, supply, transport and delivery to site, offloading, hoisting, installation, testing, setting into operation, leaving in complete working order, guarantee and the maintenance of the entire Medical Gas plant and the provision of all labour, materials, Subcontractor's equipment and everything, whether of a temporary or permanent nature required in and for such manufacture, supply, transport and delivery to site, offloading, hoisting, installation, testing, setting into operation, leaving in complete working order, guarantee and maintenance, so far as the necessity for providing the same is specified in or reasonably to be inferred from the contract. This should be read in conjunction with the **Standard Quality Specification for Medical Gas and Vacuum Installations**.

5.2.2 No building work shall be included in the subcontract and all such work, as later herein specified as being specifically excluded from this contract, shall be carried out by others in accordance with the drawings and details provided by the Engineer or the contractor as applicable and approved.

5.3 PROGRAMME

5.3.1 The programme for the works shall be agreed with the Principal Contractor.

5.3.2 The entire installation is to be complete commissioned, tested and taken over by the Engineers before the completion date. The price is to include for all overtime and weekend work required to meet the programme dates.

5.3.3 The Subcontractor shall be required immediately after acceptance of his tender to liase with the main contractor to develop the programme of his works and to draw up the programme.

5.3.4 Such programme shall show the times for the preparation of drawings, ordering and delivery times promised by the suppliers for each major item of plant, manufactured items, installation times and the programmed dates for testing and commissioning the plant.

5.4 DRAWINGS

5.4.1 Tender Drawings

The drawings accompanying this specification, as numbered below, shall be deemed to indicate the general layout and requirements only and are not shop drawings.

The Engineer shall provide the Subcontractor, free of charge, with three sets of specification documents, to include all tender drawings.

5.4.2 Architectural and Structural Drawings

The Subcontractor shall ensure that he is in possession of all information required for the installation of the Works and shall, if necessary, obtain copies of all relevant drawings from the Client.

5.4.3 Builder's Work Drawings

All Builder's work and work to be carried out by others in accordance with the specification to be provided by the sub contractor. The Subcontractor shall provide such drawings as may be necessary to suit the plant offered by him, and accepted by the

Engineer, and shall submit to the Engineer in duplicate any revisions which shall be made to such drawings.

Such builder's work drawings shall indicate the location and extent of all foundations, bases, openings, timber frames and all other builder's work and the capacities and/or dimensions of all electrical and water supply points, the method of terminating such supplies and the position of the connection points, the position and dimensions for all water drainage connections and any other work to be provided by others for the works, as detailed in these specifications.

The drawings shall be drawn to scale and in sufficient detail to enable the Contractor to execute the work without any misunderstanding.

Within a reasonable period after receiving such drawings, the Engineer shall signify his approval, or otherwise, and one signed copy o each approved drawing shall be returned to the Subcontractor.

When approved, the following number of copies of each such drawing shall be delivered to the following:

Architect:	1 Paper Print
Consulting Engineer:	2 Paper Prints + AutoCAD disk
Contractor:	3 Paper Prints

5.4.4 **Shop Drawings**

The Subcontractor shall submit to the Engineer, for approval, duplicate copies of all shop drawings as required for the manufacture and installation of the works or as the Engineer may reasonably require.

All shop drawings for work outside of plant rooms shall be drawn to a scale of not smaller than one in fifty and all drawings of work within plant rooms shall be drawn to a scale of not smaller than one in twenty-five. All details shall be drawn to a scale to show the detail required.

Within a reasonable period after receiving such drawings, the Engineer shall signify his approval, or otherwise, in writing and one signed copy of each approved drawing shall be returned to the Subcontractor.

The Subcontractor shall not, unless otherwise directed by the Engineer, in writing, commence with any work prior to the approval of the relative shop drawings. Work installed prior to the approval of shop drawings shall be liable to rejection by the Engineer and removal and/or replacement by the Subcontractor, at his cost, if it is considered by the Engineer to deviate from the Specification.

The Subcontractor shall also supply additional copies of all approved drawings in accordance with the requirements of Clause 4.46 of Part IV (Operating and Maintenance Instructions) of the Specifications.

Drawings approved as above described shall not be departed from except as authorised by the Engineer.

The Engineer shall have the right at all reasonable times, to inspect at the factory of the Contractor, all drawings of any portion of the Works.

5.4.5 Mistakes in Drawings

Any expense resulting from an error or omission in or from delay in delivery of the shop drawings, shall be borne by the Subcontractor.

The Subcontractor shall be responsible for any discrepancies, errors or omissions in the drawings and other particulars supplied by him whether such drawings and particulars have been approved by the Engineer or not, provided that such discrepancies, errors or omissions are not due to inaccurate information or particulars furnished in writing to the Subcontractor by the Engineer or Architect. The Employer shall be responsible for drawings and information supplied in writing by the Engineer or Architect and for the details of special work specified by either of them.

5.4.6 Schedule of Drawings

Drawing Nº	Description
MM 1105/001 – 405	ICU Ward – Medical Gas First Floor
MM 1105/001 – 406	ICU Ward – Medical Gas Ground Floor

5.5 GENERAL DESCRIPTION OF WORK

This is an existing hospital located in the North West Region in Rustenburg. The building lies between Heystek Street, Nelson Mandela drive and Kloof Street. The Works consist of a refurbishing an existing building into an ICU Ward.

5.6 MEDICAL OXYGEN INSTALLATION

5.6.1 Plant Room

Supply to the ICU shall be from an existing Medical gases plant

A bank of two cylinders shall be provided for duty and a further bank of two cylinders shall be provided for changeover. An automatic shuttle assembly with manual bypass shall be provided between the cylinder banks. Racking for spare cylinders shall also be provided. The complete oxygen manifold and automatic shuttle assembly shall be manufactured off site by a reputable company. (e.g. Crubia Engineering)

5.6.2 Distribution Pipe work

From the plant room medical oxygen shall be piped to the areas as indicated on the drawings

5.6.3 Zone Shut off Valves

Isolation valves for oxygen supply shall be provided to isolate the various areas as indicated on the drawings.

Termination for extensions shall be valved and plugged.

5.7 MEDICAL VACUUM INSTALLATION

5.7.1 Plant Room

The ICU medical vacuum shall be from an existing plant provided in accordance with SABS 0224

5.7.2 Distribution Pipe work

Vacuum shall be distributed to the various areas as indicated on the drawings.

5.7.3 Zone Shut off Valves

Isolation valves for medical vacuum shall be provided on vacuum bottle traps
Termination for extensions shall be valved and plugged.

5.8 MEDICAL COMPRESSED AIR INSTALLATIONS

5.8.1 Plant Room

The medical compressed air plant for the ICU Ward shall be provided from existing medical gas plant in accordance with SABS 0224

.

5.8.2 Distribution Pipe work

From the plant room low pressure medical compressed air shall be piped to outlets as indicated on the drawings

5.8.3 Zone Shut off Valves

Zone shut off valves for low pressure shall be provided for each high care ward.

The location of the zone shut off valves shall be as indicated on the drawings.

High pressure air shall be delivered to the Theatres from where it shall be reduced to provide the low pressure air to the outlets.

5.9 VALVE BOXES

All valve boxes shall be suprack type with solid hinged doors. Overall height shall be 340mm over wall flange, 240mm high door and 210mm high clear opening. The flanged cover and door shall be in G.M.S. with white powder coated epoxy finish. The back box shall be in hot dipped galvanised mild steel for building into brickwork.

The width of the valve box shall allow sufficient space for the number of zone shut off valves installed. A sample of the recessed valve box shall be delivered to site for approval.

5.10 VACUUM TRAPS

Each medical vacuum trap shall comprise of removable 4.5ℓ glass bottle (clamped for ease of withdrawal) and provided with a multi-port valve or according to drawing no. MM 1105/000 - 401. A sample trap shall be submitted to site for approval.

5.11 ALARM PANELS

One master alarm panel shall be provided in the gas cylinder storage room. One slave panel shall be provided at the nurse call station/s.
The following will be monitored:

O_2 Manifold	Left bank	normal/fail
	Right bank	normal/fail
N_2O Manifold	Left bank	normal/fail
	Right bank	normal/fail
Vacuum Plant		normal/fail
Compressed Air Plant		normal/fail

The complete wiring and conduiting for the medical gases installations shall be carried out by the medical gas contractor.

5.12 MEDICAL GAS OUTLETS

Medical gas outlets shall be Heyer type provided to SABS 0224, HTM 22 and SABS 1409.

Outlets shall be cleaned, degreased and delivered to site in individual sealed plastic bags.

The quantity of medical gas outlets is as per Bill of Quantities.

The medical gas points shall be supplied and fitted into Bedhead Trunking Units by the sub contractor.

5.13 BUILDERS WORK ITEMS

The following work shall be carried out free of charge to the Medical Gasses Contractor.

- Provision of openings in walls, floors and roof during initial building construction only.
- The casting and forming of plinths or upstands required for the mounting of items of plant i.e. compressors and vacuum pumps.
- Self-cleaning waterproof floors below plant where required.
- Building in of pipe sleeves and steel frames (provided by the medical gas sub-contractor) for the passage of pipes.
- Building in of medical gas isolation valves boxes (provided by the medical gas sub-contractor).
- Painting of walls and ceiling in the plant rooms.

5.14 ELECTRICAL CONTRACTORS ITEMS

The following work shall be carried out free of charge to the medical gases contractor:

- Supply of the required 3 phase 380V 50Hz electrical supplies to the control panels for the vacuum pumps and air compressors in the plant room.
- Supply of the required 3 phase 380V 50Hz electrical supplied to isolators adjacent to the control panel of the following equipment:

a) Oxygen manifold room
b) Main control panel.

All electrical supplies to medical gas isolators to be on emergency standby power.

5.15 FACILITIES PROVIDED TO THE MEDICAL GASES CONTRACTOR

An area on site for storage and site office.
The use of mess rooms, latrines, health and welfare facilities where so provided.
Use of scaffolding free of charge where such scaffolding can be used by the main contractor and other sub-contractors.
Provision of all power, fuel and water required for installation and testing.

5.19 CO-ORDINATION WITH THE STRUCTURE AND LIASION WITH OTHER SERVICES CONTRACTORS

The contractor shall ensure that all openings and sleeves required through the structure are provided for the internal medical gas installation. Where the location of equipment or fixture outlets or connections are in conflict with structural elements the contractor shall be responsible for the co-ordination and liaison with the engineer and the architect to ensure that conflicts are resolved in the most acceptable manner to the architects and structural engineers' requirements.

The contractor shall be mindful of all elements of the services and structural design from the time his initial involvement with the project and services drawings and architects drawing shall be examined from any possible conflicts.

The entire installation shall be carried out by the contractor bearing in mind the relationship between his work and the work to be carried out by other services subcontractors. Generally, drainage services and air conditioning duct routing shall take precedent over the other mechanical services with regard to co-ordination in the vertical plane.

Where pipe work may be run on common gang hangers the services shall be co-ordinated to avoid duplication of fixings. The contractor shall be responsible for liaison with all other services contractors to ensure that conflicts and misunderstandings are avoided and brought to the attention of the engineer immediately and in time to avoid interference with the programme of the works.

5.20 BUILDING EXPANSION JOINTS

Piping shall not pass through building expansion joints or at points subject to settlement unless proper pipe expansion joints have been provided.

5.21 HANGERS AND SUPPORTS

All hangers and supports shall be hot dipped galvanised and to BS.3974 and shall be manufactured by "Mupro", "O" line, "Unistrut" or "Flamco" or approved equal. All pipe clamps shall be "Mupro" rubber lined.

Fixings to the underside of post tension concrete slabs shall be carried out in locations to avoid the steel tension cables in the slab. The contractor shall obtain the approval of the main building contractor before fixings in each area are carried out.

5.22 MEDICAL GAS MATERIAL

All droppers and underground piping must be medical grade annealed copper piping according to SABS 1453. All other piping must be medical grade hard tempered copper piping, supplied in straight lengths, and must comply with SABS 1453. Branch off piping may be in the " half-hard" condition to facilitate the bending.

5.22.1 PIPES AND FITTINGS

The sizes for main runs and branch lines are indicated on the main drawings. Droppers may be no less than 10mm for pressurised medical gases and 12mm for vacuum. No horizontal supplies to vacuum droppers may be less than 15mm.

5.22.2 PIPE SLEEVES

Pipes running through walls and floor slabs shall be provided with split PVC sleeves. The diameter of each sleeve shall be provided to suit the pipe size. Oversized sleeves shall be rejected. Spaces between pips and sleeves shall be packed with approved rope and sealed where required.

In certain cases the provision of thermaflex insulation over final pipe finish may be permitted by the engineer in lieu of a sleeve.

5.23 NOISE

The noise level in and hospital rooms shall be NC35 maximum. The air compressors and vacuum pumps shall be enclosed in the manufacturers or the manufacturer's recommended attenuation housing

The sub-contractor shall allow all costs for achieving the required NC rating.

5.24 GUARANTEE

The medical contractor shall guarantee the materials apparatus and workmanship of his installation for a period of 12 months. The guarantee must be valid for a period starting on the date of handover by the medical gas contractor of the complete installation to the owner and is accepted by the engineer as complete and in working order.

The contractor shall cede to the proprietor the remainder of any equipment guarantees which he received from his suppliers and which extends beyond the periods of guarantee stated herein.

5.25 MAINTENANCE FOR THE MEDICAL GASSES INSTALLATION

5.25.1 General

The contractor shall be responsible for carrying out four full maintenance services on the medical gases' installation after handover and acceptance of the installation.

The contractor shall prepare a detailed inspection service report sheet showing the functions to be carried out and the intervals between such functions to enable records of servicing to be maintained.

This sheet shall have spaces for signature of both the contractor's serviceman and the hospital to verify that maintenance duties have been carried out.

The service is to be undertaken in the presence of a representative of the client hospital staff.

5.25.2 Call Outs

During the maintenance period of 12 months, the contractor shall respond immediately to Client or tenants requests for emergency service. All repair work required is to be carried out by contractor without delay.

5.25.3 End of Maintenance Period

At the end of the maintenance period the contractor shall provide the engineer with signed record copies of the maintenance inspection. The contractor shall also provide to the engineer confirmation form the client that the entire installation is in proper working order on the last day of maintenance.

5.26 TESTING

The medical gas contractor, after the complete installation and testing of the medical gas plant, pipeworks and outlet points, shall together with the designated hospital representative and engineer, test all vacuum, oxygen and low-pressure air outlet points. A Medical Gas Certificate shall be issued to certify the installation for every individual outlet in every unit / room / ward in the Hospital.

5.26.1 PIPING AND MEDICAL GAS OUTLET POINTS

Carry out all tests in accordance with SABS 0224. Test all piping to 1050kPa. There must be no pressure within 24hours after connecting the test equipment for the gas and compressed air installations.

Provide a chart recording for each gas tested. Make use of a 24-hour pressure drop recorder.

Confirm the gas type at each outlet by using an oxygen analyser to distinguish different gases.

5.26.2 MANIFOLD TEST

Bring both sides of the manifold to full operating pressure with only the low-pressure outlet valves closed and all gas bottles connected. Close all cylinder valves tightly. There must be no drop in pressure indicated on the high-pressure gauge after a period of 24 hours.

5.27 OPERATION

The medical gas service / part or whole of the installation shall not be put to operation without a Medical Gas Certificate issued by the contractor and duly signed by authorised hospital personnel and issued to the consultants and architects.

5.28 SCHEDULE OF RATES FOR VARIATIONS

A schedule of rates for all medical gases, material and labour shall be agreed with the engineer before the contract is awarded.

The priced Bill of Quantities shall be used as the basis for the schedule of rates to be agreed with the engineer.

5.29 **SCHEDULE OF INFORMATION**

Tenderer is to submit details of equipment offered. Acceptance of the tender does not imply acceptance of the equipment offered which shall be supplied in full compliance of the specification.

5.29.1 AIR COMPRESSORS

Manufacturer _____

Model _____

Type _____

Capacity each _____

kW Rating _____

O/A Dimensions _____

DB Rating _____

DB Rating after attenuation housing _____

Country of Origin _____

5.29.2 AIR DRYERS

Manufacturer _____

Model _____

Type _____

Capacity _____

kW Rating _____

O/A Dimensions _____

Country of Origin _____

5.29.3 PRE-FILTERS 1 MICRON

Manufacturer _____

Model _____

Type _____

Capacity _____

Nominal Parameter _____

O/A Dimensions _____

Country of Origin _____

5.29.4 COALESCING FILTERS 0.003 MICRON

Manufacturer _____

Model _____

Type _____

Capacity _____

Nominal Diameter _____

O/A Dimensions _____

Country of Origin _____

5.29.5 ODOUR REMOVAL FILTERS (ACTIVATED CHARCOAL)

Manufacturer _____

Model _____

Type _____

Capacity _____

Nominal Diameter _____

O/A Dimensions _____

Country of Origin _____

5.29.6 LINE PRESSURE REGULATORS LPA

Manufacturer _____

Model _____

Type _____

Capacity _____

Nominal Diameter _____

O/A Dimensions _____

Country of Origin _____

5.29.7 LINE PRESSURE REGULATORS HPA

Manufacturer _____

Model _____

Type _____

Capacity _____

Nominal Diameter _____

O/A Dimensions _____

Country of Origin _____

5.29.8 INTERFACE PANEL (AIR COMPRESSORS)

Manufacturer _____

Model _____

Type _____

O/A Dimensions _____

Country of Origin _____

5.29.9 FLEXIBLE PIPE CONNECTIONS (AIR COMPRESSORS)

Manufacturer _____

Type _____

Nominal Diameter _____

Country of Origin _____

5.29.10 ANTI VIBRATION MOUNTING (AIR COMPRESSORS)

Manufacturer _____

Type _____

Nominal Diameter _____

Country of Origin _____

5.29.11 AIR RECEIVER

Manufacturer _____

Material of Construction _____

Finish _____

Construction Standard _____

Test Pressure _____

O/A Dimensions _____

Country of Origin _____

5.29.12 VACUUM PUMPS

Manufacturer _____

Model _____

Type _____

Capacity each _____

kW Rating _____

O/A Dimensions _____

DB Rating _____

DB Rating after attenuation housing _____

Country of Origin _____

5.29.13 VACUUM RESERVOIR

Manufacturer _____

Material of Construction _____

Finish _____

Construction Standard _____

Test Pressure _____

O/A Dimensions _____

Country of Origin _____

5.29.14 BACTERIAL FILTERS

Manufacturer _____

Model _____

Type _____

Capacity _____

O/A Dimensions _____

Country of Origin _____

5.29.15 INTERFACE PANEL (VACUUM PUMPS)

Manufacturer _____

Model _____

Type _____

O/A Dimensions _____

Country of Origin _____

5.29.16 CYLINDER MANIFOLDS & AUTO CHANGE OVER EQUIPMENT

Manufacturer _____

5.29.17 PRESSURE GUAGES

Manufacturer _____

Range _____

Dimensions _____

Country of Origin _____

5.29. 18 LOW PRESSURE GAS FILTERS

Manufacturer _____

Duty / Mesh size _____

Type/Model _____

Country of Origin _____

5.29.19 AUTOMATIC CHANGE OVER DEVICE

Manufacturer _____

Material of Construction _____

Country of Origin _____

5.29.20 PRESSURE RELIEF VALVE

Manufacturer _____

Model _____

Material of Construction _____

Type _____

Country of Origin _____

5.29.21 MAIN GAS ALARM PANEL (& SLAVES)

Manufacturer _____

Gases Monitored _____

Material of Construction _____

Finish _____

O/A Dimensions _____

Country of Origin _____

5.29.22 LOCAL GAS ALARM PANEL

Manufacturer _____

Material of Construction _____

Finish _____

O/A Dimensions _____

5.29.23 PRESSURE SWITCHES FOR ALARMS

Manufacturer _____

Model _____

Type _____

Material of Construction _____

5.29.24 SERVICE OUTLET VALVES
O2, Vac & LPA

Manufacturer _____

Standard _____

Material of Construction _____

Country of Origin _____

5.29.25 ISOLATING VALVES (GAS)

Manufacturer _____

Model / Type _____

Material of Construction _____

Country of Origin _____

5.29.26 ISOLATING VALVES (VACUUM)

Manufacturer _____

Model /Type _____

Material of Construction _____

Country of Origin _____

5.29.27 VALVE BOXES

Manufacturer _____

Material of Construction _____

Finish _____

Country of Origin _____

5.29.29 COPPER TUBE

Manufacturer _____

Specification _____

Country of Origin _____

5.29.30 COPPER FITTINGS

Manufacturer _____

	Specification	_____
	Country of Origin	_____
5.29.31	SOLDER	
	Manufacturer	_____
	Specification	_____
	Country of Origin	_____
5.29.32	FLUX	
	Manufacturer	_____
	Specification	_____
	Country of Origin	_____
5.29.33	HANGERS & PIPE CLAMPS	
	Manufacturer	_____
	Material of Construction	_____
	Type / Model	_____
	Country of Origin	_____

MECHANICAL SERVICES INSTALLATION

FOR THE

JST HOSPITAL ICU BLOCK

DETAILED HOT WATER SPECIFICATION

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1. SCOPE OF CONTRACT

1.1 GENERAL DESCRIPTION OF THE WORKS

This specification covers the supply, delivery, installation, testing, commissioning and handing over of the complete **Steam and Hot Water Installation** for the **JST Hospital Phase** at **Rustenberg** as specified below and as indicated on the drawings, which form part of this specification. All the work shall be carried out to the complete satisfaction of the Client and Consulting Engineer.

1.2 SCHEDULE OF BUILDINGS AND MECHANICAL SERVICES

The buildings, number of buildings and mechanical services to be provided is as follows:-

BUILDING DESCRIPTION	MECHANICAL SERVICES
2.ICU	Calorifiers, Steam and hot water Reticulation & Pumps

1.3 DRAWINGS BY ENGINEERS AND ARCHITECTS

This specification must be read in conjunction with all Engineer's and Architect's drawings. Any discrepancies must be brought to the notice of the Engineer before submittal of the tender.

1.3.1 Mechanical Engineers' Drawings

The Mechanical Engineers' tender drawings for this project are listed below:

Drawing Number	**Area**	**Description**
MP 1105-101	Ground Floor	Water Supply Layout ground floor
MP 1105-102	1st Floor	Water Supply Layout 1st floor

1.3.2 Electrical Engineer's Drawings

A set of Electrical Installation drawings for this project will be made available at the offices of the **Consulting Engineers, Moditi Engineering,** for inspection by the tenderer to familiarise himself with the electrical installation details.

1.3.3 Architect's and Structural Engineer's Drawings

A set of Architectural and Structural drawings for this project will be made available at the offices of the **Project Manager,** for inspection by the tenderer to familiarise himself with the building construction details.

1.4 SERVICE CONDITIONS

Tenderers shall ensure that all equipment offered is suitable for use under the conditions specified and are invited to call for any further information that may be required.

1.4.1 General Location

Site Location	:	**Rustenberg,**
Site Altitude	:	**~1153 m**
Site Latitude	:	**23°, 05' South**
Site Longitude	:	**26°, 48' East**

1.4.2 Ambient Temperature Range

	Maximum	Minimum

Annual Mean	:	**27.5^{O}C**	**13.1^{O}C min**
Annual Extreme	:	**35^{O}C**	**-0.0^{O}C min**

1.4.3 External Design Conditions

Summer Ambient Temperature	:	35°C DB - 22°C WB
Winter Ambient Temperature	:	0°C DB

1.4.4 Internal Design Conditions

Summer Room Temperature	:	23 - 25°C DB
Summer Room Relative Humidity	:	40 - 60% (not controlled)
Winter Room Temperature	:	24 - 26°C DB

NOTE: ALL EQUIPMENT SHALL BE SELECTED TO SUIT THE ALTITUDE AND EXTERNAL DESIGN CONDITIONS FOR **RUSTENBERG**.

1.5 OTHER SERVICES

1.5.1 Electrical

Surface mounted and recessed lighting will be used in the buildings, as indicated.

1.5.2 Fire Evacuation Alarm System

Certain areas will be protected with a fire evacuation alarm system, which shall be interlocked with HVAC electrical circuits, in order to shut off the relevant air conditioning and ventilation systems, when a fire occurs.

1.6 BUILDING CONSTRUCTION PERIOD

The Main Contractor will provide the building construction period and program. The Sub-contractor will be required to conform to the agreed building program.

1.7 INSURANCE

The Mechanical Sub-contractor shall carry Insurance in accordance with requirements by the client.

1.8 SURETY

The Mechanical Sub-contractor shall provide surety in accordance with the client requirement.

1.9 DRAWINGS BY MECHANICAL SUB-CONTRACTOR

The Mechanical Sub-contractor shall be responsible for providing the following drawings for the execution of the project.

1.9.1 Mechanical Sub-contractor's Drawings -

1.9.2 Builder's Work Drawings **–**

1.9.3 Shop Drawings -

1.9.4 Electrical & Pneumatic Diagrams -

1.9.5 Record Drawings -

1.10 SAMPLES AND TECHNICAL DATA

The Mechanical Sub-contractor shall submit samples and/or equipment submittals including technical data of all equipment and fittings for the approval of the Engineer before ordering or commencing manufacture of these items.

1.11 INSPECTION, TESTING AND COMMISSIONING

The Mechanical Sub-contractor shall be responsible for testing and commissioning of the complete plant and allow for inspections by the Engineer as required.

1.12 OPERATING AND MAINTENANCE MANUALS

The Mechanical Sub-contractor shall provide Operating and Maintenance Manuals in accordance with tender requirements

1.13 MAINTENANCE AND DEFECTS

The Mechanical Sub-contractor shall be responsible for Maintenance and Defects in accordance with tender requirements.

The period of liability for Maintenance and Defects shall be 12 months.

2. ASSOCIATED SERVICES

2.1 BUILDER'S WORK

The Mechanical Services Sub-Contractor shall be responsible for providing all small openings in brick walls for pipework etc. and for providing the necessary flashing, support brackets for pipework ductwork etc.

The Mechanical Services Sub-contractor shall be responsible for providing all Builders' Work Drawings for the work to be carried out by the Main Contractor. Full details of all large openings for ducting, in the roof and brick walls, details of concrete bases, etc. are to be included on these drawings which are to be submitted to the Engineer for approval in good time to comply with building program.

The Mechanical Services Sub-contractor shall also check the positions and sizes of all these openings, bases, etc., provided by the Main Contractor.

The Main Contractor shall provide all waterproofing and making-good.

2.2 ELECTRICAL WORK

The Mechanical Services Sub-Contractor shall be responsible for all electrical work including the control panels, where specified and wiring to all mechanical equipment that forms part of this contract.

The Electrical Contractor will provide the mains supply and earth connection to the main isolator and earth bar at each control panel, located as indicated on the drawings.

Where no control panel is specified the Electrical Contractor will provide the main supply and earth connection, terminating at the equipment isolator as indicated on the drawings.

The Mechanical Services Sub-Contractor shall be responsible for providing all power supply loading data on the Builders' Work Drawings. He shall also submit control panel drawings, wiring diagrams and schematics for approval by the Engineer before manufacture of the control panels is commenced -

3 STEAM BOILERS

The existing steam boilers do not form part of this contract. However cutting in and connecting into mains steam lines from the boiler house is part of this contract.

4. STEAM AND CONDENSATE PIPES & FITTINGS

All Steam and Condensate Pipes & Fittings shall be in accordance with DPW **Standard Technical Specification.**

New Steam and Condensate Mains shall be provided in the plant rooms and along the covered walkway as shown.

The minimum requirements are as follows:

4.1 Materials and Grades

4.1.1 **Steam Piping** shall be of heavy grade mild steel to B51387 / SABS.62 with welded or screwed fittings up to 50 mm Ø and welded/flanged only above50 mm Ø.

4.1.2 **Welded Steam Pipe Fittings** shall be to BS.1640.

4.1.3 **Screwed Steam Pipe Fittings** shall be to B.S.143

4.1.4 **Flanges to BS.10 – Table F or Unions to BS.170** shall be provided at a maximum spacing of 20 m, at all valves and other accessories, and where necessary to facilitate removal of the pipework for servicing etc.

4.1.5 **Condensate Piping** shall be of copper to SABS.460, Class 2 shall be marked accordingly, ”Maksal”, or other approved.

4.1.6 **Soldered Capillary Fittings,** “Delcop”, or other approved, shall be used on all condensate piping.

4.1.7 **Solder** shall be Silver Brazing Alloy to SABS 23 with 15% Silver, “Silfos 15”, or other approved.

4.1.8 **Heating for Soldering** shall be by means of oxy-propane only and in accordance with the recommendations of the manufactures of the Piping and the Silver Brazing Alloy.

4.2 SIZES

The sizes of the steam and condensate mains and branches are shown on the drawings.

4.3 SUPPORTS

Supports and Support Centres shall be suitable for the size of pipe in accordance with the **Standard Technical Specification and the detail drawings.**

4.4 GRADING FOR DRAINING OF CONDENSATE AND VENTING

Particular attention shall be given to grading of steam and condensate mains, to allow for draining of condensate and air venting generally as shown. Trapsets shall be provided at all low points and Air Release Valves at all high points generally as shown. Attention shall also be given to supporting and anchoring of pipes, which are to be arranged so that expansion is taken up at the bends and at the expansion bellows generally as shown.

4.5 VALVES

Valves shall be provided at strategic positions and at all branches and terminal ends, in order to isolate sections of the main, branches and terminal fittings generally shown.

5. EXPANSION JOINTS

Where possible, expansion shall be taken up at the bends. Expansion bellows of an approved type shall be provided where necessary on long straight runs, as shown. Slide supports and anchors shall be provided at suitable positions to control pipe movement. The specified cold pull shall be provided to give the required pretension at the expansion bellows and bends. The complete installation shall be in accordance with the manufacturer's recommendations.

6. PIPE SUPPORTS, HANGERS & GUIDES

Maximum support centres shall be in accordance with **the DPW Standard Technical Specification.**

6.1 SUPPORT STANCHIONS

Support Stanchions shall be provided where pipes are run between the Plant room House and the Walkway, as shown. These shall be **fabricated from Medium Grade steam tube and shall be hot-dipped galvanized after manufacturer.** No changes will be allowed after hot-dipped galvanising, unless the component is re-galvanized.

6.2 WALL BRACKETS

Wall Brackets shall be provided where the pipes are supported from the building structure. For pipes of 76 Ø and above the pipe support system shall be of an approved proprietary brand **"Unistrut" or other approved**. **Alternatively** the wall brackets may be **manufactured from mild steel, galvanized after fabrication.**

The Wall Brackets shall be fixed to the wall by means of **"Ramset", stainless steel/epoxy masonry bolts** using M8 316 stainless steel threaded rod and hexagonal nuts, or other approved system.

6.3 HOLDERBATS

Holderbats shall be used for piping up to 54 Ø. These shall be of the **solid brass type "Cobra 62XS" or other approved.**

6.4 PIPE CLAMPS

Pipe Clamps shall be fabricated from **316 stainless steel band** 40mm wide x 2,0 mm thick for pipes up to 54 Ø and 50 mm wide x 3 mm thick for pipes above 76 Ø.

Insulated pipes shall be provided with **hollow, cylindrical, split hardwood sleeves** of the same dimensions as the insulation. The clamps shall be placed over the sleeves in this case.

6.5 PIPE HANGERS

Pipe hangers shall be provided for horizontal runs of steam, condensate and hot water piping. These shall be of an approved proprietary brand **"Pipework Engineering Services" or other approved, or by means of eye bolts, chain and shackles of approved dimensions** as shown.

6.6. COPPER PIPES

Copper pipes are to be **wrapped with PVC tape** at the supports to prevent direct contact between copper pipes and brackets of dissimilar material. This will not be required at brass holderbats.

6.7 SLIDE / ROLLER SUPPORTS AND ANCHORS

Slide / Roller Supports and Anchors shall be provided as shown on the drawings. These shall be manufactured generally in accordance with the drawings included. All **U-bolts shall be provided with half saddles** to provide maximum angular contact with the pipes.

Note: A sample of the support bracket and hanger assembly shall be submitted to the Engineer for approval before placing the main order for these components.

6.8 CONNECTIONS TO EQUIPMENT

All machines, plant, equipment and piping shall be so connected by means of flanges, socket unions or similar that they and/or piping can be easily removed and are easily accessible for repair or replacement. Where piping is welded sufficient flanges, etc. must be provided to enable this to be done.

7. DRAIN PIPES

Drain Pipes of Schedule 40 shall be provided from pumps, air release valves, etc. to the nearest gully.

8. VALVES AND ACCESSORIES

8.1 STEAM AND CONDENSATE VALVES

Steam and Condensate Valves shall be provided at all branches, terminal points, pressure reducing valve sets, and generally as shown on the drawings. These shall conform to **the Standard Technical Specification.**

Steam and Condensate Valves shall be the type with **renewable nickel alloy plug disc and stainless steel seat and union bonnet, "Crane D46", or other approved.** Steam Valves shall be **installed horizontally** to avoid trapping of condensate.

Isolating Valves on low pressure water systems fed from break pressure tanks shall be of the **full flow ball type, "Bossini", "Itap", or other approved.**

Regulating Valves on circulating water mains etc shall be of the globe type with **renewable discs, "Cobra 131", or other approved.**

8.2 STEAM SEPARATORS

Steam Separators shall be provided at low points in the steam main and prior to pressure reducing valve sets as shown. These shall be of the **"Spirax", "Armstrong T-type", or other approved, with flanged steam connections.**

8.3 PRESSURE REDUCING VALVE SETS

Pressure Reducing Valve Sets shall be provided on the steam main and at the branches serving the calorifiers, as shown. These shall be in accordance **with the Standard Technical Specification "Bailey", "Spirax", or other approved.** A maximum pressure of 400 kPa shall be provided at supply to the Plant Rooms.

8.4 STEAM TRAPSETS

Steam Trapsets shall be provided at all low points of the steam main and all terminal points as shown. These shall conform to **the Standard Technical Specification** and in accordance with the manufacture recommendations. They shall be of the **inverted bucket type, "Armstrong", "Spirax Drayton 200 Series", or other approved**, with side inlet and outlet connections. **Float type steam traps shall be used at all thermostatically controlled equipment** and shall be supplied complete with thermostatic air vent and steam-lock release facilities, **"Spirax FT 10 Series", or other approved.**

Unions shall be of the **bronze naval type with spherical seat**. **Strainers** shall be of **bronze with 1 mm 316 stainless steel screen "Armstrong", "Spirax" Y-type", or other approved.** The strainers shall be installed horizontal to avoid trapping of condensate.

8.5 AUTOMATIC AIR VENTS

Automatic Air Vents shall be installed at the terminate points of the main and at all high points of the condensate main and shall conform to **the Standard Technical Specification.**

Liquid Expansion type air vents, "Spirax AV Series", or other approved , shall be provided **on the steam main**. Air vents, **"Spirax AE Series", or other approved,** shall be approved **on the condensate mains.**

8.6 CONDENSATE RETURN PUMP SETS

Condensate Return Pump Sets shall be provided at the Calorifiers Rooms, Kitchen, ICU, Theatre and elsewhere as indicated on the drawings and shall be in accordance with the Standard Specification

The Condensate Return Pump Sets shall be "Spirax Ogden" or other approved. The pump unit shall be installed in the position shown and shall be supplied as a complete unit with the pump, collecting tank, piping, valves and fittings mounted on a supporting frame. The vent and overflow shall be extended to approved positions outside the plant room / building.

The pump capacities are shown on the drawing and are to suit the duty. A float type trapset "Spirax FT 10" or other approved shall be provided on the steam supply prior to the to the Condensate Pump.

All steam and condensate pipe connections shall be provided.

9. CALORIFIERS

9.1 HOT WATER STORAGE CYLINDERS

The minimum requirements are as follows:

a) Make and Type :

The Hot Water Storage Cylinders shall be the vertical, floor standing and pressure fed type manufactured by a member of the Pressure Vessel Manufacturers' or other approved. The cylinders shall be fabricated from lap welded mild steel plate with domed ends to BS 417, 853 and 1500 and SABS 151, to the approval of a registered inspection authority.

The cylinders shall be shot blasted and aluminium flame sprayed to 100 microns internally and cleaned, primed, undercoated and finished externally with a heat resistant paint to the paint manufacturers recommendation.

9.1.1 SCHEDULE OF HOT WATER STORAGE CYLINDERS

b) Quantity, Capacity and Dimensions

DESCRIPTION	Type	NETT CAPACITY (m^3)	DIMENSIONS (mm)
Steam Heated calorifier	Vertical	2.5	1170ϕ x 1300 high

PERFORMANCE	SHELL PASS	TUBE PASS
Fluid Type	Steam	Water
Flow	100 kg/hour	2.0 m^3/hour
Inlet Temperature	165°C	10°C
Outlet Temperature	Condensate(250 kg/hour)	70°C
Pressure Drop	n/a	10 kPa
Heating demand dent	60 kw	

c) Accessories :

The hot water storage cylinders shall be provided complete with accessories as listed below:

c.1) Mounting Legs
c.2) Access Manhole (450 mm Ø minimum of approved design)
c.3) Flanged Branches as detailed below
c.4) Instruments as detailed below
c.5) Lagging and Cladding as detailed below.
c.6) Hones Valve

d) Contents : Domestic water from the council supply mains.

e) Temperature :

e.1)	Range	(°C)	:	0 to 90
e.2)	Operating	(°C)	:	70

f) Pressure

f.1)	Working Pressure(kPa)	:	300	
f.2)	Test Pressure	(kPa)	:	450

g)

NOTE :

A PRESSURE CERTIFICATE WHICH HAS BEEN CERTIFIED BY AN INDEPENDENT REGISTERED TEST AUTHORITY SHALL BE PROVIDED BY THE MANUFACTURER.

g) Materials of Construction :

g.1)	Cylinder	:	Mild Steel of 8 mm minimum thickness.
g.2)	Dished Ends	:	Mild Steel of 10 mm minimum thickness.
g.3)	Flanges	:	Welded mild steel to BS10, table D.
g.4)	Bolts	:	304 stainless steel or cadmium plated mild steel.

h) Branch Details :

Each hot water storage tank shall be provided with the following flanged branches :

h.1) 2 No. 100 mm Ø for Inlet and Outlet.
h.2) 6 No. 50 mm Ø for Hot Water Return, Primary Hot Water Flow & Return and Drain.
h.3) 5 No. 32 mm Ø for Temperature/Pressure, Vacuum & Pressure/Safety Relief Valve and Temperature & Pressure Gauges

j) Instruments :

Each hot water storage tank shall be provided with the following instruments :

j.1) Pressure Gauge of an approved type with 100 mm Ø dial and scale 0 to 45 m (450 kPa).
j.2) 1 No. Mercury Bulb Thermometer with scale 0 to 100°C.
j.3) Temperature/Pressure Relief Valve in accordance with SABS 198.
j.4) Pressure/Safety Relief Valve
j.5) Vacuum Relief Valve in accordance with SABS 198.
j.6) Hones valve

k) Drawings :

NOTE :

1 DETAIL DRAWINGS OF THE HOT WATER STORAGE CYLINDERS SHALL BE SUBMITTED FOR APPROVAL BEFORE MANUFACTURE COMMENCES.

2 ALL CONNECTIONS SHALL BE AS SHOWN ON THE DRAWINGS.

9.2 SECONDARY HOT WATER RETURN CIRCULATING PUMPS

SECONDARY HOT WATER CIRCULATING PUMPS FOR DOMESTIC HOT WATER AT PLANTROOM

The minimum requirements are as follows :

a) Make and Type :

The Secondary and Primary Hot Water Circulating Pumps shall be glandless, multi-speed centrifugal type with bronze casing, corrosion resistant impeller and stainless steel shaft, "Wilo RS-25/50r", or other approved.

b)	Number Required				
b.1)	Plantroom				
			(Qty)	:	four (4)
c)	Fluid Pumped			:	Domestic water from Council main.
d)	Temperature Range		(°C)	:	10 to 90
e)	Capacity at specified head	(l/s)	:	2	
f)	Head		(m)	:	50
g)	Speed		(RPM)	:	2800
h)	Connection Sizes :				
h1)	Suction		(mm)	:	25
h2)	Delivery		(mm)	:	25
i)	Materials :				
i1)	Pump casing			:	Bronze
i2)	Impeller			:	Rustless
i3)	Shaft			:	Stainless Steel
k)	Pump Bearings			:	Metal impregnated carbon.
l)	Motor			:	2-pole asynchronous squirrel cage type with class IP 42 enclosure, class F insulation and thermal protection.
m)	Drive			:	Impeller direct coupled to motor shaft.
n)	Motor Power		(W)	:	80
			(Amps)	:	0.35
o)	Motor Current	(Volt/Phase/Hz)		:	220/1/50

p) Motor Starter :
To be supplied with pump complete with necessary motor overload protection.

q) Motor Control :
The circulating pump motors shall be controlled by means of an on/off switch located at the control panel.

r) Pump Specifications and Performance Data

NOTE :

THE PUMP SPECIFICATIONS AND PERFORMANCE DATA SHALL BE SUBMITTED TO THE ENGINEER FOR APPROVAL BEFORE ORDERING THE PUMPS.

10 LAGGING AND CLADDING

All Lagging and Cladding shall be carried out in accordance with of the Standard Specification.

10.1 LAGGING

The minimum requirements are as follows :

10.1.1 Steam Piping

All Steam Piping shall be insulated with resin bonded glass fibre or mineral wool pre-formed pipe sections with a factory applied canvas finish, "Owens Corning", or other approved.

The insulation thickness shall be as follows :

Thermal Conductivity (W/mK)	Pipe Diameter (mm)	Insulation Thickness (mm)
0.042	15 to 150	40

For steam pipes installed internally, all canvas laps shall be bonded with a brush application of an acceptable coating. The surface of the canvas shall be sealed with one brush coat of an acceptable coating at the rate of 1.6 m^2/litre.

For steam pipes installed externally, the pre-formed pipe sections shall be covered with sheet metal cladding according to Clause 15.2 below.

All joints, bends, valves and other fittings shall be insulated in accordance with Clause 47.11.1 of the Standard Specification. The thickness of the insulation shall not be less than the associated pipes. The insulation of all fittings shall be in accordance with the manufacturer's recommendations.

10.1.2 Condensate Piping and Hot Water Circulating Piping

All Condensate Piping and Hot Water Circulating Piping shall be insulated with flame retardant expanded polyethylene foam pre-formed pipe sections, "Thermaflex", or other approved.

The insulation thickness shall be as follows:

Thermal Conductivity (W/mK)	Pipe Diameter (mm)	Insulation Thickness (mm)
0.034	up to 40	15
0.034	50 to 100	20

Joints shall be sealed by means of tape, glue or a proprietary jointing system, in accordance with the manufacturer's recommendations.

All joints, bends, valves and other fittings shall be insulated. The thickness of the insulation shall not be less than the associated pipes. Adhesive shall be used where necessary, in accordance with the manufacturer's recommendations.

For smaller size pipes with slow bends the insulation can be drawn around the bend. For larger pipes (40 mm & above) with short radius bends, standard or segmented bends shall be used, in accordance with the manufacturer's recommendations.

10.1.3 Hot Water Storage Cylinders

The Hot Water Storage Cylinders shall be lagged with glass fibre or mineral wool resin bonded slabs.

10.2 METAL CLADDING

The minimum requirements are as follows:

10.2.1 Steam, Condensate and Hot Water Circulating Piping

All insulation on Steam, Condensate and Hot Water Circulating Piping installed externally and in Plant Rooms shall be protected with 0.4 mm thick (27 s.w.g.) stainless steel sheet metal cladding, which shall be applied directly over the insulation.

The cladding shall be secured by means of removable and re-usable stainless steel bands every 330 mm. Self-tapping screws will not be accepted.

No dents or damage to the sheet metal cladding will be accepted.

10.2.2 Hot Water Storage Cylinders

The insulation on all Hot Water Storage Cylinders shall be protected with 0.4 mm thick (27 s.w.g.) stainless steel sheet metal cladding, which shall be applied directly over the insulation.

The cladding shall be secured by means of removable and re-usable stainless steel bands every 330 mm. Self-tapping screws will not be accepted.

NOTE:

1 A SAMPLE OF THE LAGGING AND CLADDING TO BE USED IS TO BE SUBMITTED TO THE ENGINEER FOR APPROVAL BEFORE PLACING THE ORDERS FOR THESE ITEMS.

2 IN ORDER TO ENSURE A HIGH-CLASS OF WORKMANSHIP, LAGGING AND CLADDING SHALL BE APPLIED BY AN APPROVED SPECIALIST SUB-CONTRACTOR.

11 PAINTING

11.1 GENERAL

All painting shall be in accordance with the Clause 51 of the Standard Specification and the following SABS standards: SABS 064 - 1960, SABS 697 - 1972 and SABS 630 - 1972

Painting shall include the following:

Preparation	:	In accordance with SABS 064
Ground Coat	:	25-Micron red lead according to SABS 312 type 11
Undercoat	:	25-micron
Finish	:	25-micron alkyd enamel according to SABS 30.
Colour	:	In accordance with SABS 1091 - 1975.

11.2 COLOUR CODE

All painting must be in accordance with colour code SABS 1091 - 1975 as follows:

Motors	:	Factory finish or Dove Grey G22
Coupling guard	:	Signal red
Frames	:	Black
Exposed ducting & equipment	:	To match units or to Architect's instruction.
Drainage piping	:	Natural copper or black
Steam	:	Pastel Grey
Condensate	:	Brilliant Green and One Crimson, Two White and Three Crimson
Distilled Water (Boiler Feed)	:	Brilliant Green and One Crimson, Two White and Three Crimson
Demineralized Water (Boiler Feed)	:	Brilliant Green and One Crimson, Two White and Three Crimson
LP Gas	:	Light stone C37 and marking "LP Gas" at 3 metre centres.
Acetylene	:	Light stone C37 with one Maroon A01 band and marking "Acetylene" at 3 metre centres.
Oxygen	:	White and marking "Oxygen" at 3 metre centres.
Compressed Air	:	Arctic blue F28

NOTE :

FOR STAINLESS STEEL CLADDING ON STEAM AND CONDENSATE PIPING THE BASIC COLOUR (Pastel Grey) IS NOT REQUIRED.

FOR STAINLESS STEEL CLADDING ON STEAM AND CONDENSATE PIPING AND OTHER BOILER FEED PIPING INSTALLED INTERNALLY, COLOUR BANDS ARE REQUIRED AT 5 METRE INTERVALS

FOR STAINLESS STEEL CLADDING ON STEAM AND CONDENSATE PIPING INSTALLED EXTERNALLY, COLOUR BANDS ARE REQUIRED AT 10 METRE INTERVALS

12. ADDITIONAL SPECIFICATIONS

12.1 WELDING

Welders are to be coded by an approved authority (e.g. SABS) and every pipe weld shall have the code number of the welder stamped on it.

12.2 INSTALLATION

12.2.1 Hangers and Supports

All hangers and supports shall be painted in accordance with Clause 51 of the Standard Specification.

12.2.2 Nuts and Bolts

Where nuts and bolts are used the following shall apply:

For similar applications all bolts shall be of the same length.

Not more than 5 threads and not less than 2 threads shall extend through nuts.

Washers shall be used on all nuts and bolts.

All bolts, nuts and washers shall be cadmium plated unless otherwise specified.

Where applicable tapered washers shall be used.

12.4 OMISSIONS

Not all equipment for the successful completion of the project is described in the specification. Where this is the case, the contractor must follow accepted good practice of a high standard to the satisfaction of the Engineer.

13. TESTING, COMMISSIONING AND PROGRAMMING

13.1 SPECIFICATION PERFORMANCE

The engineer may ask for tests to prove that any equipment performs to specifications.

13.2 TESTING OF INSTRUMENTS

All instruments used for testing shall be calibrated by an approved authority before testing commences

13.3 TESTS TO BE PERFORMED

13.3.1 At Manufacturer's Works

The equipment shall be tested for satisfactory operation at the manufacturer's works before dispatch.

13.3.2 On Site

The equipment shall be tested for satisfactory noise and vibration free operation after erection and before handover.

13.3.3 Duct Leakage Tests

Leakage tests must be performed during installation. The engineer must be notified at least three weeks in advance of any such testing.

13.3.4 Verification of Plant Performance and Balancing

Verification of the plant performance curves and power input shall be provided as well as all airflow balancing results.

A commissioning report with the final operational performance data shall be made available before final commissioning.

13.4 TEST RESULTS

The Sub-contractor shall supply the engineer with results of all tests performed.

13.5 COMMISSIONING SCHEDULE

The sub-contractor shall submit to the engineer a complete commissioning schedule at least one month before commissioning commences. The commissioning schedule shall contain all commissioning activities, all equipment to be tested and all variables of all equipment to be checked. The following tests and measurements are to be included and recorded :

13.5.1 Mechanical Tests and Measurements

a) Capacity of the systems.
b) Operation of control, safety and alarm devices.
c) Noise levels.
d) Any other tests that may be required for the particular system.

13.5.2 Electrical Tests and Measurements

a) Motor R/S and direction of rotation.
b) Full load amps and volts.
c) Motor starter overload settings.
d) Calculate motor kW and compare with rated kW.
e) No load amps and compare with rated no load amps.
f) Any other tests which may be required for this particular system.

13.6 OPERATING AND MAINTENANCE MANUALS, AS BUILT DRAWINGS, TESTING & COMMISSIONING

The successful Sub-contractor shall allow for programming to supply approved copies of the operating instructions and maintenance manuals, including "As Built" drawings prior to commissioning and to complete this testing and commissioning at least one month before final hand-over.

13.7 PRACTICAL COMPLETION INSPECTION

After the HVAC / Mechanical Sub-contractor has completed his testing and commissioning and is satisfied that the plant is ready for the Practical Completion Inspection he shall notify the Engineer so that the Practical Completion Inspection can be arranged.

14. HYDRAULIC TESTING AND COMMISSIONING OF STEAM AND WATER SERVICES

14.1 GENERAL

All steam and water piping shall be hydraulically tested as specified and the results recorded. The Engineer or Clerk of Works shall witness the tests.

The Contractor shall provide all the necessary equipment to carry out the tests. Pipes shall be tested in sections as the work progresses and before finishes are applied or pipes are covered. The completed steam and water piping / systems shall be tested as a whole just prior to final acceptance by the Engineer.

All instruments used for testing shall be calibrated by an approved authority before testing commences.

14.2 PRESSURE TESTING

The water pressure tests are to be carried as follows:

14.2.1 All pipework is to be pressure tested before isolating valves and tap outlets are fitted. These tests are to be at 1800 kPa (18 Bar). The pressure is to be held for 20 minutes without further pumping and no leaks are permitted.

14.2.2 All pipework with joints to be buried in walls or behind tiles is to be tested as in (16.2.1) before covering with plaster or tiles. Where possible joints are to be avoided where pipes are buried in walls or behind tiles.

14.2.3 Pipework should be tested in sections as in (16.2.1) to ensure that an acceptable standard of workmanship is being maintained as work progresses.

14.2.4 Thereafter the complete installation is to be tested as in (16.2.1) before fitting the valves and taps.

14.2.5 All pipes are to be flushed with clean water before fitting the valves and taps.

14.2.6 After pressure testing as in (16.2.4) and flushing as in (16.2.5) is accepted, valves and taps are to be fitted and the complete installation is to be tested at 600 kPa (6 Bar). The pressure is to be held for 60 minutes without further pumping and no leaks are permitted.

14.2.7 All valve and tap glands are to be adjusted at 600 kPa to ensure that there is no leakage.

14.2.8 A Water Pressure Test Schedule is to be prepared to cover all sections of each building / pipe section.

A Typical Water Pressure Test Schedule is attached for completion and witnessing by the Main Contractor and the Clerk of Works respectively.

Once the Main/Sub Contractor has successfully carried out his pressure tests and completed and signed the schedules he is to notify the Clerk of Works who is required to witness and sign for acceptance of pressure tests carried out.

Once the schedules have been completed and signed for by the Clerk of Works they are to be forwarded to the Engineer for signature and for record purposes.

14.3 COMMISSIONING

The Commissioning is to be carried as follows :

14.3.1 All pipes and water storage tanks are to be flushed with clean water just prior to acceptance by the Engineer for Practical Completion.

14.3.2 After flushing all pipes and water storage tanks are to be sterilized with clean water and chlorine (HTH) just prior to acceptance by the Engineer for Practical Completion.

14.4 SAMPLE WATER PRESSURE TEST FORM AS ON NEXT PAGE

	NAME OF BUILDING					
	DESCRIPTION OF SECTION	**Test Pressure (kPa)**	**Duration (mins.)**	**Date**	**Signature Contractor**	**Signature Clerk of Works**
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Signed : ……	Signed : ……
Name in block letters : ……	Name in block letters : ……
CONTRACTOR	**CLERK OF WORKS**
Company name in block letters : ……	Company name in block letters : ……

Signature of Engineer : ……..

Name in Block letters : ……..

POTENT ENGINEERING PROJECTS

1. MEDICAL EQUIPMENT

1.1 AUTOCLAVES

1.1.1 AUTOCLAVE – 400L CAPACITY (CENTRAL STEAM)

The autoclave shall be a 400L capacity two door (barrier type) to be used for sterilisation and disinfection of equipment. This unit shall be powered from the central steam supply. The autoclaves will be supplied complete 2 loading/unloading trolleys with internal carriage with 2 trays. Construction material shall be as follows:

i) Chamber Nickel Clad Steel or 316L Stainless steel
ii) Jacket 304 Stainless steel
iii) Door 304 Stainless steel.

The doors shall be vertical sliding doors, counterbalanced and electrically operated. The door shall be sealed with a silicon gasket fitted in the groove of autoclave chamber. The doors will have an interlock such that only one door can be open at a time. The unit should not operate unless doors are fully closed. The doors will not open while the chamber is under pressure. The chamber should be fully vented before opening mechanisms id activated. The steriliser will be programmed with the following cycles:

i) 134°C packs / instruments cycle
ii) 121°C rubber goods cycle
iii) 121°C fluid cycle
iv) 134°C flash cycle
v) Vacuum drop Test Cycle

The temperature range during the gravity cycle shall be 110°C - 135°C.
The temperature range during the vacuum cycle shall be 110°C - 135°C.
Air removal shall be under vacuum/gravity. The liquid exhaust shall be computer controlled.
The unit should be supplied complete with a recorder and an RS32 serial port.

The above unit must comply with the requirements of A.S.M.E. U544.

1.1.2 AUTOCLAVE – 400L CAPACITY (WITH INTEGRAL STEAM GENERATOR)

As above but with integral steam generator. (Electric Power Supply only))

1.1.3 SCHEDULE OF AUTOCLAVES

LOCATION	EQUIP. REF. No.	QTY (No.)	TYPE	CAPACITY (L)
MINI CSSD	AUT 1	1	Central Steam	400
MINI CSSD	AUT 1	1	Electric	400

1.2 INSTRUMENT WASHING MASHINE

The instrument washing machine shall be automatic with a chamber size of approximately 406mm high x 406mm wide x 660mm deep. The instrument washing machine shall be suitable for surgical instruments, utensils and glassware and shall be suitable for recessed wall installation. The unit shall be supplied complete washing racks and 2 baskets and trolley, minimum dimensions 760 x 267 x 521mm. Construction material shall be as follows:

i) Chamber Nickel Clad Steel or 316L Stainless steel
ii) Jacket 304 Stainless steel
iii) Door 304 Stainless steel.

The machine must have a pass through design. With two sealing doors made from double layer toughened glass which must be transparent. The doors will have an interlock such that they cannot be opened until a process is completed. One door must be closed and must seal tightly before the other door is opened. The unit should not operate unless doors are fully closed. The unit must have washer type jet spray or rotating spray arms. It must be equipped with a microprocessor controlled programming unit with 4 – 6 pre-programmed cycles which can be selected through touch key pads to be located in front of the unit. The microprocessor should have capacity to store additional processes in the memory.
It is preferred that the unit has a cold pre-rinse but this is optional. The unit should have automatic detergent loading. Alarms should be made for the following conditions:

i) Component failure
ii) Door Unlocked.
iii) Temperature below set point

Indicators to be available to display the following:
i) Water in Chamber
ii) Sterilise time.
iii) Cycle select
iv) Cycle status
v) Temperature
vi) Date
vii) Chamber pressure

Air removal shall be under vacuum. The unit should be supplied complete with a recorder for temperature, time and cycle.

1.2.1 SCHEDULE OF INSTRUMENT WASHING MACHINE

LOCATION	EQUIP. REF. No.	QTY (No.)	TYPE	CAPACITY (L)
MINI CSSD	IWM 1	1	2-Door Automatic	As described above

1.3 AUTOMATIC BEDPAN WASHER

The bedpan washer shall be fully automatic with foot operated lid and start functions and will be suitable for wall installation. The unit shall have an integral electrically heated steam generator. The unit should incorporate an integral tank and pump to enable it to be used under low water pressure conditions. The unit shall have capacity to wash the following items per load:

i) 2 bedpans with lids and 4 urine bottled
ii) 4 hand wash basins and 4 urine bottles
iii) 2 suction bottles with lids.
iv) Various combinations of bowls, dishes, baskets, etc.

The unit shall be supplied complete with a microprocessor controlled programme function, universal holder for bedpans with lid, hand basins urine bottles, etc., retainer for suction bottles and nozzle for lid, basket for upright instruments, detergent tray, condenser and water cooled drain facility. Requisite shut –off valves and solenoid valves for hot and cold water, filters, check valves and water trap.

1.3.1 SCHEDULE OF AUTOMATIC BEDPAN WASHERS

LOCATION	EQUIP. REF. No.	QTY (No.)	TYPE	CAPACITY (L)
SLUICE ROOM	ABW 1	1	Automatic	As described above

1.4 SLUICE MACHINES

The sluice machines shall be hard mount type of 16.5kg capacity with a spin of 500rpm. They shall have micro 2o controls with gravity drain valve and complete with 9mm drum hole perforations and shall be cold water sluice only. The machines shall have one inlet for cold water and shall be front loading. They shall have an Electro-magnetical locking device for the door and an emergency button shall be in front.

Cabinet, tub, cylinder and shaft shall be made out of stainless steel AISI 304. Bearing house shall be made out of cast iron for perfect balance and shall have a good repartition of the vibrations with oversized bearings.

1.4.1 SCHEDULE OF SLUICE MACHINES

LOCATION	EQUIP. REF. No.	QTY (No.)	TYPE	Nominal Capacity (kg)
THEATRE SLUICE ROOM	-SM	1	Hard mount	16.5

1.5 WATER TREATMENT EQUIPMENT TECHNICAL SPECIFICATION

Furnish two sodium softening system to provide a supply of soft water at a rate of 36L/min. The system to be capable of treating a peak flow rate of 55L/min at a maximum pressure drop of 15 psi. The system to be capable of treating a minimum flow of 9L/min.

The water softening system shall have a maximum rated capacity of 60,000 grains between regenerations using 0.25kg NaCl/L of resin.

1.5.1 DESCRIPTION

The water softening system, in compliance with the equipment specifications, shall be an automatic softening system per the performance and design criteria as detailed in this specification.

1.5.2 SOFTENER TANK

Provide one mineral tank. The tank shall be a least 305mm in diameter and 1320mm height. Each tank shall be designed for a maximum working pressure of 150 psi and hydrostatically tested at 50% in excess of working pressure.

The softener tank shall be constructed of corrosion resistant polyethylene inner shell with a fiberglass wound reinforced exterior shell. A moulded polypropylene structural base shall support the tank.

1.5.3 INTERNALS

The softener shall be provided with all internals necessary for distributing and collecting water flows in a uniform manner. The underdrain system shall consist of a single strainer.

1.5.4 ION EXCHANGE RESINS

The vessel will contain 56L of high capacity industrial grade virgin 8% crosslinked
Styrene and divinylbenzene polymer Gel Cation Exchange Resin.
It shall be furnished in the Sodium regenerated form, ready for use after installation, backwash and rinse.

1.5.5 MAIN CONTROL VALVES

The softener must be fitted with 1-inch brass control valve with NPT inlet and outlet connections and shall have fully adjustable 5-cycle controls to accomplish the following regeneration steps:

- Upflow backwash
- Downflow brining,
- Slow rinse
- Rapid rinse,
- Timed brine tank refill.

An integral brine injector shall be provided in the valve capable of maintaining a proper brine concentration to the resin at varying operating pressures. Brine tank refill flow control and backwash flow control will be provided.

1.5.6 BRINE SYSTEM

A brine system consisting of a single brine measuring/salt storage tank constructed of rotationally moulded polyethylene and include a cover shall be utilised.
The brine system must be loaded with fresh make up water and dry salt after installation.

1.5.7 CONTROLS

Regeneration shall be initiated automatically. Regeneration steps and return to service shall be accomplished automatically. The system must controlled by a mechanical 12-day time clock. When the specified time has been reached, the control shall initiate regeneration of the exhausted softener.

1.5.8 GUARANTEE

The contractor shall guarantee the apparatus and work delivered by him for a period of twelve months. The guarantee period starting on the date when this contract is handed over to the Owner as a completed and working installation and accepted by the Mechanical Inspector as such.

All equipment must be guaranteed against defects as a result of patent and latent defects of the design and apparatus as well as against faulty materials and workmanship.

Fair wear and tear is excluded from the guarantee. The guarantee must provide that all parts, spares and accessories that become defective during the guarantee period, and all labour and traveling to effect such repair, be provided free of charge to the Owner.

DEPARTMENT OF HEALTH: NORTH WEST PROVINCIAL GOVERNMENT

RENOVATIONS AND ADDITIONS ICU UNIT AT JOB SHIMANKANE TABANE HOSPITAL, RUSTENBURG

SA GENERAL MAINTENANCE

PORTION 3: ADDITIONAL SPECIFICATIONS

ADDITIONAL SPECIFICATION

SA GENERAL MAINTENANCE

CONTENTS

SA 01 SCOPE
SA 02 MAINTENANCE REQUIREMENTS
SA 03 MAINTENANCE CONTROL
SA 04 COMMUNICATION
SA 05 PERFORMANCE MEASUREMENT
SA 06 MEASUREMENT AND PAYMENT

SA 01 SCOPE

Maintenance of the specified systems, services and/or parts of buildings and infrastructure shall all be referred to as "Maintenance of an Installation". Maintenance of all completed installations shall ensure reliable functioning and optimum service life thereof. Monthly maintenance responsibilities for each installation including all units and components as specified, shall commence with access to the Site (Maintenance Prior to Practical Completion). Commencement of maintenance after Practical Completion of each installation shall mean that the installation has been repaired to an acceptable level of serviceability and shall leave the Contractor with a functional installation to maintain for the liability period of 12 -months.

A difference shall be made in payment for the maintenance prior to and after practical completion of repair work.

Maintenance of an installation shall be performed in accordance with the Technical and Particular Specifications, the Operating and Maintenance Manuals (where applicable) and the Maintenance Control Plan.

Remuneration for maintaining "installations" (systems, services and/or buildings and parts of the infrastructure) in good functional condition is provided for in the Schedules of Quantities by means of monthly payment items.

This Additional Specification covers maintenance requirements, development of a maintenance control plan, identification of equipment, site maintenance administration, maintenance performance measurement, as well as the items for measurement of the Contractor’s service level and resulting payment.

SA 02 MAINTENANCE REQUIREMENTS

SA 02.01 CONTRACTOR'S RESPONSIBILITIES

The Contractor shall maintain the complete installations for 12-month liability period.

Maintenance implies and shall include monthly preventative maintenance, corrective maintenance, as well as breakdown maintenance on all components of the specified installations.

The maintenance control plan (specified in Clause SA 03) will be developed by the Contractor, to schedule the frequency of routine inspections and format of reports. The Contractor shall carry out inspections on the equipment as detailed in the Technical and Particular Specifications and the maintenance control plan. Each inspection, test or breakdown shall be recorded in an approved format and listed in a quarterly report (part of the maintenance control plan).

As part of repair of each installation, the Contractor shall submit a set of Operating and Maintenance Manuals where applicable. The Contractor shall ensure through training that the operating and maintenance personnel are conversant with the instructions as presented in the Operating and Maintenance Manuals. Continued training shall be included in the scope of maintenance work for the duration of the 36-month Contract, in accordance with Additional Specification SD: General Training.

The Operating and Maintenance Manuals, as approved by the Engineer, shall be used as a basis of preventative maintenance. The Contractor shall perform all preventative and corrective maintenance as described in the Operating and Maintenance Manuals. This shall be in accordance with the Technical and Particular Specifications.

The Contractor shall, as part of his maintenance responsibilities repair or replace faulty equipment upon logging of a breakdown, within the down-time as defined in Clause SA 05.02 at the Contractor's cost, except in the event of replacement being labelled as exceeding liability as specified in Clause 63 of the Project Specific Conditions of Contract, in which case the Department of Health will bear part of the costs.

The Contractor shall rectify any faulty condition of which he becomes aware, even if it has not been logged. Such rectification shall also be logged and listed in the quarterly report.

SA 02.02 **CONDITIONS FOR EXCEEDING THE CONTRACTOR'S LIABILITY DUE TO OPERATIONAL DAMAGE BREAKDOWNS**

Irrespective the definition of operational damage given in the Oxford dictionary, it shall be defined for the purpose of this clause as being any damage caused on purpose or through negligence by the User Client's employees, inmates (where applicable), suppliers, subcontractors, etc for any reason whatsoever. For the purpose of this clause, operational damage and vandalism shall have the same meaning. Where repair work is necessitated as a result of operational damage caused by User Clients or their associates, the Contractor will be requested to:

(a) perform work, using tendered rates for the supply, delivery and installation of material forming part of the repair work schedule, within the maximum down-time allowed for operational damage, where the Engineer rules that the damage has been caused by incorrect operation;

(b) submit one (1) quotation for repair and/or replacement of the damaged unit, where tendered rates are not available and where the Engineer rules that the damage has been caused by incorrect operation;

(c) perform the work on receipt of an order from the Engineer, within the time offered as part of the quotation, and

(d) notify the Engineer well in advance of completion of the repair work in order to enable inspection.

The responsibility of determining whether damage to the installation was caused by people other than employees or associates of the Contractor shall rest with the Engineer.

Operational damage caused by the employees, suppliers, subcontractors, etc of the Contractor, shall be repaired by the Contractor at his own cost.

SA 02.03 **CONDITIONS FOR EXCEEDING THE CONTRACTOR'S LIABILITY ABOVE MARGINAL BREAKDOWN COST**

In the event where the cost for the repair or replacement of any single component/subassembly where a breakdown has occurred due to a single failure, or where the cost for replacing a single item of equipment completely, exceeds the value of R15 000,00 (transport, accommodation and travelling cost excluded), the liability of the Contractor is limited to the value of R15 000,00. The additional cost above the value of R15 000,00 will be paid for by the Employer provided that conditions 1, 2 and 3 below have been met.

1. The defective part/component/subassembly or machine must be identifiable as a single subassembly or component and not the total of a number of small defects or breakdowns on subassemblies/components on any one or more machines.

   Examples of subassemblies/components are the following:

   (a) Should the wiring or bearings on an electric motor fail, the complete motor must be removed for repairs and the cost for the repairs on the complete motor will be regarded as repairs on a single subassembly/component.

   (b) A starter motor, for example, is a subassembly, which can be removed from the machine for repairs. The repairs on the starter motor together with the repairs on the main bearings will not be regarded as a repair on a single subassembly/component. If the complete diesel engine is replaced with its associated subassemblies the replacement of the complete unit will be regarded as a single component.

   (c) A pump as a whole is regarded as a single component. The pump and driving machine on long coupled pumps are regarded as separate subassemblies. Pumps and motors on close-coupled equipment are regarded as a single component. The pump and motor of a sump pump are therefore regarded as a single component.

   (d) Control equipment for the control of a single item, with the sensing device, the controller itself and the final controlled variable are regarded as a single component of the system. The repairs on any one item on a controller have an influence on the rest of the control equipment and must after the replacement be commissioned again as a unit.

2. The Contractor shall submit a written report to the Engineer for approval. This report shall contain the following information:

   (a) The make and model number of the machine serviced/inspected/ repaired/replaced;

   (b) The identification number of the machine;

   (c) A description or name and part number of the defective part/component or subassembly;

   (d) A statement on whether the component could be repaired, together with a cost estimate;

   (e) A quotation valid for a minimum period of 60 days if the component/part/subassembly has to be replaced or repaired by an

outside firm. If the subassembly/machine is to be repaired or replaced by an outside company, the Contractor shall supply one (1) quotation for such parts/repairs or a quotation from any sole supplier. Only an original quotation will be accepted. The mark-up on such work shall be a percentage as tendered and shall be applicable to the total cost (VAT excluded) of repair work by outside companies;

(f) The expected urgency for the replacement or repairs, and

(g) The delivery time of a new component/subassembly/machine or delivery times on spares required to repair the defective component/ subassembly.

3. A written approval to proceed with the work must be issued by the Department. Copies of the original VAT invoices from outside companies for all repairs or spare parts supplied must be attached to the Contractor's invoice.

SA 02.04 COMPONENTS INCLUDED IN MAINTENANCE SCOPE

The main sections of a facility with their subsections are as set out in the Technical Specifications and Particular Specifications where applicable and in the Schedule of Quantities and will each be deemed "an installation". Maintenance, as specified, will be applicable to all of these installations.

- Installations MA – HVAC Installations
- Installations MD - Steam Distribution Installations (Only portion of line worked on)
- Installations ME - Hot Water Installations
- Installations MG - Autoclave Installations
- Installations FA - Fire Installations
- Installations PA - Plumbing Installations
- Installations LA - Lift Installations
- Medical gas Installation

Maintenance of each of these installations will be the responsibility of the Contractor and will be evaluated on a monthly basis by the Engineer. The remuneration for maintenance work and responsibilities will be certified accordingly.

This description of the Works is not necessarily complete and shall not limit the work to be carried out by the Contractor under this Contract.

Approximate quantities of each type of work are given in the Schedule of Quantities.

NOTE: A clear distinction will be made between the repair work and the maintenance responsibilities of each installation.

SA 02.05 COMMENCEMENT OF MAINTENANCE PERIOD

Maintenance responsibilities for an installation prior to practical completion of repair work shall include maintenance of all individual units, equipment or components thereof, for which no repair work is required (as per the contract document) or for which the repair work has not yet started, and shall commence with access to the installation.

Where access to an installation with a view to commence repair work is delayed, then the maintenance responsibilities which in such cases will consist of keeping the installation in the condition it is in, shall commence immediately at the start of the Contract.

Such maintenance before access is obtained, shall consist for example of fixing leaks without replacing pipework or opening a blocked pipeline without further altering or inspecting such pipes.

The Contractor shall accept full maintenance responsibilities for each completed installation upon issue of a Certificate of Practical Completion for repair work of that installation.

The preliminary construction programme differentiates between commencement of maintenance on various installations.

SA 02.06 PREVENTATIVE MAINTENANCE: DEFINITION

This entails the rendering of services and servicing of equipment according to a predetermined maintenance control plan to:

(a) replace and service components of equipment, units or parts thereof for each installation at prescheduled moments regardless of condition;

(b) readjust, reset, clean, corrosion protect all components of equipment, units or parts thereof for each installation, and

(c) Carry out all implied actions to maintain installations in their present functional condition.

Preventative maintenance shall be aimed at minimisation of breakdowns.

SA 02.07 CORRECTIVE MAINTENANCE: DEFINITION

This entails regular observation of the equipment, identifying pending breakdowns, maladjustment or anomalies of equipment, units or parts of installations and subsequent action to restore installations to the functional condition as before the breakdown.

SA 02.08 BREAKDOWN MAINTENANCE: DEFINITION

This entails repair and/or replacement of defective equipment, units or parts of installations following a breakdown that leaves the installation inoperable or unsafe, and subsequent action to restore installations to their normal functional condition, within the maximum down-time allowed.

SA 02.09 SITE MAINTENANCE RECORD KEEPING

The Contractor shall provide and maintain hard-cover A4 maintenance files for each installation for the duration of the Contract. All schedules, checklists, breakdown reports, preventative maintenance records, component replacement records and quarterly reports shall be filed, together with information regarding repairs exceeding the Contractor's liability, as set out in SA 02.02 and SA 02.03.

Site maintenance records shall be submitted at each monthly meeting.

SA 02.10 SUPPLY OF LABOUR, EQUIPMENT AND MATERIAL

SA 02.10.01 Labour

Competent personnel that have been trained by the Contractor, in accordance with Additional Specification SD: General Training shall execute all maintenance work.

SA 02.10.02 Equipment

All tools and equipment required for maintenance work shall be supplied by the Contractor at his cost (except where otherwise provided).

SA 02.10.03 Material

All material, spare parts, components, equipment and appurtenances necessary for the complete maintenance of each installation shall be supplied and installed by the Contractor at his cost, to a maximum value per part/subassembly as specified in the Special Conditions of Contract for exceeding Contractor's Liability.

Materials as provided for in the Schedule of Quantities, shall be supplied and delivered by the Contractor at the tendered rates upon order of the Engineer only, and shall be free-issued to the User Client for own use. The Contractor shall inform the Engineer of all scheduled deliveries to arrange official hand-over with the User Client.

SA 02.11 IDENTIFICATION OF EQUIPMENT

A unique identification number will be allocated only to each mechanical equipment item forming part of the installation. This identification number will be allocated and administered in collaboration with the User Client and must be described in the maintenance control plan.

Reference shall be made to identification numbers in the maintenance control plan, operating and maintenance manuals and during all maintenance activities, including the logging of breakdowns and other correspondence. Identification numbers shall also be indicated on as-built drawings.

SA 03 MAINTENANCE CONTROL

SA 03.01 SCOPE

Maintenance quality control shall be the responsibility of the Contractor. The Contractor shall introduce a maintenance control plan to assist him in ensuring that preventative, corrective and breakdown maintenance are performed as described in the operating and maintenance manuals and Technical and Particular Specifications.

SA 03.02 PRELIMINARY MAINTENANCE CONTROL PLAN

A preliminary version of the maintenance control plan shall be submitted with the programme and the framework of the preliminary version shall be as close as possible to that of the final maintenance control plan as specified in SA 03.03 below. Detail contained in this preliminary maintenance control plan shall include:

(a) Actual time that a representative of the Contractor will be present on Site for the duration of the maintenance period;

(b) The scope and frequency of routine inspections

(c) Repair methodology

(d) Details of training plan to be implemented in accordance with Additional Specification SD

SA 03.03 MAINTENANCE CONTROL PLAN

(a) The maintenance control plan shall be based on the Contractor's preliminary maintenance control plan, and shall be bound in a neat, A4-sized, ring-bound document with a cover page and back cover. The contents of the document shall be indexed.

In drawing up the document, the Contractor may reproduce relevant paragraphs and clauses from any of the specifications forming past of the Contract documents, but should there be any discrepancies between such clauses and paragraphs in the maintenance control plan and those in the Contract documents, those in the Contract documents shall be regarded as being correct and shall apply.

(b) To ensure that the Engineer is satisfied that the Contractor understands the purpose and advantage of carrying out maintenance work according to a maintenance control plan he shall, as an introduction to the control plan document, set out his views as to what he believes the implementation of a maintenance control plan will achieve.

(c) The maintenance control plan shall also contain the following:

(i) A summary of the repair and maintenance work to be carried out under the Contract giving details of the conditions of the various installations at the facility(ies) affected by the activities under the Contract. The Contractor shall bear in mind that maintenance work may have to be carried out before the repair phase of the installation has been entirely completed and the summary mentioned above shall therefore differentiate between maintenance work before and after the repair phase has been completed.

(ii) Details of how the Contractor intends to carry out the various types of maintenance work especially breakdown maintenance should breakdowns occur.

(iii) Details of how the call centre works, as specified in clause SA 04 as well as all statistics of breakdowns, leakages, blockages, etc. available from the call centre for the installation and the age of the installation that has been taken into account in compiling the contents of the maintenance control plan.

(iv) A list of organisations and persons directly involved with the Contract or whose requirements have to be taken into account during the entire Contract Period such as the Department of Health, the User Client, the Consulting Engineer, the Contractor, the Local Authority, etc. Each person's position within his organisation as well as the applicable phone numbers shall be given.

(v) Details of monthly meetings to be hold with the Department of Health, the User Client, Contractor and Engineer;

(vi) Reports to be submitted after every routine inspection (all reports, checklists, breakdown records, score card results, etc. for each system of an installation shall be kept on the site in a hard cover file);

(vii) Procedures to address complaints and logged breakdowns;

(viii) Details of quarterly reports, summarising all inspections, together with inspection data such as nature of test, names of persons carrying out tests and inspection results. Detail of repairs and replacements, together with testing of repaired equipment shall also be reflected in this report, and

(ix) Assistance to be given by the Engineer with decisions regarding material, equipment and other recommendations.

(d) The codes of practice as set out in ISO 10006 and ISO 9004 for quality systems and management shall be used as a guideline for compiling a maintenance control plan. ISO accreditation is not a requirement in terms of this Contract.

(e) The maintenance control plan shall be upgraded when its contents are no longer representative of actual conditions.

(f) The Contractor shall check the contents of existing Operating and Maintenance Manuals (if available) and shall update or modify and then incorporate applicable data into his own manuals. Where no manuals exist, the Contractor shall draw up his own Operating and Maintenance Manuals.

Pertinent data contained in the Operating and Maintenance Manual may be transferred to the Maintenance control plan to make it a document which can be used as an independent handbook for maintenance work.

The Contractor is referred to the contents of paragraph (a) above regarding the reproduction of data, as this shall also be applicable to data reproduced from Operating and Maintenance Manuals.

SA 04 COMMUNICATION

The maintenance control plan (Clause SA 03) will provide, after agreement between the Contractor and the Engineer, for the following communication and complaint logging procedure:

(a) The Contractor shall establish a telephone and fax line and a cellular telephone connection to ensure that he can be reached at any time.

(b) The Contractor shall primarily be responsible for determining the items requiring preventative, corrective and breakdown maintenance, and shall communicate this information directly to his maintenance workforce.

(c) Should the Engineer or operating personnel of the User Client determine or suspect that preventative, corrective or breakdown maintenance is required, a call shall be logged through the call centre to reach the Contractor as soon as possible.

(d) Reaction times will be as described in Clause SA 05.02.

(e) All complaints of the User Client shall be reported to the Engineer via the call centre, as set out in the maintenance control plan, and the Engineer shall issue instructions to the Contractor. After the Contractor has attended to the complaint, the Engineer will provide feedback to the call centre both telephonically and via fax.

The call centre logs the details of the Engineer’s call and provides feedback to the complainant.

SA 05 PERFORMANCE MEASUREMENT

The Contractor's performance shall be measured against the following parameters:

SA 05.01 SPECIAL TESTING OF AN INSTALLATION

The Engineer may at any time inspect any part of the entire installation. During Maintenance work, the Engineer shall at his discretion order special tests to be carried out on complete installations at intervals of not less than four months, to verify the satisfactory functional condition of the installation.

The Engineer reserves the right to select at random component equipment and trade practices to be tested by independent authorities for compliance with specifications as specified in this Contract document.

The Contractor shall provide all equipment, tools and instruments required for testing.

SA 05.02 MAXIMUM MAINTENANCE DOWN-TIME

After a complaint has been logged and forwarded to the Contractor, the Contractor shall be expected to minimise the maintenance down-time until the system component is fully operational to the satisfaction of the Engineer. Should the Contractor not respond within the maximum down-time, the Engineer may arrange, at the cost of the Contractor, for the necessary repair work to be done by others.

Should the actual down-time exceed the maximum down-time the Contractor shall be liable to a payment reduction for the difference between actual down-time and maximum down-time. This is reflected in the table below:

REQUIRED MAINTENANCE	MAXIMUM DOWN-TIME ALLOWED	PAYMENT REDUCTION IF EXCEEDED
Fatal breakdown (where specified)	2 hours (immediate response)	R2 500/hour
Emergency Breakdown	24 hours	R2 500/day
Ordinary Breakdown	7 days	R500/day
Operational damage repair	7 days	R500/day

"Maximum down-time" shall mean the period of time allowed to repair a breakdown, and "actual down-time" shall mean the measured period from the instant when the breakdown was logged with the Contractor until the installation has been repaired to its functional specification.

"Immediate response repairs" shall imply breakdown maintenance repair work where no breakdowns are allowed at any time in terms of the Technical Specification.

“Fatal” breakdown (immediate response) repairs are:

(a) Fridges and Cold Rooms inoperable.
(b) Security lighting being out of order at night.
(c) Standby generators not operating when required.

"Emergency maintenance repairs" shall imply any breakdown maintenance repair work required to rectify a component or unit of the installation that disables the installation from functioning at its designed maximum requirement in terms of the Technical Specification.

“Emergency” breakdowns are also applicable to the above items where the extent of the breakdown is repaired without normal operation being affected.

Examples are:

(a) U.P.S installations
(b) Security lighting becoming inoperable during day-light hours
(c) Hot Water Repairs
(d) Kitchen equipment becoming inoperable

"Ordinary maintenance repairs" shall imply all breakdown maintenance repair work required other than immediate response or emergency maintenance repairs.

SA 05.03 PERFORMANCE-BASED PAYMENT

Remuneration for all value-related as well as all time-related preliminary and general charges shall be deemed included in the monthly maintenance payments for the various installations.

SA 05.03.01 Score-card

The Engineer shall inspect each installation monthly after Practical Completion of the repair phase of the installation. The Engineer shall use a score-card to measure the quality of preventative and corrective maintenance rendered by the Contractor during the preceding month, on all components that form part of the installation, in accordance with the maintenance specifications. The Engineer will record his inspection directly onto the score-card. The score-card shall serve to evaluate ten performance indicators each month in the manner set out below.

The Contractor shall always have the opportunity to score the maximum points, provided that his preventative and corrective maintenance work comply with the Specifications. The Employer shall be protected against a reduced or unsatisfactory service level and may refuse payment on such points.

SA 05.03.02 Performance indicators

Performance indicators shall be selected to measure the Contractor's service level of preventative and corrective maintenance.

The Contractor and the Engineer shall each have the opportunity to select five (5) performance indicators each month, which shall focus on the measurement of maintenance quality against the relevant specifications for the ensuing month. All ten (1) performance indicators are known to both the Engineer and the Contractor.

The Contractor shall aim to perform satisfactorily on all ten performance indicators. All indicators shall be selected from the scope of his normal preventative and corrective maintenance work and shall be based on the maintenance control plan and operating and maintenance manuals. The work shall either be satisfactory, or unsatisfactory, and the Contractor shall score one (1) or zero (0) respectively per indicator.
Performance indicators shall be used to focus on certain key aspects of the work and shall in no way limit the Contractor's responsibility to do all the required work.

SA 05.03.03 Satisfactory performance

The Engineer shall inspect the site on an arbitrary day to measure the quality of maintenance against the ten selected performance indicators. Should the Contractor score the maximum points (10) he shall receive his full maintenance payment for the installation. Should the quality of preventative maintenance, or components requiring persistent corrective maintenance be unsatisfactory according to the score-card, the Contractor may fail to achieve full payment due to a reduced service level. Each monthly payment for maintenance shall be subject to evaluation based on the score-card.

A copy of the score-card including a guideline for the use thereof is included in this Specification.

SA 06 MEASUREMENT AND PAYMENT

SA.01 **MAINTENANCE OF A COMPLETED INSTALLATION** ..... Unit: point

The unit of measurement shall be a point. Each month shall represent a maximum of ten points and a minimum of zero points, depending on the performance and quality of maintenance. Ten points per month, determined by using the tendered rate per point, shall include full compensation for all liabilities and obligations described or implied in the Contract document and deemed by the Contractor to be applicable to the maintenance phase of the Contract, for the complete monthly maintenance of an entire installation after practical completion of repair work, and all appurtenant works deemed to form part thereof, as defined in the relevant Technical or Particular Specifications.

The combined tendered rate for ten points (which shall not be less than 10% of the total tendered Contract Price) shall also include full compensation for complete preventative, corrective and breakdown maintenance (as defined in this General Maintenance Specification), including full compensation for all costs related to resetting, repair, procurement, supply, delivery, replacement, protecting, furnishing, installing, testing and commissioning of all items and material required to maintain the complete installation in a perfect functional condition. The only items not to be included in the rate for monthly maintenance points are:

1. Supply, delivery, installation and testing of special equipment/materials that will be measured elsewhere, and

2. Special testing of an installation.

Different installations shall be listed in the Schedule of Quantities, in accordance with the definition of each installation.

Although ten points per month shall include full compensation for preventative, corrective and breakdown maintenance, the Contractor might fail to achieve all points applicable in the event of unsatisfactory performance, in which case he shall still perform all maintenance requirements according to specification, but at his own cost where a reduction in points awarded is insufficient to cover his cost.

Remuneration for all value-related as well as all time-related preliminary and general charges shall be deemed included in the monthly maintenance payments for the various installations.

SA.02 **MAINTENANCE OF AN INSTALLATION PRIOR TO PRACTICAL COMPLETION** ..... Unit: point

The unit of measurement shall be a point. Each month shall represent a maximum of ten points and a minimum of zero points, depending on the quality of maintenance. Ten points per month determined by using the tendered rate per point, shall include full compensation for the monthly maintenance of an incomplete installation until practical completion of the repair work thereof.

The combined rate tendered for ten points (which shall not be less than 10% of the total tendered Contract Price) shall include full compensation for preventative, corrective and breakdown maintenance (as defined in this General Maintenance Specification) of all units, equipment and/or components thereof that require no initial repair work in terms of the complete installation. As repair work progresses, maintenance responsibilities shall be extended to include those units, equipment or parts thereof that have been serviced, repaired or reconditioned.

Different installations shall be listed in the Schedule of Quantities, immediately

below maintenance of a completed installation. The total number of points for maintenance of a completed installation plus maintenance of the same installation prior to practical completion shall be 360.

Although ten points per month shall include full compensation for preventative corrective and breakdown maintenance, the Contractor might in the event of unsatisfactory performance fail to achieve all points applicable, in which case he shall still perform all maintenance requirements according to specification, but at his own cost where a reduction in points awarded is insufficient to cover his cost.

SA.03 **ADDITIONAL TESTS:**

SA.03.01 **Where ordered by the Engineer** .....Unit: rand (R)

SA.03.02 **Charge required by the Contractor on subitem SA.03.01 above**.....Unit: %

An amount has been allowed in the Schedule of Quantities to cover the cost of additional tests required by the Engineer. The Engineer will have the sole authority to spend the amount or part thereof under subitem SA.03.01.

The tendered percentage under subitem SA.03.02 will be paid to the Contractor on the value of each payment made to the approved testing authority.

SA.04 **PAYMENT REDUCTION DUE TO EXCEEDING OF MAXIMUM ALLOWABLE DOWN-TIME DURING FATAL BREAKDOWN**.....Unit: hours

The unit of measurement shall be the number of hours during which a component of an installation was in a disfunctional condition and required immediate response repairs.

The negative fixed rate shall include full compensation for the User Client's loss in productivity and, multiplied by the number of hours measured, shall be deducted from the certified amount due to the Contractor.

SA.05 **PAYMENT REDUCTION DUE TO EXCEEDING OF MAXIMUM ALLOWABLE DOWN-TIME DURING EMERGENCY BREAKDOWN** .... Unit: days

The unit of measurement shall be the number of days, in excess of 48 hours, during which a component of an installation was in a disfunctional condition that required emergency repairs.

The negative fixed rate shall include full compensation for the User Client's loss in productivity and, multiplied by the number of days measured, shall be deducted from the certified amount due to the Contractor.

SA.06 **PAYMENT REDUCTION DUE TO EXCEEDING OF MAXIMUM ALLOWABLE DOWN-TIME DURING ORDINARY BREAKDOWN** .....…Unit: days

The unit of measurement shall be the number of days, in excess of 7 days, during which a component of an installation was in a disfunctional condition that required ordinary repairs.

The negative fixed rate shall include full compensation for the User Client's loss in productivity and, multiplied by the number of days measured, shall be deducted from the certified amount due to the Contractor.

SA.07 **PAYMENT REDUCTION DUE TO EXCEEDING OF MAXIMUM ALLOWABLE DOWN-TIME DURING OPERATIONAL DAMAGE BREAKDOWN**..... Unit: days

The unit of measurement shall be the number of days, in excess of 7 days, during which a component of an installation was in a disfunctional condition that required ordinary repairs.

The negative fixed rate shall include full compensation for the Client's loss in productivity and, multiplied by the number of days measured, shall be deducted from the certified amount due to the Contractor.

SA.08 **MAINTENANCE CONTROL PLAN** ..... Unit: each

The unit of measurement shall be the number of A4 documents compiled and supplied for each installation or part thereof, as required under sub-items SA 03.02 and SA 03.03.

MAINTENANCE SCORE-CARD

CONTRACT NUMBER: .....

CONTRACT: .....

CONTRACTOR: .....

ENGINEER: .....

INSTALLATION: | | **MONTH**: | | | OF **36**

The following components of the installation were selected by the contractor at the Monthly Maintenance Meeting nr. | | | as performance indicators to be tested according to specification:

1. CONTRACTOR'S SELECTION	**0**	**1**
1.1		
1.2		
1.3		
1.4		
1.5		
SUBTOTAL:		

The following components of the installation were selected by the Engineer as performance indicators to be tested According to specification:

2. ENGINEER'S SELECTION		
2.1		
2.2		
2.3		
2.4		
2.5		
SUBTOTAL:		

TOTAL SCORE:		

D	D	/	M	M	/	Y	Y

....

Engineer's Representative **Signature** **Date**

GUIDELINE FOR THE USE OF THE MAINTENANCE SCORE-CARD

The score-card and performance indicators must be used as a maintenance management tool. The aim with each score-card is to ensure that:

(a) The project focuses on key aspects of maintenance per month;
(b) The Contractor receives payment for his work, and
(c) The Employer receives value for money and a sustained high level of service.

Performance indicators must be selected to measure the Contractor's service level of preventative and corrective maintenance that will be based on the Maintenance Control Plan and the Operating and Maintenance Manuals (containing information specified in the Contract documentation).

For each specific installation, different performance indicators must be defined each month based on the content of the maintenance in relation to the scope of maintenance work per installation and must be based on the Contractor's service level record on preventative and corrective maintenance.

Breakdowns must be dealt with if and when necessary by logging of the breakdown and monitoring the downtime.

The Contractor and the Engineer must agree on all performance indicators at an occasion prior to the month during which the Contractor's performance (service level of maintenance) will be measured.

DEPARTMENT OF HEALTH: NORTH WEST PROVINCIAL GOVERNMENT

RENOVATIONS OF ICU UNIT AT

JOB SHIMANKANE TABANE HOSPITAL, RUSTENBURG

SB OPERATING AND MAINTENANCE MANUALS

ADDITIONAL SPECIFICATION

SB OPERATING AND MAINTENANCE MANUALS

CONTENTS

SB 01 SCOPE
SB 02 PROCEDURE FOR SUBMISSION OF MANUALS
SB 03 FORMAT OF OPERATING AND MAINTENANCE MANUALS
SB 04 CONTENTS
SB 05 MEASUREMENT AND PAYMENT

SB 01 SCOPE

The Contractor shall be responsible for the compilation of complete sets of Operating and Maintenance Manuals. A separate Operating and Maintenance Manual shall be supplied for each installation where required and as defined in the Additional Specification SA: General Maintenance.

SB 02 PROCEDURE FOR SUBMISSION OF MANUALS

SB 02.01 SUBMISSION OF DRAFT MANUALS

A draft copy of each Operating and Maintenance Manual shall be submitted to the Engineer prior to safety inspection of the installation. Approval of the draft Operating and Maintenance Manuals shall be a prerequisite for commencement of the safety inspection in terms of the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993)

The manuals will be reviewed and checked by the Engineer and returned to the Contractor with comments, where necessary. The Contractor shall make the necessary changes and amendments to the manuals to incorporate the Engineer's comments.

SB 02.02 DEVELOPMENT OF FINAL MANUALS

A final draft copy of each Operating and Maintenance Manual shall be submitted to the Engineer at least one week prior to commencement of Day 1 tests on commissioning. This set of manuals will not be accepted without the Contractor's verification of the information contained in the manuals and the professional language editing thereof. The Engineer shall return the manuals to the Contractor, who shall make the final corrections. The Engineer will, however, not be responsible for the quality control on manuals. Approval of final Operating and Maintenance Manuals shall be a prerequisite for issuing of a Certificate of Practical Completion for repair of the installation.

After the Engineer has approved the final Operating and Maintenance Manuals, the Contractor shall provide the Engineer with seven (7) sets of the manuals. Approval of the final Operating and Maintenance Manuals shall be a prerequisite for issuing of a Certificate of Completion.

SB 03 FORMAT OF OPERATING AND MAINTENANCE MANUALS

(a) Manuals shall be bound in hardcover lever-arch files with plastic coatings. The files shall be clearly labelled on the front cover, as well as on the back band, with the following information:

(i) The title "Operating and Maintenance Manuals"

(ii) Name of the installation (as defined in Additional Specification SA: General Maintenance)

(iii) Name of the contract and contract number

(iv) The Contractor's name, address and contact telephone number and fax (logo optional)

(v) Month and year in which the manuals are finally handed over to the Employer

(vi) Name of the User Client.

(b) Pamphlets and bound leaflets/booklets from suppliers or manufacturers shall be placed in plastic pockets.

(c) Drawings and diagrams larger than A3 shall be folded and placed in plastic pockets to be easily removed or stored.

(d) The sections of the manuals specified below shall be clearly partitioned.

(e) Cross-referencing between drawings/diagrams and text shall be in a clear and consequent format.

(f) The Operating and Maintenance Manuals shall be supplied in English.

SB 04 CONTENTS

SB 04.01 TABLE OF CONTENTS

The table of contents shall appear on the second page and shall consist of the headings of the various sections in the manual and the relevant page numbers.

The table of contents shall essentially contain at least the following:

1. Introduction
   - 1.1 Scope of the manual
   - 1.2 General arrangement of the manual
   - 1.3 Description of installation
   - 1.4 Specifications

2. List of drawings and diagrams

3. Parts and components

4. Operating procedures

5. Maintenance

   5.1 Purpose of maintenance
   5.2 Preventative maintenance
   5.3 Trouble-shooting

6. Breakdown maintenance and repair

7. List of Appendices.

SB 04.02 INTRODUCTION

The introduction shall contain at least the following:

SB 04.02.01 Scope of the manual

A summary shall explain the scope of the contents.

SB 04.02.02 General arrangement of the manual

A brief description shall explain the way in which the manual is arranged.

SB 04.02.03 Description of installation

This section shall give a functional description of the complete installation covered by the manual, including all systems and/or functional units deemed to form part thereof, as defined in Additional Specification SA: General Maintenance.

SB 04.02.04 Specifications

A summary shall be given of the specifications applicable to the particular part of the Contract.

SB 04.03 DRAWINGS AND DIAGRAMS

SB 04.03.01 Mechanical flow diagrams (MFDs) and single line diagrams

Mechanical flow diagrams (for mechanical systems) or single line diagrams (for electrical systems) of the system and/or functional unit shall be included in the Operating and Maintenance Manuals for easy reference by the operators of the installation. Diagrams shall be drawn not only for parts of an installation that have been repaired, but also for the complete installation, including all the components.

SB 04.04 PARTS AND COMPONENTS

SB 04.04.01 Equipment data sheets

A data sheet shall be drawn up for each piece of equipment and/or machine forming part of the installation and shall contain the following information:

(a) Equipment tag number
(b) Equipment description
(c) Model/make/manufacturer
(d) Supplier/Reconditioning details
(e) Ordering details

(f) Details of fixed components
(g) Details of lubrication
(h) Maintenance references (refer to supplier/reconditioning technical manual).

SB 04.04.02 Technical equipment manuals

For each piece of equipment and/or machine forming part of the installation the following information shall be included in this section of the Operating and Maintenance Manuals:

(a) The supplier or reconditioning manual and/or standards of operating and maintenance instructions;

(b) Illustrated parts breakdown and/or group assembly drawings as agreed with the Engineer;

(c) Parts lists and data sheets, including all characteristic curves for machines indicating operation point, efficiency, power consumption, etc;

(d) Calibration charts, and

(e) Test certificates for hydraulic pressure tests, flame-proof grading, materials, non-destructive examinations, coating and lining details, etc.

Each detailed description shall be accompanied by a set of engineering drawings. From the drawings the functionality of each part or component used, as well as the special characteristics associated with the part or component shall be very clear.

SB 04.04.03 Parts and components list

A detailed description shall specify all the parts and components used for the duration of the Contract. This description shall include new parts and components, as well as existing parts and components that have either been reconditioned or used as specified in the Contract.

The description shall state at least the part or component number, part or component name, the size of the part or component, an explanatory description, the quantity used, the material of which the part or component is made, the coating (if any), date of purchase, as well as any relevant remarks as to the application thereof.

Details of the manufacturer of the part or component shall also be listed. This shall at least state the name, address, telephone number, fax number and name of a contact person.

The supplier of the part or component shall also be stated and shall include at least the name, address, telephone number, fax number, name of a contact person and an alternative supplier (if available).

SB 04.04.04 Drawings

Drawings shall contain a descriptive heading, an explanatory key and relevant comments. Drawings shall be done on a computer-aided design package approved by the Engineer.

A compound drawing for all subassemblies shall clearly indicate how and where the various parts fit in the subassembly. The compound drawing shall be linked to the equipment data sheets and parts and components list and shall clearly specify the parts or components used, their model numbers, their sizes and the quantities used. The compound drawings shall also be accompanied by a short description explaining the workings of the subassembly, as well as the assembly of the parts or components to complete the subassembly.

SB 04.05 OPERATING PROCEDURES

The operating instructions shall be a step by step description of the manual start-up and shut-down procedure for every piece of equipment and/or process reconditioned, repaired or supplied with references to the MFDs. For automatic operation the operators shall be referred to the automatic control manual (if applicable).

The functioning of the installation shall be clearly described, using a flow diagram depicting the interrelationships among the various subassemblies. The subassemblies shall be described by descriptive drawings.

Each mechanical or process flow diagram shall contain at least a heading, relevant comments and a key.

Every subassembly shall also have its own flow diagram explaining the operation of the subassembly, as well as the application of each part and component. The application of the subassembly shall also be very clear. The flow diagram shall consist of at least a heading, relevant comments and an explanatory key.

A detailed description shall be given of all operational systems forming part of the installation, explaining the operation and functioning of the system and the number of operations personnel required for performing the operation successfully.

The preparations, which are required before the system can be operational, shall be clearly stated and explained.

The operation tasks shall be clearly explained with reference to dangerous situations that might occur. Hazardous operations shall be explained in great detail and cover all the applicable safety precautions.

SB 04.06 MAINTENANCE

SB 04.06.01 Purpose of maintenance

The maintenance process shall be explained and the main responsibilities described.

SB 04.06.02 Preventative maintenance

A preventative maintenance and lubrication schedule shall be included in this section. This schedule shall be in table format and shall include a summary of all the maintenance actions required for each different system and/or functional unit covered by this manual, in order to give a single summary of all routine preventative maintenance actions required for the complete installation.

The schedule shall indicate daily, weekly, fortnightly, monthly and yearly maintenance actions. A lubrication schedule summary shall also be included under this section.

The frequency of routine preventative maintenance actions shall be indicated very clearly.

The Contractor shall provide the maintenance requirements as prescribed by the manufacturer. The type of maintenance shall be clearly indicated. The description of the maintenance to be performed shall include at least the part name, location of the part in either the assembly or subassembly, the model number, the quantity of the particular part or component to be maintained, the type of maintenance, and notes on the maintenance procedure.

A brief description shall accompany the maintenance schedule, indicating special tools to be used, maintenance and test equipment required for the test procedures. Any special tools necessary for maintenance shall be specified in terms of name, model, size, manufacturer, supplier (name, telephone number, fax number, contact person), coating (if any) and notes on the use of the equipment.

Remarks on the system readiness checks of each subassembly shall be explained in detail. Routine inspection and maintenance processes shall be described. It shall be very clear what needs to be done, how to perform the necessary task and any dangers that are present.

SB 04.06.03 Trouble-shooting

An explanation shall be given to assist the maintenance personnel in analysing and resolving malfunctions that might occur. Various scenarios with possible causes and rectification procedures shall be explained.

The scenarios shall be accompanied by drawings indicating the position of the part that is faulty. Each of these drawings shall have a heading, comments and an explanatory key.

SB 04.07 BREAKDOWN MAINTENANCE AND REPAIR

The Contractor shall describe the complete procedure to be followed in the event of a breakdown. It shall be very clear what the operating personnel should look for, how to eliminate any dangers due to the breakdown (eg electricity must be shut off in the event of problems with the wiring) and who should be contacted. The Contractor shall supply the names and telephone numbers of at least two contact persons who may be contacted in the event of a breakdown.

The Contractor shall refer to Additional Specification SA: General Maintenance, to determine the reaction time for the repair to the breakdown.

Repair instructions shall provide the maintenance personnel with detailed instructions for the removal and/or replacement of any item requiring replacement due to malfunctioning. Contact numbers shall also be given to assist maintenance personnel, should a breakdown occur.

The Contractor shall specify the actions expected of maintenance personnel in the event of a breakdown.

The Contractor shall also specify the testing procedures to be followed before the system can be put into operation again. Every procedure shall be

described clearly and all the potential dangers pointed out, as well as the precautions that have to be taken.

The testing procedures shall be accompanied by drawings illustrating the process to be performed. Every drawing shall have a heading, comments and an explanatory key.

SB 05 MEASUREMENT AND PAYMENT

SB.01 **Compile and supply a complete set of Operating and Maintenance Manuals** .....Unit : each

The unit of measurement shall be a sum for each complete set (seven copies) of Operating and Maintenance Manuals. Operating and Maintenance Manuals for different installations shall be measured separately in the Schedule of Quantities.

The tendered sum shall include full compensation for all technical research, gathering of information, compilation of manufacturer's instructions, compilation of drawings and diagrams, and for writing of all the descriptions, instructions and functional procedures, as well as language editing, in order to provide a clear and correct set of Operating and Maintenance Manuals.

The tendered sum shall also include full compensation for all expenses such as paper, copy work, binding and printing necessary for the completion of the manuals.

The tendered sum shall also include full compensation for the compilation of draft sets of operating and maintenance manuals in accordance with the specification, and for incorporation of all comments and corrective requirements.

SB.02 **Compile and supply a complete key plan** .....Unit : each

The unit of measurement shall be a sum for each complete set (three A0-size copies) of the key plan(s).

The tendered sum shall include full compensation for all expenses such as paper, copy work and printing required for the completion of the key plan.

The key plan shall include and comply with the following:

(a) Detail ground survey

All services must be shown on a complete key plan as required by the Engineer, including roads, fences, paving, transmission and telephone lines, etc. For sewerage reticulation and stormwater drainage systems the pipe sizes, as well as invert heights must be provided. An effort must be made to trace the routes of these services.

(b) Survey of buildings

The "footprint" of all the buildings and structures must be surveyed.

(c) General

All survey data shall be captured in electronic format (DXF).Seven copies of such information shall be provided on compact disk (cd).

DEPARTMENT OF HEALTH: NORTH WEST PROVINCIAL GOVERNMENT

RENOVATIONS AND ADDITIONS OF ICU UNIT AT JOB SHIMANKANE TABANE HOSPITAL, RUSTENBURG

SC GENERAL DECOMMISSIONING, TESTING AND COMMISSIONING PROCEDURES

ADDITIONAL SPECIFICATION

SC GENERAL DECOMMISSIONING, TESTING AND COMMISSIONING PROCEDURES

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SC 03	DETAILED COMMISSIONING PROGRAMME
SC 04	COMMISSIONING COMMUNICATION CHANNELS
SC 05	COMMISSIONING RISK CONTROL AND PENALTIES
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SC 11	RECOMMISSIONING, COMMISSIONING AND COMPLETION OF INSTALLATIONS
SC 12	MEASUREMENT AND PAYMENT

SC 01 SCOPE

This specification encompasses all aspects of the repairs of systems and services that form part of an installation, including the factory and on-site testing, decommissioning, installation and commissioning of all equipment, instrumentation and materials reconditioned, supplied and installed as part of an installation as defined in Additional Specification SA: General Maintenance.

The specified procedures are the minimum requirements to be supplemented by various technical and particular specifications in this document. These requirements shall apply to all commissioning work scheduled as part of the initial repair work on installations, as well as commissioning work that is part of the routine preventive and corrective maintenance.

SC 02 PHASED REPAIRS AND UPGRADING OF THE INSTALLATION

When an installation consists of parallel systems or components, the complete installation and all its components shall be repaired without taking the complete installation out of commission at any time, unless otherwise specified in the Technical Specifications.

In order to schedule the repairs of an installation, all work shall be done in phases as specified in the Technical Specifications and illustrated in detail on the drawings. Repairs of each part shall terminate with the successful reconditioning of that part.
Each part of the system shall be decommissioned and recommissioned in the sequence specified in the Technical Specifications and on the drawings.

The Contractor shall install all the necessary temporary specials, spool pieces, supporting frames and brackets to provide a functional link between each repaired and upgraded part of the system and the part of the installation that has not yet been repaired and upgraded during recommissioning. Electrical and instrumentation Contractors and subcontractors shall ensure that the system remains operational as specified, using either existing or newly installed instruments, cables and controls.

Payment is based on the successful recommissioning of a specific part of the installation.

SC 03 DETAILED COMMISSIONING PROGRAMME

No work of any kind on any part of the existing installation shall take place prior to the Engineer's approval of a detailed commissioning programme. This programme shall be submitted in addition to the general programme for planning and monitoring contract progress, at least two weeks prior to any programmed shutdown. The programme shall be the coordinated product of the Engineer and the User Client. Commissioning programmes shall take all process requirements into account. The detailed commissioning programme shall indicate all actions necessary for:

(a) Decommissioning

(b) Recommissioning of parts of the installation

(c) Commissioning of the installation as a whole.

All work deemed necessary for practical completion of the installation shall be indicated on the commissioning programme.

The programme shall indicate the milestones to be achieved before shutdown and decommissioning as activities of zero duration, all of which shall be prerequisites linked to the "start" of decommissioning.

The following specific actions shall be included in the programme, clearly indicating the time allowed for:

(a) Communication, including the time for confirmation of the official shutdown;

(b) Draining parts of the installation to sumps, where available, or to other storage facilities provided by the Contractor;

(c) Installation of temporary blanked flanges or other means of isolation where necessary;

(d) Partial decommissioning and removal of existing material and equipment to perform work, including protection of pipework against hot work, cutting into pipework, loosening bolts, flanges and all other work necessary for recommissioning;

(e) Installation of temporary functional links (pipe specials) between any two parts of the installation;

(f) Each individual field weld, subject to the Engineer's approval;

(g) Non-destructive testing of materials, for manufacturing/construction quality and for producing test results;

(h) Installation of all instruments and their connection to SCADA systems;

(i) Installation and connection of all power cables;

(j) De-aeration of all pipe sections;

(k) Communication between the Contractor, the Engineer, the Employer and the User Client;

(l) Start-up of the complete system, indicating start-up procedures.

Inspection of the prefabricated installation, testing of all equipment prior to final commissioning, pressure testing and non-destructive testing shall be clearly scheduled in the project progress programme.

Day 30 tests and instruction/training sessions with the User Client shall be scheduled in the project progress programme.

SC 04 COMMISSIONING COMMUNICATION CHANNELS

The Contractor shall communicate with the User Client's operating and maintenance managers via the Engineer to finalise start-up after decommissioning in accordance with the specified procedures.

The following key parties shall be involved before and during shutdown and decommissioning of any part of the system:

Contractor:	Site Agent
Engineer:	Resident Engineer
Employer:	Representative of Area Manager
User Client:	Operating and Maintenance Manager.

SC 05 COMMISSIONING RISK CONTROL AND PENALTIES

(a) The safety instructions stipulated by the Occupational Health and Safety Act, 1993 (Act 85 of 1993) shall be adhered to at all times.

(b) The Contractor shall not be allowed to work on any part of the installation without obtaining a commissioning check permit on the day of shutdown. A typical example of a commissioning check permit is included in this document, referring to the minimum required milestones to be achieved prior to decommissioning.

(c) Payment reductions for exceeding the maximum permissible down-time during maintenance shall apply as stipulated in the General and special Conditions of Contract. This stipulation does not include shutdowns during programmed routine preventive maintenance work.

SC 06 DELAYS OF SCHEDULED SHUTDOWNS

Specific dates on which an installation shall be shut down for decommissioning shall be finalised during coordination meetings of all the parties involved, including the Engineer, the Employer, the User Client and the Contractor.

Although a date for each shutdown will be scheduled at the coordination meetings, the actual date of the shutdown shall be determined by the process requirements and user demands, allowing for a window of seven (7) calendar days from the date of the planned shutdown.

Prospective tenderers shall make allowances in their tendered rates for the shutdown to occur at any time during this seven-day period. No additional payment shall be due if the shutdown occurs within this seven-day period.

If the Contractor fails to commence with the shutdown and decommissioning of the installation within the scheduled period, all additional costs arising from the shutdown at a later stage shall be for the Contractor's account.

SC 07 MATERIAL AND EQUIPMENT PROCUREMENT AND PROTECTION

It is the responsibility of the Contractor to ensure the functionality of all units of new equipment prior to decommissioning, before installation of any specific part of the system. If the equipment, whether free-issued or not, does not conform to the functionality specifications during pre-installation testing, the Contractor shall notify the Engineer in writing without delay.

SC 08 TESTING OF EQUIPMENT PRIOR TO RECOMMISSIONING

The equipment shall be tested for functionality after pre-installation of equipment in parts of the installation.

(a) The Contractor shall inform the Engineer well in advance of his intention to perform the first tests and start-up of equipment in order to allow a representative of the Engineer to witness the tests. The extent of all precommissioning tests and checks shall be agreed with the Engineer prior to commencement.

(b) The Contractor shall first conduct his own tests of the equipment. When he is satisfied that the equipment complies with the specifications, he shall notify the Engineer that he is ready for the official tests on completion. The Contractor shall not conduct an official test without the Engineer's presence or approval. All equipment shall conform to the specified requirements.

(c) Before starting up any part of the installation or filling the tanks and sumps with liquid, the Contractor shall clean out the tanks, pipes, fittings, equipment or structures and, if necessary, make arrangements with other Contractors to remove their building rubble form the structures, check that all safety devices and alarms have been set and activated, all nuts have been tightened correctly, that all the equipment is complete and ready for start-up, that the plant has been installed correctly, and that copies of the operating manuals have been handed to the Engineer.

(d) The Contractor shall start up each section of equipment after ensuring that oil fillings, lubrication, vibration monitoring, cable termination and so on have been correctly completed. He is also responsible for the first

refilling of all lubricating oils and for adjusting the plant to operate according to the specifications. Before any equipment is started or energised, the Contractor shall ensure that it is safe in terms of the personnel and equipment on the site to do so. The Contractor's tendered rates and sums shall allow for these costs.

All equipment shall be tested according to the relevant specifications that form part of this document.

No shutdown or decommissioning of any part of the system shall take place unless all the equipment to be installed have been tested by the Contractor and approved by the Engineer.

SC 09 TESTING OF MATERIAL AND EQUIPMENT SPECIFICATIONS AND WORKMANSHIP

All results of the required non-destructive, precommissioning and manufacturing testing shall be submitted to the Engineer well in advance of testing the equipment on recommissioning. All such test results shall be submitted before Day 1 commissioning tests and no certificate of practical completion shall be issued prior to receipt of the required test results.

SC 10 DECOMMISSIONING

The decommissioning period shall commence on the instant of the entire system shutdown. The recommissioning period shall start in parallel with decommissioning.

Shutdown and decommissioning shall not proceed without compliance with all the milestones in the detailed commissioning programme. The list of milestones in this document is not complete but indicates the minimum requirements. Milestones to be achieved prior to shutdown and decommissioning may be added to the programme at the Engineer's discretion.

The Contractor is responsible for the safe decommissioning of all material, equipment, components and instrumentation to avoid damage to parts or components of the installation.

SC 11 RECOMMISSIONING, COMMISSIONING AND COMPLETION OF INSTALLATIONS

SC 11.01 RECOMMISSIONING

Recommissioning means the commissioning of all sections or systems that form part of the installation to meet the required functional specifications for the individual section or system prior to commissioning of the repaired and upgraded installation.

The Contractor is responsible for the recommissioning of all parts of the system and he shall perform the tasks listed below.

(a) Prior notice shall be given to and proper arrangements shall be made for recommissioning with the Employer, the Engineer, the User Client and the suppliers of equipment that is affected by recommissioning and testing.

(b) If plant and equipment supplied by others are to be commissioned, the supplier's specific permission together with all requirements related to commissioning shall be obtained prior to recommissioning without in any way altering the Special Conditions of Contract with reference to the Contractor's liability in terms of defects.

(c) The new and reconditioned parts of the installation shall be thoroughly inspected by a responsible representative of the Contractor to ensure that manufacture/construction and installation work have been completed according to the specifications.

SC 11.02 **COMMISSIONING AND COMPLETION OF REPAIRS AND UPGRADING WORK**

Commissioning means commissioning of the repaired and upgraded installation as a whole to perform in perfect working order.

(a) The commissioning period for each installation as a whole:

(i) Commences with the Day 1 tests of the complete repaired and upgraded installation;

(ii) Includes commissioning of all sections and systems that have been recommissioned prior to the Day 1 tests;

(iii) Includes training of the User Client's operating personnel and the maintenance teams;

(iv) Terminates with a Day 30 test in compliance with the commissioning report.

(b) The purpose of the Day 1 tests is to ensure that:

(i) The electronic, electrical and mechanical equipment and materials are functional and in perfect working order with respect to each other and the installation as a whole;

(ii) The commissioning period, including training, commences on successful completion of the Day 1 tests;

(iii) The Contractor is entitled to a certificate of practical completion for the repairs and upgrading of the installation on successful completion of the Day 1 tests;

(iv) The Contractor becomes responsible for maintenance of the installation and is entitled to performance-based payments in compliance with the Special Conditions of Contract and Additional Specification SA: General Maintenance.

(c) Commissioning shall be undertaken over a trouble-free period up to Day 30. During this period the Contractor shall train the User Client's operators and his maintenance team for operating and maintaining the installation. This training shall allow for all possible operational conditions, including emergency conditions, the correct servicing of every part, the type of oil or grease to be used, and similar tasks. The training shall take place by means of demonstrations, and the operating and maintenance manuals shall be referred to for this purpose.

(d) Day 30 commissioning tests shall be performed thirty calendar days after the successful completion of the Day 1 tests. The commissioning period

of the installation terminates upon the successful completion of the Day 30 tests.

(e) The Contractor shall conduct all the tests required to satisfy the Engineer that the installation is performing according to specification, and shall make allowance for these tests in his tendered rates and prices. These tests shall be conducted to certify that the installation, as repaired, upgraded and installed, is in perfect working order in terms of the specified functional requirements. The Contractor shall note that all equipment is to be tested as part of an installation, where appropriate, and will not be passed if all protection devices, interlocking with other equipment, etc, are not fully functional.

(f) The Engineer shall provide commissioning sheets to the Contractor at least three weeks before the commissioning period commences, for all the equipment supplied, reconditioned and installed by the Contractor. The Contractor shall complete the commissioning sheets during the commissioning period and all items listed shall be entered. No completion certificate will be issued for an installation of which the equipment has incomplete commissioning reports. Information that is not available or applicable, or instances where certain tests have not been carried out, are subject to the Engineer's decision.

(g) Commissioning of the plant (which includes the thirty days between the Day 1 and Day 30 tests) includes operating under conditions that adequately prove that all the specifications have been met. All safety devices, standby plant, automatic controls and protection devices shall be adequately tested for reliability and correct functioning. The Contractor may be called upon to repeat testing during the maintenance period if the performance of the equipment is suspected to be substandard. Costs related to such tests shall be for the Contractor's account and shall comply with the specified requirements. Copies of updated commissioning reports shall be provided to the Engineer within two days after a test has been performed.

(h) The Contractor is responsible for providing all labour and materials (including testing equipment) during the commissioning period and shall carry out all the servicing and adjustments to ensure that the installation operates as specified. Valid calibration certificates shall be available for all testing equipment on the site during the commissioning period.

(i) Programmes for the Day 1 tests, Day 30 tests and instruction/training sessions with the User Client's operators and maintenance team shall be prepared by the Contractor and submitted to the Engineer at least two weeks before the commissioning period commences. The Contractor shall provide weekly updates of these schedules for the duration of the commissioning period.

(j) The Contractor shall note that if any equipment fails during the commissioning period, the equipment shall be repaired or replaced by the Contractor, and testing and commissioning shall commence from scratch.

(k) Successful commissioning of an installation entitles the Contractor to a certificate of completion for the installation.

SC 12 MEASUREMENT AND PAYMENT

SC.01 **Decommissioning and removing parts of the installation** .....Unit: sum

The unit of measurement shall be a sum.

The tendered sum shall include full compensation for all actions and labour required for shutdown and decommissioning of the entire installation as specified to enable decommissioning and removal of parts of the installation as listed in the Schedule of Quantities.

The tendered sum shall include full compensation for the decommissioning and removal of the parts and components of an installation as listed individually in the Schedule of Quantities, including actions and/or costs resulting from such work, to enable the recommissioning of parts of the repaired and/or upgraded installation.

The tendered sum shall include full compensation for final dismantling of decommissioned materials and equipment and the removal of all such items to stores on site, as directed by the Engineer.

SC.02 **Commissioning and testing of parts of the installation** .....Unit: sum

The unit of measurement shall be a sum.

The tendered sum shall include full compensation for commissioning and testing parts of the installation to be operational while still incomplete in relation to the entire repaired and/or upgraded system or installation.

Separate payment items shall be scheduled for separate parts of the system.

SC.03 **Commissioning and testing of the installation** .....Unit: sum

The unit of measurement shall be a sum.

The tendered sum shall include full compensation for commissioning the upgraded installation as a whole and for all costs and expenses related to labour, removal, repair, reinstallation and testing of material and equipment during the commissioning period for each part of the installation. The tendered sum shall include full compensation for the final commissioning and testing, including Day 1 and Day 30 tests, of all parts and components of the installation to the specified functional condition.

Payment shall be based on successful completion of the Day 30 tests.

SC.04 **Provision for safety and hot work requirements during shutdown** ..... Unit: number

The unit of measurement shall be the number of shutdowns during which all the required safety and hot work requirements are provided.

The tendered rates shall include full compensation for all the required safety and hot work requirements and arrangements in accordance with the specifications during a shutdown period, including all labour, personnel, equipment, materials and consumables required.

DEPARTMENT OF HEALTH: NORTHWEST PROVINCIAL GOVERNMENT

RENOVATIONS AND ADDITIONS OF ICU UNIT AT JOB SHIMANKANE TABANE HOSPITAL, RUSTENBURG

SD GENERAL TRAINING

ADDITIONAL SPECIFICATION

SD GENERAL TRAINING

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SD 01 SCOPE

The Contractor shall be responsible for providing diverse training to various groups, including operating and maintenance personnel. The Contractor shall develop and facilitate initial training sessions for all parties, as well as training sessions at specified intervals to revive and supplement the initial training. An accredited trainer shall present all training sessions.

This specification includes all requirements for methods to be employed, the syllabus required by the User Client, the syllabus required for maintenance managers and workers and the method of measurement and payment.

SD 02 BASIC METHOD REQUIREMENT

The Contractor shall be responsible for conducting a complete investigation of the groups that have to be trained in order to compile a proper training plan.

The investigation shall cover at least the following aspects:

(a) Assess likelihood of conformance to task-specific requirements *(status quo)* of capabilities.

(b) Identify minimum pre-qualification criteria in terms of existing knowledge and skill levels in relation to reaching target requirements.

(c) Evaluate personnel in terms of pre-qualification criteria and tasks to be performed (skills profile).

(d) Identify training needs.

(e) Develop appropriate and accredited training courses and material in terms of task-specific activities and identified training needs, and compile the training syllabus per installation.

The Contractor shall identify an accredited trainer to assist in the above investigation and finalise the compilation of a training plan and syllabus. Approval of the syllabus shall be a condition for issue of a Certificate of Practical Completion for repair of an installation. Once the training plan and syllabus have been approved the Contractor shall liaise with the Engineer to establish a date and appropriate training venue that would be conductive to learning to perform training.

The training shall be revived within one month after initial training to determine its effectiveness. Further regular training sessions shall be scheduled according to the effectiveness of initial training.

The Engineer will be responsible for recording all training sessions and shall keep an attendance register. The Engineer will also examine the trainees officially with each training session and issue certificates of trainees' acquired skills on satisfactory completion of the training.

SD 03 TRAINING OF USER CLIENT PERSONNEL

The Contractor's training shall include training of the User Client's operators on biannual basis to acquaint them with operating of installations (especially electrical and mechanical systems). The training sessions shall comprise lectures and on-site (hands-on) demonstrations, and shall be conducted over two-day periods. The Contractor shall liaise with the Engineer to prepare for the correct number of trainee operators.

The content of training courses for operators shall include the essential features of operating the installation, as also described in the Operating and Maintenance Manuals.

Completion of an installation shall, in terms of the Special Conditions of Contract, be subject to successful completion of training. The training course shall also be based on the Operating and Maintenance Manuals. No training shall commence without the Engineer's approval of the final draft Operating and Maintenance Manual for the particular installation.

SD 04 TRAINING OF MAINTENANCE PERSONNEL

The Contractor shall train either his own employees, or local labourers, with regard to maintenance of the installation.

The training of maintenance managers shall include the following aspects:

(a) Awareness of safety, health and personal hygiene in terms of the requirements of the Occupational Health and Safety Act, 1993 (Act 85 of 1993);

(b) functioning of the installation, including all its systems, services, parts of buildings and infrastructure;

(c) all specific tasks related to routine preventative maintenance;

(d) interpretation and understanding of Operating and Maintenance Manuals with specific reference to requirements in cases of corrective and breakdown maintenance, and

(e) repair/reconditioning and installation/construction of equipment and materials forming part of an installation.

SD 05 MEASUREMENT AND PAYMENT

SD.01 **Development of a syllabus for training of operators** ..... Unit: sum

The unit of measurement shall be the lump sum for the compilation of a training syllabus for each installation that shall be measured separately in the Schedule of Quantities.

The tendered sum shall include full compensation for identification of pre-qualification criteria and training needs, staff assessment and evaluation prior to training, all technical research, development and compilation of an accredited training course and course material, and all other actions necessary for commencement of official training sessions in accordance with the specification.

The tendered sum shall also include full compensation for the compilation of a draft syllabus and for incorporation of all the Engineer's comments and corrective requirements.

SD.02 **Presenting a training course for operators**..... Unit: number

The unit of measurement shall be the number of training courses presented based on the approved syllabus.

The tendered rate shall include full compensation for presenting a two-day training course, including lectures, demonstrations, on-site training and hands-on development and improvement of operators' skills to enable the operators to operate installations safely and efficiently.

The tendered rate shall include full compensation for the Contractor's time, appointment of the accredited trainer for the course, and for all material expenses such as paper hand-outs and slides for the whole group of trainees, the number of which shall be determined during development of the training course.

SD.03 **Presenting a training course for maintenance personnel**..... Unit: number

The unit of measurement shall be the number of training courses presented.

The tendered rate shall include full compensation for presenting a two-day training course, including lectures, demonstrations, on-site training and hands-on development, and improvement of maintenance personnel's skills to enable them to maintain and repair installations safely and efficiently at the satisfactory functional condition specified.

The tendered rate shall include full compensation for the Contractor's time, appointment of the accredited trainer for the course, and for all material expenses such as paper hand-outs and slides for the whole group of trainees, the number of which shall be determined during development of the training course.